

1993

Econoline, F-150,
F-250, F-350, Bronco,
F-Super Duty

Powertrain/Drivetrain Service Manual



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**INDEX/IMPORTANT
INFORMATION**

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INTRODUCTION

Important Safety Notice

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This Service Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each.

Accordingly, anyone who departs from the instructions provided in this manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

Notes, Cautions, and Warnings

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transaxle, set it in PARK unless instructed otherwise for a specific operation. If you have a manual transaxle, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific operation. Place wood blocks (4" x 4" or larger) against the front and rear surfaces of the tires to provide further restraint from inadvertent vehicle movement.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on a vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle.
- If it is necessary to work under the hood, keep hands and other objects clear of the radiator fan blades! The electric cooling fans can start to operate any time by an increase in underhood temperature, but only when the ignition switch is in the RUN position. For this reason care should be taken to ensure that the electric cooling fan motor is completely disconnected when working under the hood when engine is not running.

HOW TO USE THIS MANUAL

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Subjects Covered in This Manual

This 1993 Service Manual covers normal service repairs and maintenance for vehicles sold in the United States and Canada.

A separate publication, the 1993 Powertrain Control/Emissions Diagnosis Manual covers:

- Engine Controls and Diagnosis
- Transmission/Transaxle Controls and Diagnosis
- Emissions Diagnosis

How This Manual is Organized

This manual is organized by Group, Section, and Page.

Group

A Group covers a specific portion of the vehicle. The first set of numbers on each page indicate the Group.

				GROUP NUMBER		01-00-1
				GROUP		
				BODY		01
SECTION TITLE		PAGE	SECTION TITLE		PAGE	
BODY, GENERAL SERVICE.....		01-00-1	HANDLES, LOCKS, LATCHES AND			
FRONT END BODY PANELS			MECHANISMS.....		01-14-1	
AND STRUCTURE.....		01-02-1	FRONT WINDOW WIPERS.....		01-16A-1	

NOTE: A Group usually contains more than one Section.

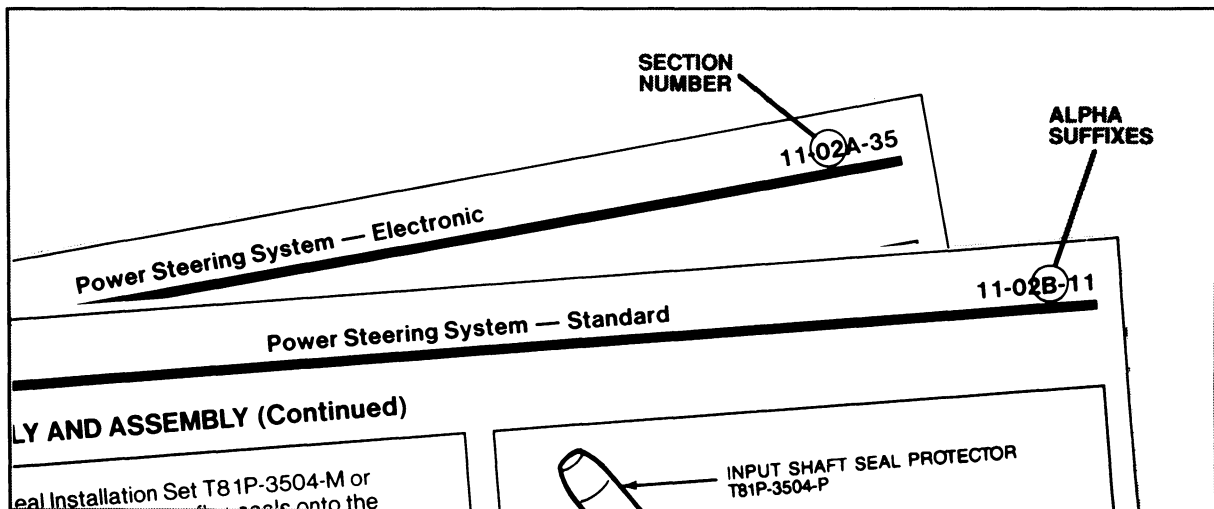
The eighteen Groups found in this manual are:

- 00 – General Service Information
- 01 – Body
- 02 – Frame and Mounting
- 03 – Engine
- 04 – Suspension
- 05 – Driveline
- 06 – Brake System
- 07 – Transmission (rear-wheel drive) or Transaxle (front-wheel drive)
- 08 – Clutch System
- 09 – Exhaust System
- 10 – Fuel System
- 11 – Steering System
- 12 – Climate Control System
- 13 – Instrumentation and Warning Systems
- 14 – Battery and Charging System
- 15 – Audio Systems
- 17 – Lighting
- 18 – Electrical Distribution

Section

Each Section covers a component or system. The second set of numbers on each page indicate the Section.

If the vehicle has more than one type of component, such as two types of engines or power steering systems, alpha suffixes are used.

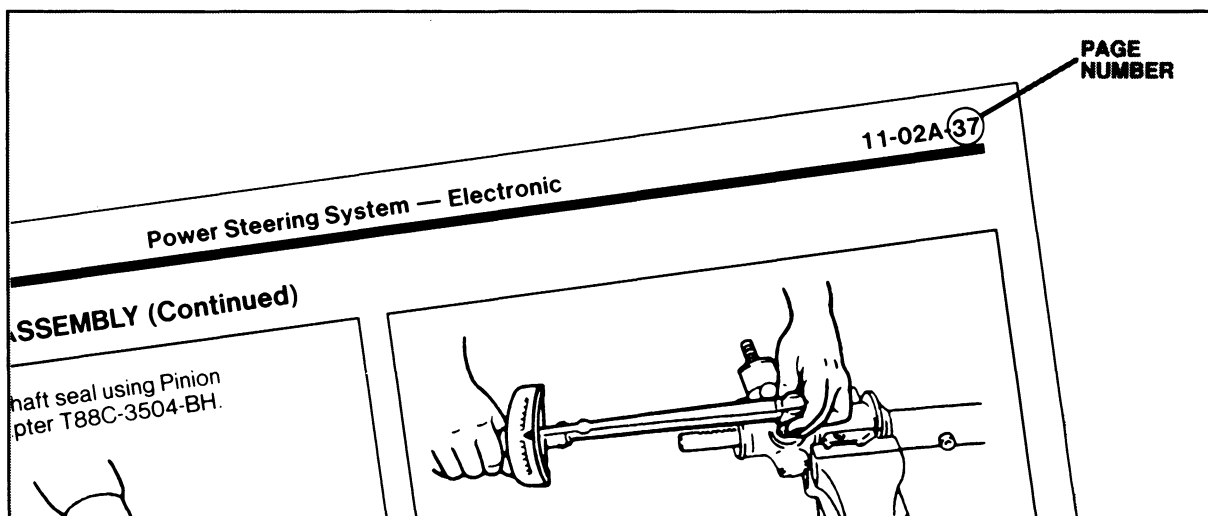


To assist in locating a subject, whenever feasible, Section titles have the subject first, followed by a descriptive word(s).

- Mirrors – Rearview
- Mirrors – Power

Page

The third set of numbers indicate the Page in each Section.



How to Find Material in This Manual

1. Locate the Group number in the Table of Contents. **If you are not sure which Section contains the information you need, look up the component/system in the alphabetical index located in the back of this manual.**
2. Locate the Section number by using the Group index located at the beginning of each Group.
3. Locate the specific Page by using the Section index at the beginning of each Section.

How to Use Each Section

Each Section has a standard organization that consists of the following information:

Vehicle Application

Identifies the product (vehicle, model, engine, transmission, etc.) that the section applies to:

- Probe GT
- Aerostar and Ranger with integral carrier and 7.5 ring gear

Description and Operation

Describes how the component or system works.

Diagnosis and Testing

Identifies how to pinpoint problems.

Removal and Installation

Describes how to remove and reinstall components and systems.

Disassembly and Assembly

Lists how to take apart the component/system, and put it back together.

Adjustments

Describes how to perform in-vehicle adjustments.

Specifications

Summarizes all the specifications used in the Section.

Special Service Tools/Equipment

Lists all the Special Service Tools and Rotunda Equipment used in the Section.

Additional headings such as General Service Procedures and Cleaning and Inspection may be used.

What's New in This Manual

You will notice that changes have been made to some of the standard terminology that was found in past Service Manuals. Changes in state or federal law have mandated terminology changes. Please refer to the J1930 Terminology List that is located in the back of this manual.

One additional feature found in this manual is the footer located at the bottom of each page. This footer denotes the vehicle model year, carline, and Service Manual print date. If a page is accidentally separated from the manual, the footer will help you determine its proper location.

What to Do if You Discover an Error

If you discover a questionable procedure or if you have any suggestions for improving this manual, please use one of the feedback forms provided in the front and back of this manual. Your feedback is very important to improving Ford technical publications. You will get a response to your concern. If necessary, a revision will be issued.

NOTE: The descriptions and specifications contained in this manual were in effect at the time this manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design without notice and without incurring any obligation.

GROUP

GENERAL INFORMATION 00

SECTION TITLE	PAGE	SECTION TITLE	PAGE
IDENTIFICATION CODES	00-01-1	MAINTENANCE AND LUBRICATION	00-03-1

SECTION 00-01 Identification Codes

SUBJECT	PAGE	SUBJECT	PAGE
GENERAL INFORMATION		GENERAL INFORMATION (Cont'd.)	
Built Date Stamp Locations	00-01-5	Vehicle Safety Compliance Certification Label	00-01-1
Vehicle Data	00-01-5	VEHICLE APPLICATION	00-01-1
Vehicle Identification Number (VIN)	00-01-4		

VEHICLE APPLICATION

E-150-250-350, F-150-250-350, F-Super Duty Series and Bronco Vehicles

GENERAL INFORMATION

Vehicle Safety Compliance Certification Label

The English Safety Compliance Certification Label is attached to the drivers door lock pillar. The French Safety Compliance Certification Label is attached to the door latch edge on the passenger's side door. The label contains the name of the manufacturer, the month and year of manufacture, the certification statement, and the Vehicle Identification Number. The label also contains gross vehicle weight ratings, wheel and tire data, and information codes for additional vehicle data.

GENERAL INFORMATION (Continued)

SAFETY COMPLIANCE CERTIFICATION LABELS
COMPLETE VEHICLES

(UNITED STATES)

MFD. BY FORD MOTOR CO. IN U.S.A.
GVWR: 8800 LB/3900 KG

DATE: 10/92

FRONT GAWR: 2915 LB
1322 KG
LT235/85R16E
16x8K
AT 51 PSI COLD

WITH TIRES RIMS

REAR GAWR: 6084 LB
2759 KG
LT235/85R16E
16x8K
AT 80 PSI COLD

WITH TIRES RIMS

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VIN: 2FTHF25Y5LCA00001
TYPE: TRUCK

F0128
T0423

W7406
EXTERIOR PAINT COLORS

WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	SPRINGS
133	F257	AK4	G	35			CF

▽ FOTA-15204A10-AA

(QUEBEC)

FABR. AUX E-U PAR LA FORD MOTOR CO.

DATE: 9/92

PNBV: 8800 LB/ 3991KG

PNBE AV: 3765 LB
1707 KG
LT235/85R16E
16X8K

AVEC
«PNEUS»
«JANTES»

PNBE AR: 6084 LB
2759 KG
LT235/85R16E
16X8K

À 51 LB/PO² À FROID

À 80 LB/PO² À FROID

CE VEHICULE EST CONFORME A TOUTES LES NORMES FEDERALES DE SECURITE DES V.A. EN VIGUEUR A LA DATE DE FABR. INQUEE CI-DESSUS.

NIV: 1FTHX25G8LKA00002
TYPE: CAMION

F0195
T0040

AV AT
COULEUR

B2
N° COMM SPEC.

EMPATT.	TYPE/PBV	CARR	B.V.	PONT	BANDE	RESSORT
155	X259	FKM	E	C5	2	H3A

▽ FOTA-15204A10-CA

(CANADA)

MFD. BY FORD MOTOR CO. OF CANADA LTD.
GVWR: 8800 LB/3900 KG

DATE: 9/92

FRONT GAWR: 2915 LB
1322 KG
LT235/85R16E
16X8K
AT 51 PSI COLD

WITH TIRES RIMS

REAR GAWR: 6084 LB
2759 KG
LT235/85R16E
16X8K
AT 80 PSI COLD

WITH TIRES RIMS

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VIN: 2FTHF25Y5LCA00003
TYPE: TRUCK

F0128
T0423

W7406
EXTERIOR PAINT COLORS

WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	SPRING
133	F257	AK4	G	35			CF

MADE IN CANADA

▽ FOTA-15204A10-BA

FOR VEHICLES MFG. IN U.S.A. FOR QUEBEC, CANADA.

(QUEBEC)

FABR. PAR FORD DU CANADA LIMITEE

DATE: 9/92

PNBV: 8250 LB/ 2834 KG

PNBE AVANT: 2800 LB
1270 KG
P235/75R15XL
15X6.0JK

AVEC
«PNEUS»
«JANTES»

PNBE ARRIERE: 3800 LB
1723 KG
P235/75R15XL
15X6.0JK

À 35 LB/PO² À FROID

À 41 LB/PO² À FROID

CE VEHICULE EST CONFORME A TOUTES LES NORMES FEDERALES DE SECURITE DES V.A. EN VIGUEUR A LA DATE DE FABR. INQUEE CI-DESSUS.

NIV: 2FTEF15Y4LCA00004
TYPE: CAMION

F0144
T0269

YW
COULEURS EXT.

B2
N° COMM SPEC.

EMPATT.	TYPE/PBV	CARR	B.V.	PONT	BANDE	RESSORT
133	F155	CJ4	E	H9		CD

MADE IN CANADA

▽ FOTA-15204A10-DA

FOR VEHICLES MFG. IN CANADA FOR QUEBEC, CANADA.

INCOMPLETE VEHICLES (CAN)

THE INCOMPLETE VEHICLE RATING DECAL IS INSTALLED ON THE DRIVER'S DOOR LOCK PILLAR IN PLACE OF THE SAFETY COMPLIANCE CERTIFICATION LABEL.

INCOMPLETE VEHICLE MANUFACTURED BY FORD MOTOR CO. OF CANADA LTD.
MADE IN CANADA
GVWR: 11000 LB/4989 KG

DATE: 9/92

FRONT GAWR: 4200 LB
1905 KG
LT215/85R16D
16x8K
AT 58 PSI COLD

WITH TIRES RIMS

REAR GAWR: 8250 LB
3742 KG
LT215/85R16D
16x8K
AT 65 PSI COLD

WITH TIRES RIMS DUAL

VIN: 2FDKF37M6LCA00006

W7406
EXTERIOR PAINT COLORS

WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	SPRINGS
161	F379	AJ8	E	65			N Y

▽ FOTA-15204A10-FA

INCOMPLETE VEHICLE MANUFACTURED BY
FORD MOTOR COMPANY
MADE IN U.S.A.

DATE: 9/92

GVWR: 11000 LB/4989 KG

FRONT GAWR: 4200 LB
1905 KG
LT215/85R16D
16x8K
AT 58 PSI COLD

WITH TIRES RIMS

REAR GAWR: 8250 LB
3742 KG
LT215/85R16D
16x8K
AT 65 PSI COLD

WITH TIRES RIMS DUAL

VIN: 1FDKF37M0LKA00005


YY
EXTERIOR PAINT COLORS

WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	SPRINGS
161	F379	AJ8	E	65			N Y

▽ FOTA-15204A10-EA

CY2668-L

GENERAL INFORMATION (Continued)

①	MFD. BY FORD MOTOR CO. IN U.S.A.		⑦
②	DATE: 2/93	GVWR: 6600 LB/2994 KG	⑧
③	FRONT GAWR: 3320 LB	REAR GAWR: 4004 LB	⑨
④	1506KG	1816KG	⑩
⑤	LT 215/85R 16D	LT 215/85R 16D	⑪
⑥	16 x 6K	16 x 6K	
	AT 51 PSI COLD	AT 58 PSI COLD	
	THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE		
⑫	VIN:	1FTEF25H5PLA00000	
⑬	TYPE: TRUCK		
	(A) (B) (C) (D) (E) (F) (G) (H)		
			
	7N	9M	
⑭	EXTERIOR PAINT COLORS		
	WB	TYPE-GVW	
	133	F251	
	BODY	TRANS	
	LG4	E	
	AXLE	TAPE	
	342	B	
	SPRING		
	2 D 2 9		
	(A)(B)(C)(D)		
		DSO	
		48	
		F0083	
		T0112	

① NAME AND LOCATION OF MANUFACTURER

② DATE OF MANUFACTURE

③ FRONT GROSS AXLE WEIGHT RATINGS IN POUNDS (LB) AND KILOGRAMS (KG)

④ FRONT TIRE SIZE

⑤ RIM SIZE

⑥ FRONT TIRE COLD PSI

⑦ GROSS VEHICLE WEIGHT RATING IN POUNDS (LB) AND KILOGRAMS (KG)

⑧ REAR GROSS AXLE WEIGHT RATING IN POUNDS (LB) AND KILOGRAMS (KG)

⑨ REAR TIRE SIZE

⑩ RIM SIZE

⑪ REAR TIRE COLD PSI

⑫ VEHICLE IDENTIFICATION NUMBER
(A) WORLD MANUFACTURER IDENTIFIER

(B) BRAKE SYSTEM AND GROSS VEHICLE WEIGHT RATING (GVWR) CLASS FOR FORD COMPLETED TRUCKS AND MPV'S. FOR BUSES AND INCOMPLETE VEHICLES, THE FOURTH DIGIT DETERMINES THE BRAKE SYSTEM (ONLY).

(C) MODEL OR LINE, SERIES, CHASSIS, CAB OR BODY TYPE

(D) ENGINE TYPE

(E) CHECK DIGIT

(F) MODEL YEAR (FORD-COMPLETED TRUCKS AND MPV'S)

(G) ASSEMBLY PLANT CODE

(H) SEQUENCE NUMBER

⑬ TYPE VEHICLE

⑭ EXTERIOR PAINT CODES (TWO SETS OF FIGURES DESIGNATES A TWO-TONE)

⑮ WHEELBASE IN INCHES

⑯ MODEL CODE AND GVW

⑰ INTERIOR TRIM, SEAT AND BODY/CAB TYPE

⑱ TRANSMISSION CODE

⑲ REAR AXLE CODE

⑳ FRONT AXLE CODE IF SO EQUIPPED

㉑ DISTRICT/SPECIAL ORDER CODES

㉒ EXTERNAL BODY TAPE STRIPE CODE

㉓ SUSPENSION IDENTIFICATION CODES
(A) AUX./OPT. USAGE CODE (FRONT)
(B) FRONT SPRING CODE
(C) AUX./OPT. USAGE CODE (REAR)
(D) REAR SPRING CODE

㉔ FRONT AXLE ACCESSORY RESERVE CAPACITY IN POUNDS

㉕ TOTAL ACCESSORY RESERVE CAPACITY IN POUNDS

CW1017-A

GENERAL INFORMATION (Continued)

VEHICLE IDENTIFICATION NUMBER (VIN) CODES

WORLD MANUFACTURER IDENTIFIER
(VIN POSITIONS 1, 2 AND 3)

1FT EF25H5 P LA00001

VIN CODE	MANUFACTURER	MAKE	TYPE
1FM	FORD MOTOR COMPANY, USA	FORD	MULTI PURPOSE PASSENGER VEHICLE (MPV)
1FT	FORD MOTOR COMPANY, USA	FORD	TRUCK (COMPLETED VEHICLE)
1FD	FORD MOTOR COMPANY, USA	FORD	INCOMPLETE VEHICLE (IV)
1FC	FORD MOTOR COMPANY, USA	FORD	BASIC (STRIPPED) CHASSIS
1FB	FORD MOTOR COMPANY, USA	FORD	BUS
1FF	FORD MOTOR COMPANY, USA	FORD	MOTOR VEHICLE EQUIPMENT WITHOUT ENGINE/ POWERTRAIN (GLIDER)
2FM	FORD MOTOR COMPANY OF CANADA, LTD.	FORD	MPV
2FT	FORD MOTOR COMPANY OF CANADA, LTD.	FORD	TRUCK (COMPLETED VEHICLE)
2FD	FORD MOTOR COMPANY OF CANADA, LTD.	FORD	INCOMPLETE VEHICLE
2FC	FORD MOTOR COMPANY OF CANADA, LTD.	FORD	BASIC (STRIPPED) CHASSIS
2FB	FORD MOTOR COMPANY OF CANADA, LTD.	FORD	BUS
2FF	FORD MOTOR COMPANY OF CANADA, LTD.	FORD	MOTOR VEHICLE EQUIPMENT WITHOUT ENGINE/ POWERTRAIN (GLIDER)
3FC	FORD MOTOR COMPANY OF MEXICO	FORD	BASIC (STRIPPED) CHASSIS

CY2377-M

Refer to the code definition portion of this section for specific definitions of the numbers and letters of the Vehicle Identification Number (VIN).

Build Date Stamp Locations

The vehicle build date stamp is located as follows: On Bronco and Light Trucks (F-150-250-350) the vehicle build date is stamped on the front surface of the radiator support on the passengers side of the vehicle. On Econoline vehicles (E-150-250-350), the build date is stamped on top of the radiator support. Following is a sample of the four-digit number that indicates the month and day of build.

Actual Build Date / Vehicle Date Stamp**January 24 / 0124****October 21 / 1021**

Yellow ink is normally used for the date stamp. When the marking surface is painted the body color, the date stamp will be marked in red ink. Units from the Ontario Truck Plant (Code C) will be marked with silver ink.

Vehicle Data

The Vehicle Data appears on the Safety Compliance Certification Label on the second and third lines following the identification number. The code set (two numbers or a number and letter) above COLOR identify the exterior paint color (two sets of codes designate a two-tone). The three digits under WB designate the wheelbase in inches. The letter and three digits under TYPE-GVW designate the truck model within a series and the gross vehicle weight rating. The letters and / or numeral under BODY designate the interior trim, seat and body type. The transmission installed in the vehicle is identified under TRANS by an alphabetical code. A letter and a number or two numbers under AXLE identify the rear axle ratio (when required, a letter is also stamped or number after the rear axle code to identify the front axle). The letters and / or numerals under TAPE designate the external bodyside tape stripe. The spring usage codes for the vehicle is identified under SPRING.

A two-digit number is stamped above DSO to identify the district which ordered the vehicle. If the vehicle is built to special order (Domestic Special Order, Foreign Special Order, Limited Production Option or other special order), the complete order number will also appear above DSO. The following charts list the various vehicle data codes.

GENERAL INFORMATION (Continued)

Vehicle Identification Number (VIN) Codes

**BRAKE SYSTEM AND GVWR CLASS FOR TRUCKS AND MPV'S —
BRAKE SYSTEM (ONLY) FOR BUSES AND INCOMPLETE VEHICLES
(VIN POSITION 4)**

1 F T E F 2 5 H 5 P L A 0 0 0 0 1

BRAKE SYSTEM	GVWR CLASS	GVWR RANGE	VIN CODE
HYDRAULIC	CLASS A	NOT GREATER THAN 3,000 POUNDS	A
HYDRAULIC	CLASS B	3,001 — 4,000 POUNDS	B
HYDRAULIC	CLASS C	4,001 — 5,000 POUNDS	C
HYDRAULIC	CLASS D	5,001 — 6,000 POUNDS	D
HYDRAULIC	CLASS E	6,001 — 7,000 POUNDS	E
HYDRAULIC	CLASS F	7,001 — 8,000 POUNDS	F
HYDRAULIC	CLASS G	8,001 — 8,500 POUNDS	G
		8,501 — 9,000 POUNDS	H
HYDRAULIC	CLASS H	9,001 — 10,000 POUNDS	J
HYDRAULIC	CLASS 3	10,001 — 14,000 POUNDS	K
HYDRAULIC	CLASS 4	14,001 — 16,000 POUNDS	L
HYDRAULIC	CLASS 5	16,001 — 19,500 POUNDS	M

CY2674-K

GENERAL INFORMATION (Continued)

General Information

MODEL OR LINE, SERIES, CHASSIS, CAB OR BODY TYPE
(VIN POSITIONS 5, 6, AND 7)1FTE **F** H5PLA00001

VIN CODE		LINE	SERIES	CHASSIS TYPE	CAB OR BODY TYPE	VEHICLE TYPE ①
CLUB WAGON	SUPER WAGON		CUSTOM			
E11	—	CLUB WAGON	E150	4x2	CLUB WAGON	MPV
E31	—	CLUB WAGON	E350	4x2	CLUB WAGON	OR BUS
—	S31	CLUB WAGON	E350	4x2	SUPER WAGON	MPV OR BUS ②

MEMO: ONE OF THE FOLLOWING OPTIONAL EXTERIOR NAMEPLATES (INDICATING DIFFERENT TRIM LEVELS) MAY ALSO BE AFFIXED TO THE VEHICLE IN ADDITION TO THE CLUB WAGON XL NAMEPLATE:
 •XLT •CHATEAU ②EXCLUDES SCHOOL BUS

REGULAR VAN	SUPER VAN		BASE			
E14		ECONOLINE	E150	4x2	CARGO VAN — REGULAR VAN/ SUPER VAN	TRUCK OR IV
E24		ECONOLINE	E250	4x2	CARGO VAN — REGULAR VAN/ SUPER VAN	TRUCK OR IV
E34	S34	ECONOLINE	E350	4x2	CARGO VAN — REGULAR VAN/ SUPER VAN	TRUCK OR IV
OTHER						
E29	—	ECONOLINE	E250	4x2	COMMERCIAL STRIPPED CHASSIS	IV
E37	—	ECONOLINE	E350	4x2	COMMERCIAL CUTAWAY	IV
E30	—	ECONOLINE	E350	4x2	RV CUTAWAY	IV
E39	—	ECONOLINE	E350	4x2	COMMERCIAL BASIC (STRIPPED) CHASSIS	IV
E33	—	ECONOLINE	E350	4x2	RV BASIC (STRIPPED) CHASSIS	IV

① "MPV" MEANS MULTI PURPOSE PASSENGER VEHICLE. "IV" MEANS INCOMPLETE VEHICLE. "TRUCK" MEANS COMPLETED VEHICLE.

MEMO: FOR ALL ECONOLINE EXCEPT BASIC (STRIPPED) CHASSIS, THE OPTIONAL EXTERIOR NAMEPLATES "XL" AND "RV CONVERSION" (INDICATING TRIM LEVEL) MAY ALSO BE AFFIXED TO THE VEHICLE IN ADDITION TO THE ECONOLINE NAMEPLATE.

NOTE: ALL 1993 MODEL COMMERCIAL AND RV BASIC (STRIPPED) CHASSIS INCOMPLETE VEHICLES ARE DESIGNATED BY A "1FC" WORLD MANUFACTURER IDENTIFIER (WMI) CODE. THE RV BASIC (STRIPPED) CHASSIS IS AVAILABLE ONLY ON A SPECIAL ORDER BASIS.

VIN CODE	LINE	SERIES	CHASSIS TYPE	CAB OR BODY TYPE	VEHICLE TYPE ①
U15	BRONCO	CUSTOM	4x4	BRONCO	MPV

MEMO: ONE OF THE FOLLOWING OPTIONAL EXTERIOR NAMEPLATES (INDICATING HIGHER TRIM LEVELS) MAY ALSO BE AFFIXED TO THE VEHICLE IN ADDITION TO THE BRONCO NAMEPLATE:
 • XLT • EDDIE BAUER

REGULAR CAB	SUPER CAB OR CREW CAB		XL			
F14	X14	F-SERIES	F150	4x4	PICKUP — REGULAR CAB/SUPER CAB	TRUCK
F15	X15	F-SERIES	F150	4x2	PICKUP — REGULAR CAB/SUPER CAB	TRUCK
F25	X25	F-SERIES	F250	4x2	PICKUP — REGULAR CAB/SUPER CAB	TRUCK
F26	X26	F-SERIES	F250	4x4	PICKUP — REGULAR CAB/SUPER CAB	TRUCK
F35	W35X35	F-SERIES	F350	4x2	PICKUP — REGULAR CAB/CREW CAB/ SUPER CAB	TRUCK
F37	—	F-SERIES	F350	4x2	REGULAR CAB (CHASSIS CAB)	IV
F36	W36	F-SERIES	F350	4x4	PICKUP — REGULAR CAB/CREW CAB	TRUCK
F38	—	F-SERIES	F350	4x4	REGULAR CAB (CHASSIS CAB)	IV
F47	—	F-SERIES	F-SUPER DUTY	4x2	REGULAR CAB (CHASSIS CAB)	IV
F53	—	F-SERIES	F-SUPER DUTY	4x2	RV BASIC STRIPPED CHASSIS	IV
F59	—	F-SERIES	F-SUPER DUTY	4x2	COMMERCIAL BASIC STRIPPED CHASSIS	IV

① "MPV" MEANS MULTI-PURPOSE PASSENGER VEHICLE. "IV" MEANS INCOMPLETE VEHICLE.

MEMO: ONE OF THE FOLLOWING OPTIONAL EXTERIOR NAMEPLATES (INDICATING HIGHER TRIM LEVELS) MAY ALSO BE AFFIXED TO THE VEHICLE IN ADDITION TO THE F-SERIES NAMEPLATES:
 • XLT

NOTE: SPECIAL ORDER (DSO) UNITS WILL BE CODED WITH THE APPROPRIATE SERIES VIN CODES LISTED ABOVE.

CY2379-M

GENERAL INFORMATION (Continued)

ENGINE TYPE, DISPLACEMENT, CYLINDERS,
FUEL TYPE, AND MANUFACTURER
(VIN POSITION 8)1 F T E F 2 5 **H** 5 P L A 0 0 0 0 1

VIN CODE	DISPLACEMENT		CYLINDERS	FUEL	MANUFACTURER
	LITER	CID			
Y	4.9	300	I-6	GASOLINE	FORD
N	5.0	302	V-8	GASOLINE	FORD
H	5.8	351	V-8	GASOLINE	FORD
R	5.8	351	V-8	GASOLINE	FORD
G	7.5	460	V-8	GASOLINE	FORD
M	7.3	445	V-8	DIESEL	NAVISTAR
C	7.3	445	V-8	DIESEL	NAVISTAR

CY2380-M

CHECK DIGIT FOR ALL VEHICLES
(VIN POSITION 9)1 F T E F 2 5 H **5** P L A 0 0 0 0 1

CY2381-M

VEHICLE MODEL YEAR
FOR FORD-COMPLETED VEHICLES
(VIN POSITION 10)1 F T E F 2 5 H 5 **N** L A 0 0 0 0 1

VIN CODE	YEAR
K	1989
L	1990
M	1991
N	1992
P	1993
R	1994
S	1995
T	1996
V	1997

CY2382-M

ASSEMBLY PLANT CODES
(VIN POSITION 11)1 F T E F 2 5 H 5 P **L** A 0 0 0 0 1

VIN CODE	VEHICLE ASSEMBLY PLANT — NAME AND LOCATION
C	ONTARIO TRUCK: OAKVILLE, ONTARIO
H	LORAIN: LORAIN, OHIO
J	MONTERREY, N.L.: MEXICO
K	KANSAS CITY: CLAYCOMO, MISSOURI
L	MICHIGAN TRUCK: WAYNE, MICHIGAN
N	NORFOLK: NORFOLK, VIRGINIA
P	TWIN CITIES: ST. PAUL, MINNESOTA
U	LOUISVILLE: LOUISVILLE, KENTUCKY

CY2383-M

PRODUCTION SEQUENCE NUMBER
(VIN POSITIONS 12 THROUGH 17)1 F T E F 2 5 H 5 P L **A** 0 0 0 0 1

SEQUENCE NUMBER
A 00001 — A 99,000
B 00001 — B 99,999
AND SO ON.

CY2384-M

GENERAL INFORMATION (Continued)

**EXTERIOR PAINT COLOR CODES
BRONCO, F-150-250-350, F-SUPER DUTY**

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: _____ **GVWR:** _____

FRONT GAWR: _____ **REAR GAWR:** _____


WITH TIRES RIMS **WITH TIRES RIMS**

AT PSI COLD **AT PSI COLD**

**THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF
MANUFACTURE SHOWN ABOVE**

VIN: _____

TYPE: _____



YC

EXTERIOR PAINT COLORS						DSO
WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	SPRING
133	F252	LG4	F	342	B	2D29

BRONCO EXTERIOR PAINT COLOR CODES

CODE	COLOR
YC	BLACK
MS	SMOKE METALLIC
EH	MEDIUM CABERNET SOLID
MW	BRIGHT REGATTA BLUE METALLIC
MX	DARK SHADOW BLUE METALLIC
DB	LIGHT MOCHA SOLID
PB	JEWEL GREEN METALLIC
MC	LIGHT SMOKE METALLIC
EP	VERMILION SOLID
DW	DARK MOCHA METALLIC
DJ	MEDIUM MOCHA METALLIC
YO	OXFORD WHITE SOLID
FIBERGLASS ROOF COLORS	
A	BLACK
B	BLUE
K	PAWNEE TAN
R	CURRANT RED
W	WHITE

NOTE - TWO SETS OF CODES INDICATE TWO-TONE PAINT


**F-150-250-350 AND F-SUPER DUTY
EXTERIOR PAINT COLOR CODES**

CODE	COLOR
YC	BLACK
MS	SMOKE METALLIC
MC	LIGHT SMOKE METALLIC
EH	MEDIUM CABERNET SOLID
MW	BRIGHT REGATTA BLUE METALLIC
YY	WHITE
DC	MEDIUM MOCHA C/C
DB	LIGHT MOCHA SOLID
DW	DARK MOCHA METALLIC
RC	MEDIUM PLATINUM C/C
YN	SILVER C/C
PB	JEWEL GREEN METALLIC
MK	TWILIGHT BLUE C/C
EL	WILD STRAWBERRY C/C
DD	MOCHA FROST C/C
MX	DARK SHADOW BLUE METALLIC
K3	BIMINI BLUE C/C
EG	ELECTRIC CURRANT RED C/C
EP	VERMILION SOLID
DJ	MEDIUM MOCHA METALLIC
6C	IRIS C/C
YO	OXFORD WHITE SOLID

CY2668-K

GENERAL INFORMATION (Continued)

EXTERIOR PAINT COLOR CODES
E-150-250-350

MFD. BY FORD MOTOR CO. IN U.S.A.							
DATE:		GVWR: LB/ KG					
FRONT GAWR: LB		REAR GAWR: LB					
KG	WITH TIRES RIMS	KG	WITH TIRES RIMS				
AT PSI COLD		AT PSI COLD					
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE							
VIN: _____							
TYPE: _____							
							
DC EC							
EXTERIOR PAINT COLORS							
WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	DSO SPRING
138	E112		EY	T	16	B	2C2D

E-150-250-350

CODE	COLOR
ZC	GLACIER WHITE SOLID
YY	WHITE
RC	MEDIUM PLATINUM C/C
YN	SILVER C/C
K2	ATLANTIC BLUE SOLID
MA	LIGHT CRYSTAL BLUE C/C
DD	MOCHA FROST C/C
YC	BLACK SOLID
DC	MEDIUM MOCHA C/C
EG	ELECTRIC CURRANT RED C/C
MK	TWILIGHT BLUE C/C
EC	CURRANT RED SOLID

NOTE: TWO SETS OF CODES INDICATE TWO-TONE PAINT.

CY2794-H

GENERAL INFORMATION (Continued)

**TYPE — GROSS VEHICLE WEIGHT (GVW) CODES
BRONCO, F-150-250-350, F-SUPER DUTY**

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: _____ GVWR: _____
FRONT GAWR: _____ REAR GAWR: _____

WITH TIRES RIMS **WITH TIRES RIMS**

AT PSI COLD **AT PSI COLD**

**THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF
MANUFACTURE SHOWN ABOVE**

VIN: _____

TYPE: _____

7N 9M DSO
EXTERIOR PAINT COLORS

WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	SPRING
133		F251	LG4	F	342	B	2D29

F25 1

SERIES	SERIES CODE	GVWR CODE	GVWR (LB.)	WHEELBASE (IN.)
BRONCO				
U150	U15	2	6050	105
	U15	4	6300	105
	U15	5	6450	105

F-150-250-350				
F-150 (4x2)	F15	3	5250	117
	F15	4	5450	133
	F15	5	6250	133
	F15	1	5000	117
	F15	2	5450	117
	F15	7	5150	117
	X15	1	6050	139
F-150 (4x4)	X15	2	6250	155
	F14	1	6100	117
	F14	2	6250	133
	X14	3	6250	139
F-250 (4x2) LIGHT DUTY	X14	1	6250	155
	F25	1	8600	133
F-250 (4x2) HEAVY DUTY	F25	7	8600	133
	F25	9	8800	155
	X25	9	8800	155

SERIES	SERIES CODE	GVWR CODE	GVWR (LB.)	WHEELBASE (IN.)
F-250 (4x4)	F26	1	6800	133
	X26	8	8800	155
	F26	8	8600	133
F-350 (4x2)	F35	2	10,000	133
	F37	4	8800	133
	F37	8	10,000	137, 161
	F37	9	11,000	137, 161
	W35	2	9200	168
	W35	3	10,000	168
	X35	1	10,000	155
F-350 (4x4)	F36	1	9000	133
	F38	2	8800	133
	F38	4	11,000	137, 161
	F38	1	16,000	137
	W36	1	9200	168
F-SUPER DUTY (4x2) CHASSIS CAB	F47	8	15,000	185
	F47	7	15,000	137, 161
F-SUPER DUTY COMMERCIAL STRIPPED CHASSIS	F59	1	16,000	158, 178
F-SUPER DUTY MOTOR HOME STRIPPED CHASSIS	F53	1	16,000	178, 203
		1	17,000	178, 190
	F53	0	15,200	208, 228

CY2669-K

GENERAL INFORMATION (Continued)

GROSS VEHICLE WEIGHT (GVW) CODES
E-150-250-350

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE:		GVWR: LB/ KG	
FRONT GAWR: LB		REAR GAWR: LB	
KG	WITH TIRES RIMS	KG	WITH TIRES RIMS
AT PSI COLD		AT PSI COLD	

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF
MANUFACTURE SHOWN ABOVE

VIN: _____

TYPE: _____

1D 7A

EXTERIOR PAINT COLORS

WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	SPRING
138	E112	EY	T	16	B	2C29

E11	2
-----	---

E-150-350 CLUB – CUSTOM XLT AND CHATEAU WAGONS

SERIES	SERIES CODE	GVWR CODE	GVWR (LB.)
E-150 REGULAR	E11	2	6,700
E-350 REGULAR	E31	P	8,700
E-350 SUPER	S31	5	9,300
	S31	4	9,100
	S31	3	8,800

E-150-250-350 CARGO VANS

SERIES	SERIES CODE	GVWR CODE	GVWR (LB.)
E-150 REGULAR CARGO	E14	1	5,500
	E14	2	6,500
	E14	3	6,700
E-250 REGULAR CARGO	E24	1	7,200
	E24	2	8,450
	E24	3	8,550
E-250 SUPER CARGO	S24	1	7,300
	S24	2	8,450
	S24	3	8,550
E-350 REGULAR CARGO	E34	1	9,400
	E34	2	9,500
E-350 SUPER CARGO	S34	1	9,400
	S34	5	9,300

E-350 RV CUTAWAY

SERIES	SERIES CODE	GVWR CODE	GVWR (LB.)
E-350 RV CUTAWAY	E30	Q	9,800 SRW
	E30	2	10,500 DR
	E30	Y	11,500 DR

SR: SINGLE REAR WHEELS
DR: DUAL REAR WHEELS

E-350 COMMERCIAL CUTAWAY

SERIES	SERIES CODE	GVWR CODE	GVWR (LB.)
E-350 COMMERCIAL CUTAWAY	E37	1	10,000 DR
	E37	2	10,300 DR
	E37	3	10,700 DR
	E37	Q	9,800 SRW

SR: SINGLE REAR WHEELS
DR: DUAL REAR WHEELS

E-250-350 COMMERCIAL STRIPPED CHASSIS

SERIES	SERIES CODE	GVWR CODE	GVWR (LB.)
E-350 COMMERCIAL STRIPPED CHASSIS	E39	U	9,400 SR
	E39	W	10,000 DR
	E29	2	8,450 SR
	E29	3	8,550 SR

SR: SINGLE REAR WHEELS
DR: DUAL REAR WHEELS

E-350 STRIPPED CHASSIS

SERIES	SERIES CODE	GVWR CODE	GVWR (LB.)
E-350 RV STRIPPED CHASSIS	E33	Y	11,500 DR

CY2779-J

GENERAL INFORMATION (Continued)

**BODY CODES
BRONCO, LIGHT TRUCK,
(F-150-250-350, F-SUPER DUTY)**

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE:

GVWR:

FRONT GAWR:

REAR GAWR:

WITH
TIRES
RIMS

WITH
TIRES
RIMS

AT PSI COLD

AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF
MANUFACTURE SHOWN ABOVE

VIN:

TYPE:



1D 7A
EXTERIOR PAINT COLORS

DSO

WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	SPRING
133		F252	LJ4	F	342	B	2D29

A J 4

LIGHT TRUCK

CODE	FABRIC	SEAT TYPE
A	VINYL	BENCH
B	KNIT VINYL	BENCH
C	KNIT VINYL	BENCH
D	BODYCLOTH	FLIGHT BENCH
F	CLOTH	CAPTAINS CHAIR
G	BODYCLOTH	BENCH
P	CLOTH	BUCKET

BRONCO

CODE	FABRIC	SEAT TYPE
S	VINYL	BUCKET
V	CLOTH	CAPTAINS CHAIR
W	CLOTH	CAPTAINS CHAIR
X	LEATHER	CAPTAINS CHAIR
U	CLOTH/VINYL	SPLIT BENCH

BRONCO AND F-SERIES

TRIM COLOR	
CODE	COLOR
J	GRANITE
D	SCARLET
B	CRYSTAL BLUE
K	MEDIUM CHESTNUT


**F-SERIES ONLY
CAB/BACK OF CAB**

REGULAR	SPECIFICATIONS
4	STYLESIDE PICKUP
8	CHASSIS CAB
X	STRIPPED CHASSIS (MEXICO)
M	STYLESIDE PICKUP - SUPER CAB
D	STYLESIDE PICKUP - CREW CAB
3	FLARESIDE
C	FLARESIDE - SUPER CAB

CY2388-M

GENERAL INFORMATION (Continued)

BODY CODES
E-150-250-350

MFD. BY FORD MOTOR CO. IN U.S.A.						
DATE:		GVWR: LB/ KG				
FRONT GAWR: LB		REAR GAWR: LB				
KG	WITH TIRES RIMS	KG	WITH TIRES RIMS			
AT PSI COLD		AT PSI COLD				
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE						
VIN:						
TYPE:						
						
1G	9N					
EXTERIOR PAINT COLORS						
WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	DSO SPRING
138	E112	AJ	T	16	2	2C2D

A	J
---	---

SEAT TRIM AND STYLE

CODE	TRIM	TYPE
A	VINYL	BUCKET
B	VINYL	BUCKET
C	CLOTH	BUCKET
D	CLOTH	CAPTAINS CHAIR
L	CLOTH	CAPTAINS CHAIR
X	NO TRIM	CAPTAINS CHAIR

TRIM COLOR

CODE	COLOR
B	CRYSTAL BLUE
J	GRANITE
P	MOCHA

CY2780-J

GENERAL INFORMATION (Continued)

TRANSMISSION CODES
BRONCO, E-150-250-350, F-150-250-350, F-SUPER DUTY

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE:

GVWR:

FRONT GAWR:

REAR GAWR:

WITH TIRES RIMS

WITH TIRES RIMS

AT PSI COLD

AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VIN:
TYPE:

EXTERIOR PAINT COLORS

WB

TYPE GVW

BODY

TRANS

AXLE

TAPE

DSO

SPRING

133

F252

LG4

F

342

B

2D29

CODE	DESCRIPTION
BRONCO	
M	MANUAL — 5-SPEED OVERDRIVE (M5OD) (MAZDA)
E	AUTOMATIC — E4OD
F	MANUAL — 4-SPEED (B-W T-18)
W	MANUAL — 5-SPEED HD OVERDRIVE (M5OD-HD) (ZF)
T	AUTOMATIC — 4-SPEED — AOD


E-150-250-350	
G	AUTOMATIC — C6
T	AUTOMATIC — 4-SPEED AOD
E	AUTOMATIC — E4OD
U	AUTOMATIC 4R70W (AODE-W)

F-150-250-350, F-SUPER DUTY CHASSIS CAB, F-SUPER DUTY STRIPPED CHASSIS	
G	AUTOMATIC — C6
T	AUTOMATIC — AOD
E	AUTOMATIC — E4OD
F	MANUAL — 4-SPEED (B-W T-18)
C	MANUAL — 5-SPEED CLOSE RATIO (Z-F)
M	MANUAL — 5-SPEED OVERDRIVE (M5OD) (MAZDA)
W	MANUAL — 5-SPEED H.D. OVERDRIVE (M5OD-HD) (Z-F)

CY2390-L

GENERAL INFORMATION (Continued)

AXLE CODES
BRONCO, F-150-250-350, F-SUPER DUTY

MFD. BY FORD MOTOR CO. IN U.S.A.							
DATE:	GVWR:						
FRONT GAWR:	REAR GAWR:						
	WITH TIRES		WITH TIRES				
	RIMS		RIMS				
AT PSI COLD			AT PSI COLD				
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE							
VIN: _____							
TYPE: _____							
							
<div> <div>7N</div> <div>9M</div> </div> <div>EXTERIOR PAINT COLORS</div> <div>DSO</div>							
WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	SPRING
133		F252	LG4	F	252	B	2D29

25 2

REAR AXLE CODES

CODE	CAPACITY (LBS.)	RATIO
12	3800	2.73
18	3800	3.08
19	3800	3.55
H5	3800	4.10
H8	3800	3.08
H9	3800	3.55
25	3800	4.10
29	5300	3.55
B5	5300	4.10
B9	5300	3.55
35	6250	4.10
39	6250	3.55
C5	6250	4.10
C9	6250	3.55
45	7400	4.10
49	7400	3.55
D5	7400	4.10
65	8250	4.10
69	8250	3.55
F5	8250	4.10
72	11,000	4.63
73	11,000	5.13
W5	8250	4.00

FRONT AXLE CODES (NOT APPLICABLE ON E-150-250-350)

BRONCO AND F-150-250-350	
CODE	DESCRIPTION
2	FRONT AXLE LIMITED SLIP

CY2871-H

GENERAL INFORMATION (Continued)

AXLE CODES
E-150-250-350

MFD. BY FORD MOTOR CO. IN U.S.A.						
DATE:		GVWR: LB/ KG				
FRONT GAWR: LB		WITH		REAR GAWR: LB		WITH
KG		TIRES		KG		TIRES
		RIMS				RIMS
AT PSI COLD			AT PSI COLD			
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR						
VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF						
MANUFACTURE SHOWN ABOVE						
VIN:						
TYPE:						
1D		7A		DSO		
EXTERIOR PAINT COLORS						
WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE
138	E112	EY	T	18	B	2C2D

E-150-250-350 REGULAR REAR AXLE

CODE	# CAPACITY	RATIO
12	3800	2.73
18	3800	3.08
19	3800	3.55
23	5400	3.54
24	5400	3.73
33	6340	3.54
52	7800	4.10
32	6340	4.10
62	8000	4.10
17	3800	3.31
35	6340	4.09
34	6340	3.73
56	7800	4.10


E-150-250-350 LIMITED-SLIP REAR AXLE

CODE	# CAPACITY	RATIO
H8	3800	3.08
H9	3800	3.08
B4	5400	3.73
C2	6340	4.10
C3	6340	3.54
E2	7800	4.10
F2	8000	4.10
H7	3800	3.31
C5	6340	4.09
C4	6340	3.73
E6	7800	4.10

CY2781-H

GENERAL INFORMATION (Continued)

EXTERNAL BODY TAPE STRIPE CODES
BRONCO, E-150-250-350, F-150-250-350, F-SUPER DUTY

MFD. BY FORD MOTOR CO. IN U.S.A.					
DATE:		GVWR:			
FRONT GAWR:		REAR GAWR:			
		WITH TIRES RIMS			WITH TIRES RIMS
AT PSI COLD		AT PSI COLD			
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE					
VIN: 					
TYPE: 					
					
7N	9M				
EXTERIOR PAINT COLORS					
WB	TYPE GVW	BODY	TRANS	AXLE	TAPES
133	F252	LG4	F	342	U
					DSO
					2D29

BRONCO EXTERNAL TUTORNE BODY TAPE STRIPE CODES

CODE	TAPE STRIPE
A	BLACK/SILVER
B	DK SHAD BLUE/SILVER
D	CABERNET/SILVER
E	(SCARLET)/SILVER
G	SMOKE/SILVER
J	JEWEL GREEN/SILVER
L	BRT REG BLUE/SILVER
T	DK MOCHA/LT MOCHA
U	MED MOCHA/DK MOCHA

F-150-250-350, ALL TUTORNES STYLESIDE TAPE

CODE	TAPE STRIPE
A	BLACK/SILVER
B	DK SHADOW BLUE/SILVER
D	CABERNET/SILVER
E	VERMILION/SILVER
G	SMOKE/SILVER
J	JEWEL GREEN/SILVER
L	BRT REGATTA BLUE/SILVER
M	BIMINI BLUE/SILVER
N	TWILIGHT BLUE/SILVER
P	PLATINUM/SILVER
R	WILD STRAWBERRY/SILVER
T	DARK MOCHA/LT MOCHA
U	MED MOCHA/DARK MOCHA
Y	MOCHA C/C/DARK MOCHA

F-150-250-350 FLARESIDE LO-LINE TAPE

CODE	TAPE STRIPE
C	HOT PINK/LAVENDER
H	HOT PINK/SILVER
K	SEA GREEN/LAVENDER
O	MED AQUA/DKAQUA
SPORT PACKAGE	
7	SILVER

E-150-250-350 TAPE STRIPES — TUTORNE

CODE	TAPE STRIPE
1	RED/SILVER
2	PLATINUM/SILVER
3	DARK BLUE/LIGHT BLUE
4	MEDIUM MOCHA/PASTEL MOCHA
TAPE STRIPES — CHATEAU	
A	BLUE/RED
B	PLATINUM/RED
C	MOCHA/RED

CY2672-K

GENERAL INFORMATION (Continued)

**SUSPENSION — SPRING IDENTIFICATION CODES
BRONCO, F-150-250-350, F-SUPER DUTY**

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE:
FRONT GAWR:GVWR:
REAR GAWR:WITH
TIRES
RIMSWITH
TIRES
RIMS

AT PSI COLD

AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF
MANUFACTURE SHOWN ABOVE

VIN:

TYPE:


 7N 9M
EXTERIOR PAINT COLORS

DSO

WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	SPRING
133		F252	LG4	F	342	B	2D29

BRONCO SPRING IDENTIFICATION CODES

AUX/OPT. USAGE CODE (FRONT) — NOT APPLICABLE

AUX/OPT. USAGE CODE (REAR) — NOT APPLICABLE

FRONT SPRING CODES — BRONCO

CODE	PART NUMBER
B	E0TA-5310-BC
C	E0TA-5310-CC
G	E0TA-5310-GC
U	E0TA-5310-UC
V	E0TA-5310-VB

**F-150-250-350, F-SUPER DUTY
FRONT SPRING CODES**

CODE	PART NUMBER
B	E0TA-5310-BC
C	E0TA-5310-CC
D	E0TA-5310-DC
E	E0TA-5310-EC
F	E0TA-5310-FC
G	E0TA-5310-GC
H	E3TA-5310-XA
J	E3TA-5310-YA
K	E3TA-5310-ZA
M	E3TA-5310-AAA
N	E5TS-5310-BA
R	F1TA-5310-ANA
S	FITA-5310-APA
T	FITA-5310-ARA
U	E0TA-5310-UC
V	E0TA-5310-VB
5	FITA-5310-AHA
6	FITA-5310-AJA
7	FITA-5310-AKA
8	FITA-5310-AMA
9	FITA-5310-ALA
1	FITA-5310-ASA
P	F3TA-5310-SA

USAGE CODE (FRONT)

FRONT SPRING CODE

USAGE CODE (REAR)

REAR SPRING CODE

REAR SPRING CODES — BRONCO

CODE	PART NUMBER
Z	E3TA-5560-ANA

**F-150-250-350, F-SUPER DUTY
REAR SPRING CODE**

CODE	PART NUMBER
A	E4TA-5560-SA
D	E7TA-5560-NA
F	E7TA-5560-FA
L	FITA-5560-PA
V	F2TA-5560-YA
Y	E7TA-5560-YA
6	FITA-5560-MA
7	FOTA-5560-LA
8	E9TA-5A975-AA
9	F2TA-5560-VA
J	F3TA-5560-LA
S	F2TA-5560-AA

CY2673-H

GENERAL INFORMATION (Continued)

SUSPENSION — SPRING IDENTIFICATION CODES E-150-250-350

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE:	GVWR: LB/ KG
FRONT GAWR: LB KG	REAR GAWR: LB KG
WITH TIRES RIMS	WITH TIRES RIMS
AT PSI COLD	AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF
MANUFACTURE SHOWN ABOVE

VIN:
TYPE:

EXTERIOR PAINT COLORS

WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	DSO SPRING
138	E112		EY	T	16	B	2C2D

USAGE CODE (FRONT)	2	C	2	D
FRONT SPRING CODE				
USAGE CODE (REAR)				
REAR SPRING CODE				

E-150-250-350 FRONT SPRING CODES

CODE	PART NUMBER
A	F2UA-AA
B	F2UA-BA
C	F2UA-CA
D	F2UA-DA
E	F2UA-EA
F	F2UA-FA
G	F2UA-GA
H	F2UA-HA
J	F2UA-JA
K	F2UA-KA
L	F2UA-LA
M	F2UA-MA
N	F2UA-NA
P	F2UA-PA
R	R2UA-RA
S	F2UA-SA
T	F2UA-TA
U	F2UA-UA
V	F2UA-VA
Z	F2UA-ZA

E-150-250-350 FRONT SPRING CODES

CODE	PART NUMBER
A	F2UA-AB
C	F2UA-CA
D	F2UA-DF
F	F2UA-FF
G	F2UA-GF
H	F2UA-HF
J	F2UA-JF
K	F2UA-KF

CY2782-H

GENERAL INFORMATION (Continued)

**DISTRICT SALES OFFICE (DSO) AND WHEELBASE (WB) CODES
BRONCO, E-150-250-350, F-150-250-350, F-SUPER DUTY**

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: _____ GVWR: _____
FRONT GAWR: _____ REAR GAWR: _____

WITH TIRES RIMS WITH TIRES RIMS

AT PSI COLD AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF
MANUFACTURE SHOWN ABOVE

VIN: _____
TYPE: _____

7N 9M 21

EXTERIOR PAINT COLORS

WB	TYPE	GVW	BODY	TRANS	AXLE	TAPE	DSO	SPRING
133		F252	LG4	F	342	B		2D29

DSO — FSO — PTO (DOMESTIC, FOREIGN AND SPECIAL ORDER)

THE D.S.O. SPACE WILL SHOW A TWO-DIGIT CODE NUMBER OF THE DISTRICT WHICH ORDERED THE UNIT (SEE CHART BELOW). THIS CODE WILL APPEAR ON ALL UNITS — DOMESTIC OR EXPORT. IF UNIT IS BUILT ON A D.S.O., F.S.O., P.T.O. (SPECIAL ORDERS), THE COMPLETE ORDER NUMBER IS UNDER THE D.S.O. SPACER AFTER THE DISTRICT CODE NUMBER.

WHEELBASE (INCHES)
BRONCO

105

F-150-250-350	F-SUPER DUTY
117	137
133	155
137	161
139	168
	178
	208

E-150-250-350 (ECONOLINE AND CLUB WAGON)

138
158
176

CODE	DISTRICT
11	BOSTON
13	NEW YORK
14	PITTSBURGH
16	PHILADELPHIA
17	WASHINGTON
21	ATLANTA
22	CHARLOTTE
23	MEMPHIS
24	JACKSONVILLE
26	NEW ORLEANS
28	LOUISVILLE
41	CHICAGO
42	CLEVELAND
43	MILWAUKEE
46	INDIANAPOLIS
47	CINCINNATI
48	DETROIT

CODE	DISTRICT
52	DALLAS
53	KANSAS CITY
54	OMAHA
55	ST. LOUIS
57	HOUSTON
58	TWIN CITIES
71	LOS ANGELES
72	SAN JOSE
74	SEATTLE
75	PHOENIX
76	DENVER
83	GOVERNMENT
84	HOME OFFICE RESERVE
85	AMERICAN RED CROSS
86	RECREATION VEHICLES
87	BODY COMPANY
89	TRANSPORTATION SERVICES
90's	EXPORT
00	SPECIAL

FORD OF CANADA

MERCURY REGIONS	FORD REGIONS
A1 CENTRAL	B1 CENTRAL
A2 EASTERN	B2 EASTERN
A3 ATLANTIC	B3 ATLANTIC
A4 MIDWESTERN	B4 MIDWESTERN
A6 WESTERN	B6 WESTERN
A7 PACIFIC	B7 PACIFIC
A8 GREAT LAKES	B8 GREAT LAKES
11 EXPORT	11 EXPORT

CY2392-L

SECTION 00-03 Maintenance and Lubrication

SUBJECT	PAGE	SUBJECT	PAGE
MAINTENANCE		MAINTENANCE (Cont'd.)	
Lubrication	00-03-11	Scheduled Maintenance, Emissions	00-03-1
Maintenance Schedules	00-03-3	SPECIFICATIONS	00-03-24
Owner Maintenance Checks	00-03-10	VEHICLE APPLICATION	00-03-1

VEHICLE APPLICATION

E-150-250-350, F-150-250-350, F-Super Duty and Bronco Vehicles

MAINTENANCE

The scheduled and non-scheduled maintenance recommendations are included in this section for reference. The emission systems scheduled maintenance services and the vehicle maintenance services are separated. Be sure to perform all maintenance services by referring to both sections of the schedule.

It should be noted, however, that any modification of the emission control systems could create liability under federal law (U.S.) if made prior to the first sale and registration and, under the laws of some states, if made thereafter. Further, federal law prohibits vehicle manufacturers or dealers and other persons engaged in the business of repairing, servicing, selling, leasing, or trading motor vehicles as well as fleet operations, from knowingly removing or rendering an emission control system inoperative after sale and delivery to an ultimate purchaser. In Canada, modifications of the emission control system could create liability under applicable federal or provincial laws.

Scheduled Maintenance, Emissions

An Emission Systems Required Maintenance Chart for each appear on the following pages.

The vehicle charts list the items required to maintain the vehicle emission systems at levels determined by the federal government (Environmental Protection Agency). Refer to the appropriate sections of the Powertrain / Drivetrain Manual and the Powertrain Control / Emissions Diagnosis Manual ¹ for the maintenance procedures, which are related to the items listed on the maintenance schedule. Use these procedures to perform the required emission system maintenance items listed on the maintenance charts.



Maintenance service adjustments must conform to specifications contained in the Powertrain Control / Emissions Diagnosis Manual, ¹ to those listed in the Truck Performance Specifications issue of the Technical Service Bulletin or shown on the Vehicle Emission Control Information Decal which is located on or near the engine, or the emission systems may become inoperative.

If an engine is equipped with an MFI ignition system and any high tension ignition wire was detached from a spark plug, the distributor cap or the coil to perform a maintenance operation, Silicone Dielectric Compound D7AZ-19A331-A (ESA-M1C171-A) or equivalent must be applied to the boot before reconnection. Using a small, clean screwdriver, apply a thin layer of Silicone Dielectric Compound on the entire interior surface of the boot.

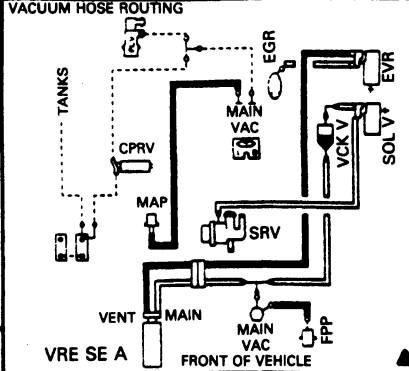
As a safety precaution, before starting the engine to perform maintenance, make sure the transmission selector is in park (automatic transmission) or neutral (manual transmission), the parking brake set and the wheels blocked.

MAINTENANCE (Continued)

TO ASSURE THE DURABILITY OF THE VEHICLE AND ITS EMISSION CONTROL SYSTEMS, IT IS NECESSARY THAT SCHEDULED MAINTENANCE BE PERFORMED AT THE DESIGNATED INTERVALS. FORD RECOMMENDS THE USE OF GENUINE FORD REPLACEMENT PARTS. THE MAINTENANCE, REPLACEMENT, OR REPAIR OF THE EMISSIONS CONTROL DEVICES AND SYSTEMS (THE COST OF WHICH IS NOT COVERED BY WARRANTY) MAY BE PERFORMED BY ANY AUTOMOTIVE REPAIR ESTABLISHMENT OR INDIVIDUAL AND MAY USE OTHER THAN FORD SERVICE PARTS FOR SUCH MAINTENANCE OR REPAIR. IF OTHER THAN FORD OR MOTORCRAFT PARTS OR FORD AUTHORIZED REMANUFACTURED PARTS ARE USED FOR MAINTENANCE REPLACEMENTS OR FOR THE SERVICE OF COMPONENTS AFFECTING EMISSIONS CONTROL, THE OWNER SHOULD ASSURE HIMSELF THAT SUCH PARTS ARE WARRANTED BY THEIR MANUFACTURER TO BE EQUIVALENT TO GENUINE FORD MOTOR COMPANY PARTS IN PERFORMANCE AND DURABILITY. PLEASE CONSULT THE WARRANTY BOOKLET FOR COMPLETE WARRANTY INFORMATION.

		Ford Motor Company IMPORTANT ENGINE INFORMATION	
<p>THIS VEHICLE IS EQUIPPED WITH EEC-IV MFI SYSTEMS. ENGINE IDLE SPEED, IDLE MIXTURE, AND IGNITION TIMING ARE NOT ADJUSTABLE. SEE ENGINE/EMISSIONS DIAGNOSIS SHOP MANUAL FOR ADDITIONAL INFORMATION.</p>			
<p>To check engine timing set parking brake and block wheels. Engine must be at normal operating temperature, transmission in neutral, and accessories off.</p>			
<ol style="list-style-type: none"> (1) Turn off engine. (2) Disconnect the in-line Spout Connector (). (3) Re-start previously warmed-up engine. (4) Verify that the ignition timing is 10° BTDC. If not see shop manual. (5) Turn engine off and restore electrical connection. 			
<p>Use SAE10W-30 Oil API Service SG — Energy Conserving II.</p>			
<p>THIS ENGINE CONFORMS TO U.S. EPA REGULATIONS APPLICABLE TO 1993 MODEL YEAR NEW HEAVY-DUTY ENGINES. THIS ENGINE IS CERTIFIED FOR USE IN ALL HEAVY-DUTY VEHICLES.</p>			
F2AE-9C485 H H P	Catalyst	Spark Plug: ASF-42C 7.5L-9HN NFM07 5BSA5-RDS/AIR/HO2S/EGR/MP	Gap: 042-046

VACUUM HOSE ROUTING



A16408-B

MAINTENANCE (Continued)

ADJUSTMENT PROCEDURE NOTES

IGNITION TIMING SPECIFICATION

FORD MOTOR COMPANY
IMPORTANT VEHICLE INFORMATION

THIS VEHICLE IS EQUIPPED WITH EEC IV MFI SYSTEMS. IDLE SPEEDS AND IDLE MIXTURES ARE NOT ADJUSTABLE. SEE SHOP MANUAL FOR ADDITIONAL INFORMATION.

ADJUST IGNITION TIMING WITH THE TRANSMISSION IN NEUTRAL, PARKING BRAKE SET AND THE WHEELS BLOCKED. ENGINE MUST BE AT NORMAL OPERATING TEMPERATURE.

- (1) TURN OFF ENGINE.
- (2) DISCONNECT THE IN-LINE SPOUT CONNECTOR (\square OR \square).
- (3) RE-START PREVIOUSLY WARMED-UP ENGINE.
- (4) ADJUST IGNITION TIMING TO 10° BTDC.
- (5) TURN OFF ENGINE AND RESTORE ELECTRICAL CONNECTION.

FIRING ORDER - 15426378

THIS VEHICLE CONFORMS TO U.S. EPA REGULATIONS APPLICABLE TO 1993 MODEL YEAR NEW LIGHT-DUTY TRUCKS. COMPLIANCE DEMONSTRATED AND DESIGNED FOR PRINCIPAL USE BELOW 4000 FEET. FOR NEW VEHICLE COMPLIANCE ABOVE 4000 FEET, SEE SERVICE PUBLICATIONS.

ETAE-9C485-CCR CATALYST

SPARK PLUG GAP SPECIFICATION

SPARK PLUG: ASE-42C
5.0L - 7MM
RFMS,OTSHAGX - AIP/ECR/EGS/TWC/FI

ENGINE TYPE

ENGINE VACUUM HOSE ROUTING (TYPICAL)

VACUUM HOSE ROUTING

SPARK PLUG GAP SPECIFICATION

TYPICAL VEHICLE EMISSION CONTROL INFORMATION DECAL (UNDER 8500 GVW)

A10418-D

Maintenance Schedules

Three maintenance schedules are specified for the 1993 Bronco, Econoline and F-Series trucks. They are identified by the letters B, E and G. The application of the various maintenance schedules are as follows:

Maintenance Schedule B, Gasoline Engine Equipped Vehicles with Light Duty Emissions (Under 8500 Pounds GVWR)

The following catalyst-equipped vehicles, designated for use with unleaded fuel only should be maintained according to Maintenance Schedule B.

- F-150
- Lightning
- F-250
- E-150-250 and Club Wagon
- Bronco

Maintenance Schedule G, Gasoline Engine Equipped Vehicles with Heavy Duty Emissions (Over 8500 Pounds GVWR)

Maintenance Schedule G is used for the following unleaded fuel vehicles with 4.9L, 5.8L and 7.5L MFI engines.

- F-250-350
- F-Super Duty
- E-250-350 and Club Wagon

Maintenance Schedule E, 7.3L Diesel Engine Equipped Vehicles

Maintenance Schedule E is used for the following vehicles:

- F-250 Heavy Duty
- F-350
- F-Super Duty
- E-250 Heavy Duty
- E-350

Required Maintenance Service Procedures

Refer to the appropriate sections of the Powertrain/Drivetrain Manual and the Powertrain Control/Emissions Diagnosis Manual² for the required maintenance service procedures.

² Can be purchased as a separate item.

MAINTENANCE (Continued)

MAINTENANCE SCHEDULE B – NORMAL DRIVING CONDITIONS

F-150/250 and Bronco Unleaded Fuel Vehicles with Light Duty Emissions (Under 8,500 lbs. GVWR)

B – Required for all vehicles.

b – Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

NORMAL DRIVING SERVICE INTERVALS – PERFORM AT THE MONTHS OR DISTANCES SHOWN, WHICHEVER OCCURS FIRST.																	
MAINTENANCE OPERATION	MILES (Thousands)	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75	82.5	90	97.5	105	112.5	120
	KILOMETERS (Thousands)	12	24	36	48	60	72	84	96	108	121	132	145	156	169	181	193
Emission Control Systems																	
Change Engine Oil and Oil Filter – every 6 months OR ⑤		B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Replace Spark Plugs – Standard					B				B				B				B
Replace Coolant – every 36 months OR					B				B				B				b
Check Cooling System, Hoses and Clamps ④																	
Replace Frame-Mounted Fuel Filter			B		B		B		B		B		B		B		B
Replace Air Cleaner Filter ⑥		B			B				b				b				b
Replace Crankcase Emission Air Filter ⑥					B				b				b				b
Replace PCV Valve ③									b								b
Check Secondary Air Injection Hoses and Clamps ① ④									b								b
Inspect Drive Belt Condition									b								b
Other Systems																	
Change Rear Axle Lube ⑦ ⑨														B			
Check Wheel Lug Nut Torque ②		B	B	B	B	B	B	B	B								
Check Clutch Reservoir Fluid Level		B	B	B	B	B	B	B	B								
Lubricate Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins			B		B		B		B								
Inspect and Lubricate Automatic Transmission Shift Linkage (Bellcrank System) and Inspect Fluid ⑦ ⑧		B	B	B	B	B	B	B	B								
Inspect and Lubricate Front Wheel Bearings ⑧					B				B								
Rotate Tires		B		B		B		B									
Inspect Disc Brake System and Lubricate Caliper Slide Rails			B		B		B		B								
Inspect Drum Brake Systems, Hoses, and Lines ⑧			B		B		B		B								
Inspect Exhaust System for Leaks, Damage or Loose Parts ④					B				B								
Inspect and Remove any Foreign Material Trapped by Exhaust System Shielding		B	B	B	B	B	B	B	B								
Inspect Parking Brake System for Damage and Operation					B				B								
Lubricate Throttle and Kickdown Lever Ball Studs					B				B								
Lubricate Steering Linkage, Driveshaft Slip Yoke if equipped with Grease Fittings ⑧		B	B	B	B	B	B	B	B								
Lubricate Front Axle R.H. Axle Shaft Slip Yoke																	B
Inspect Spindle Needle Bearing Lubrication (4x4) ⑧					B				B								
Inspect Hub Lock Lubrication (4x4)					B				B								
Change Transfer Case Oil (4x4)																	B
Change Manual Transmission Oil (HD M50D/55-42 and Warner T18)																	B

Beyond 60,000 miles/96 000 km
continue recommended maintenance
operations at intervals indicated for
0-60,000 miles/96 000 km

① Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.

② Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation. See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

③ At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.0L and 5.8L engines except California and Canada vehicles.

④ Check means a functional measurement of Systems' operation (performance, leaks or conditions of parts). Correct as required.
NOTE: Refer to page 2 of the Maintenance Schedule Record Log book for "NO COST PCV VALVE REPLACEMENT."

⑤ UNIQUE DRIVING CONDITIONS

If your driving habits **FREQUENTLY** include one or more of the following conditions:

- Short trips of **less** than 10 miles (16 km) when outside temperatures remain below freezing.
 - Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
 - Operating in severe dust conditions.
 - Operating during **hot weather** in stop-and-go "rush hour" traffic.
 - Extensive idling, such as police, taxi or door-to-door delivery use.
 - Snow plowing.
 - High speed operation with a fully loaded vehicle (Max. GVW).
- Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.

⑥ AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

– If operating in severe dust conditions, ask your dealer for proper replacement intervals.

⑦ AUTOMATIC/HD MANUAL TRANSMISSION FLUID – Change each 30,000 miles (48 000 km)

– if your driving habits **frequently** include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.

- Towing a trailer or slide-in camper.
- Door-to-door delivery, police or taxi.
- Operating a transmission mounted PTO.

⑧ EXTREME SERVICE ITEMS

If your vehicle is operated **off-highway**, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

- Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.
- Inspect front wheel bearings and lubrication.
- Inspect disc brake system, lube caliper slide rails.
- Inspect drum brake system, hoses and lines.
- Inspect exhaust system for leaks, damage or loose parts and remove any foreign material trapped by shielding.
- Lubricate clutch release lever pivot (7.3L and 7.5L).

⑨ All rear axle lube quantities must be replaced every 100,000 miles (160 000 km) or if the axle has been submerged in water. Otherwise, the lube should not be checked or changed unless a leak is suspected or repair required.

CA13378-E

MAINTENANCE (Continued)

MAINTENANCE SCHEDULE G – NORMAL DRIVING CONDITIONS

F-250 HD/350 and Super Duty Unleaded Fuel Vehicles with 4.9L, 5.8L, and 7.5L MFI Engines and Heavy Duty Emissions (Over 8,500 lbs. GVWR)

G – Required for all vehicles

g – Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

(g) = This item not required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(g)" in order to achieve best vehicle operation. Failure to perform this recommended maintenance will not invalidate the vehicle emissions warranty or manufacturer recall liability.

NORMAL DRIVING SERVICE INTERVALS – PERFORM AT THE MONTHS OR DISTANCES SHOWN, WHICHEVER OCCURS FIRST.																									
MAINTENANCE OPERATION	MILES (Thousands)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	KILOMETERS (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96	104	112	121	129	136	145	152	160	169	177	184	193
Emission Control Systems																									
Change Engine Oil and Oil Filter – every 6 months OR (3)		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Replace Spark Plugs							G						G						G						G
Replace Engine Coolant – every 36 months OR							G						G						G						g
Check Cooling System, Hoses and Clamps (4)																									
Replace Frame Mounted Fuel Filter			G				G			G			G			G			G			G			G
Replace Air Cleaner Filter (5)							G						g						g						g
Replace Crankcase Emission Air Filter							G						g						g						g
Replace PCV Valve													g/1												g
Replace Ignition Wires													g												g
Check Secondary Air Injection Hoses and Clamps (1) (4)													g												g
Inspect Drive Belt Condition			G				G			G			G			G			G			G			G

(1) Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.

(2) Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles equipped with dual rear wheels or equipped for snowplowing). See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

(3) At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost except Canada vehicles.

(4) Check means a functional measurement of Systems' operation (performance, leaks or condition of parts). Correct as required.
NOTE: Refer to page 2 of the Maintenance Schedule Record Log book for "NO COST PCV VALVE REPLACEMENT."

UNIQUE DRIVING CONDITIONS

If your driving habits **FREQUENTLY** include one or more of the following conditions:

- Short trips of **less** than 10 miles (16 km) when outside temperatures remain below freezing.
- Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
- Operating in severe dust conditions.
- Operating during **hot weather** in stop-and-go "rush hour" traffic.
- Extensive idling, such as police, taxi or door-to-door delivery use.
- Snow plowing.
- High speed operation with a fully loaded vehicle (Max. GVW).

AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

– If operating in severe dust conditions, ask your dealer for proper replacement intervals.

AUTOMATIC/HD MANUAL 5-SPEED (S5-42) TRANSMISSION FLUID and SUPER-DUTY REAR AXLE LUBE

– Change each 30,000 miles (48 000 km) – if your driving habits **frequently** include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
- Towing a trailer or slide-in camper.
- Door-to-door delivery, police or taxi.
- Operating a transmission mounted PTO.
- Sandy, dusty or wet conditions (F-Super Duty only)

EXTREME SERVICE ITEMS

If your vehicle is operated **off-highway**, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

- Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.
- Inspect front wheel bearings and lubrication.
- Lubricate automatic transmission external controls (Bellcrank system) (F-Super Duty only).
- Inspect disc brake system, lube caliper slide rails.
- Inspect drum brake system, hoses and lines.
- Inspect exhaust system for leaks, damage or loose parts and remove any foreign material.

SUPER DUTY REAR AXLES F-250 HD/F-350 With Ford Design Rear Axles

- The lube change interval should be shortened to 3000 miles, or 3 months, whichever occurs first, during extended trailer tow operation above 70°F ambient and wide open throttle for extended periods above 45 mph.
- The 3000 mile lube change interval may be waived if the rear axle has been filled with Ford approved 75W-140 synthetic gear lube meeting material specification WSL-M2C192-A.

CA13379-E

MAINTENANCE (Continued)

MAINTENANCE SCHEDULE G – NORMAL DRIVING CONDITIONS

F-250 HD/350 and Super Duty Unleaded Fuel Vehicles with 4.9L, 5.8L, and 7.5L MFI Engines and Heavy Duty Emissions (Over 8,500 lbs. GVWR)

G – Required for all vehicles

g – Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

(g) = This item not required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(g)" in order to achieve best vehicle operation. Failure to perform this recommended maintenance will not invalidate the vehicle emissions warranty or manufacturer recall liability.

NORMAL DRIVING SERVICE INTERVALS – PERFORM AT THE MONTHS OR DISTANCES SHOWN, WHICHEVER OCCURS FIRST.																									
MAINTENANCE OPERATION	MILES (Thousands)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	KILOMETERS (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96	104	112	121	129	136	145	152	160	169	177	184	193
Other Systems																									
Change Rear Axle Lube ^{(7) ⑨ ⑩}																					G				
Check Wheel Lug Nut Torque ⁸		G	G	G	G	G	G	G	G	G	G	G	G												
Torque Front and Rear Spring U-Bolts (F-Super Duty Commercial and Motorhome Chassis ^①)		G		G			G				G										G				
Check and Lubricate Clutch Release Lever (7.5L)		G	G	G	G	G	G	G	G	G	G	G	G												
Check Clutch Fluid Reservoir Level		G	G	G	G	G	G	G	G	G	G	G	G												
Lubricate Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins				G			G				G														
Lubricate Automatic Transmission Linkage (Bellcrank System) and Inspect Fluid ⁽⁷⁾		G	G	G	G	G	G	G	G	G	G	G	G												
Lubricate Front Axle Spindle Pins, Steering Linkage, Driveshaft Slip Yoke if Equipped with Fittings		G	G	G	G	G	G	G	G	G	G	G	G												
Lubricate Front Axle Spindle Pins (F-Super Duty)				G			G				G														
Rotate Tires ⁽²⁾		G		G			G				G														
Inspect Disc Brake System, Lube Caliper Slide Rails and Knuckle Top and Bottom Inner Pad Slots				G			G				G														
Inspect Drum Brake System, Hoses and Lines				G			G				G														
Inspect and Lubricate Front Wheel Bearings							G																		
Inspect and Remove any Foreign Material Trapped by Exhaust System Shielding		G	G	G	G	G	G	G	G	G	G	G	G												
Inspect Exhaust System for Leaks, Damage or Loose Parts							G																		
Inspect Parking Brake System for Damage and Operation							G																		
Inspect Parking Brake Fluid Level (F-Super Duty)				G			G				G														
Lubricate Throttle and Kickdown Cable Ball Studs							G																		
Lubricate Front Drive Axle R.H. Axle Slip Yoke (4x4) (F250)							G																		
Inspect Spindle Needle Bearing Lubrication (4x4)							G																		
Inspect Hub Lock Lubrication (4x4)							G																		
Change Transfer Case Oil (4x4)							G																		
Change Manual Transmission Oil (HD M50D/S5-42) ⁽⁷⁾																					G				

Beyond 60,000 miles/96 000 km
continue recommended maintenance operations at
intervals indicated for 0-60,000 miles/96 000 km

① Required at first 1,000 miles (1 600 km) for initial service.

② Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles equipped with dual rear wheels or equipped for snowplowing). See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

③ At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost except Canada vehicles.

④ Check means a functional measurement of Systems' operation (performance, leaks or condition of parts). Correct as required.
NOTE: Refer to page 2 of the Maintenance Schedule Record Log book for "NO COST PCV VALVE REPLACEMENT."

⑤ UNIQUE DRIVING CONDITIONS

If your driving habits **FREQUENTLY** include one or more of the following conditions:

- Short trips of **less** than 10 miles (16 km) when outside temperatures remain below freezing.
- Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
- Operating in severe dust conditions.
- Operating during **hot weather** in stop-and-go "rush hour" traffic.
- Extensive idling, such as police, taxi or door-to-door delivery use.
- Snow plowing.
- High speed operation with a fully loaded vehicle (Max. GVW).

Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.

⑥ AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

– If operating in severe dust conditions, ask your dealer for proper replacement intervals.

⑦ AUTOMATIC/HD MANUAL 5-SPEED (S5-42) TRANSMISSION FLUID, SUPERDUTY AND F-250 HD/F-350 WITH FORD DESIGN REAR AXLE LUBE – Change each 30,000 miles (48 000 km) – if your driving habits **frequently** include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
- Towing a trailer or slide-in camper.
- Door-to-door delivery, police or taxi.
- Operating a transmission mounted PTO.
- Sandy, dusty or wet conditions (F-Super Duty Only)

⑧ EXTREME SERVICE ITEMS

If your vehicle is operated **off-highway**, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

- Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.
- Inspect front wheel bearings and lubrication.
- Lubricate automatic transmission external controls (Bellcrank system) (F-Super Duty only).
- Inspect disc brake system, lube caliper slide rails.
- Inspect drum brake system, hoses and lines.
- Inspect exhaust system for leaks, damage or loose parts and remove any foreign material.
- Lubricate clutch release lever pivot (7.5L).

⑨ SUPER DUTY REAR AXLES AND F-250 HD/F-350 WITH FORD DESIGN REAR AXLE

- The lube change interval should be shortened to 3000 miles, or 3 months, whichever occurs first, during extended trailer tow operation above 70°F ambient and wide open throttle for extended periods above 45 mph.
- The 3000 mile lube change interval may be waived if the rear axle has been filled with Ford approved 75W-140 synthetic gear lube meeting material specification WSL-M2C192-A.

⑩ Under normal driving conditions it is not necessary to check the rear drive axle lubricant. However, the lubricant should be changed every 100,000 miles (160 000 km) or if the rear axle has been submerged in water. OTHERWISE, THE REAR AXLE LUBRICANT SHOULD NOT BE CHECKED OR CHANGED UNLESS A LEAK IS SUSPECTED OR REPAIR IS REQUIRED.

CA15265-C

MAINTENANCE (Continued)

MAINTENANCE SCHEDULE B – NORMAL DRIVING CONDITIONS

E-150/250 and Club Wagon Unleaded Fuel Vehicles with Light Duty Emissions (Under 8,500 lbs. GVWR)

B – Required for all vehicles.

b – Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

(b) = This item not required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(b)" in order to achieve best vehicle operation. Failure to perform this recommended maintenance will not invalidate the vehicle emissions warranty or manufacturer recall liability.

NORMAL DRIVING SERVICE INTERVALS – PERFORM AT THE MONTHS OR DISTANCES SHOWN, WHICHEVER OCCURS FIRST																		
MAINTENANCE OPERATION	MILES (Thousands)	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75	82.5	90	97.5	105	112.5	120	
	KILOMETERS (Thousands)	12	24	36	48	60	72	84	96	109	121	133	145	157	169	181	193	
Emission Control Systems																		
Change Engine Oil and Oil Filter – every 6 months OR③		B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Replace Spark Plugs – Standard					B				B				B					B
Replace Coolant – every 36 months OR					B				B				B					b
Check Cooling System, Hoses and Clamps④																		
ANNUALLY																		
Replace Frame-Mounted Fuel Filter			B			B			B			B			B			B
Replace Air Cleaner Filter⑥						B			b					b				b
Replace Crankcase Emission Air Filter⑥						B			b					b				b
Replace PCV Valve③									b									b
Check Secondary Air Injection Hoses and Clamps① ④									b									b
Inspect Drive Belt Condition									B									B
Other Systems																		
Change Rear Axle Lube⑤															B			
Check Wheel Lug Nut Torque②		B	B	B	B	B	B	B	B									
Rotate Tires②		B			B			B										
Inspect and Lubricate Automatic Transmission Shift Linkage (Bellcrank System) and Inspect FluidF		B	B	B	B	B	B	B	B									
Inspect and Lubricate Front Wheel Bearings						B				B								
Inspect Disc Brake System and Lubricate Caliper Slide Rails and Knuckle Top and Bottom Inner Pad Slots				B		B				B								
Inspect Drum Brake Systems, Hoses, and Lines				B		B				B								
Inspect Exhaust System for Leaks, Damage or Loose Parts						B				B								
Inspect and Remove any Foreign Material Trapped by Exhaust System Shielding		B	B	B	B	B	B	B	B									
Inspect Parking Brake System for Damage and Operation						B				B								
Lubricate Throttle and Kickdown Lever Ball Studs						B				B								
Lubricate Steering Linkage, Driveshaft Slip Yoke if Equipped with Grease Fittings		B	B	B	B	B	B	B	B									
Check Warning Lights and Gauges				B														

Beyond 60,000 miles/96 000 km, continue recommended maintenance operations at intervals indicated for 0-60,000 miles/96 000 km.

Beyond 60,000 miles/96 000 km, continue recommended maintenance operations at intervals indicated for 0-60,000 miles/96 000 km.

① Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.

② Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation. See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

③ At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.0L and 5.8L engines except California and Canada vehicles.

④ Check means a functional measurement of Systems' operation (performance, leaks or conditions of parts). Correct as required.

⑤ UNIQUE DRIVING CONDITIONS

If your driving habits **FREQUENTLY** include one or more of the following conditions:

- Short trips of **less** than 10 miles (16 km) when outside temperatures remain below freezing.
- Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
- Operating in severe dust conditions.
- Operating during **hot weather** in stop-and-go "rush hour" traffic.
- Extensive idling, such as police, taxi or door-to-door delivery service.
- High speed operation with a fully loaded vehicle (max. GVW).

Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.

⑥ AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

– If operating in severe dust conditions, ask your dealer for proper replacement intervals.

⑦ AUTOMATIC TRANSMISSION FLUID – Change each 30,000 miles (48 000 km) – if your driving habits **frequently** include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.

- Towing a trailer or slide-in camper.
- Door-to-door delivery, police or taxi.

⑧ EXTREME SERVICE ITEMS

If your vehicle is operated **off-highway**, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily:

- Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.
- Inspect front wheel bearings and lubrication.
- Inspect disc brake system, lube caliper slide rails.
- Inspect drum brake system, hoses and lines.
- Inspect exhaust system for leaks, damage or loose parts and remove any foreign material trapped by shielding.
- Lubricate clutch release lever pivot (7.5L).
- ⑨ All rear axle lube quantities must be replaced every 100,000 miles (160 000 Km) or if the axle has been submerged in water. Otherwise, the lube should not be checked or changed unless a leak is suspected or repair required.

CY13380-E

MAINTENANCE (Continued)

MAINTENANCE SCHEDULE G – NORMAL DRIVING CONDITIONS

E-250/350 and Club Wagon Unleaded Fuel Vehicles with 4.9L, 5.8L, and 7.5L EFI Engines and Heavy Duty Emissions (Over 8,500 lbs. GVWR)

G – Required for all vehicles

g – Required for 49 States vehicles and recommended only for California and Canada vehicles.

Ford recommends that you perform maintenance on all designated items to achieve best vehicle operation.

(g) = This item not required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(g)" in order to achieve best vehicle operation. Failure to perform this recommended maintenance will not invalidate the vehicle emissions warranty or manufacturer recall liability.

NORMAL DRIVING SERVICE INTERVALS – PERFORM AT THE MONTHS OR DISTANCES SHOWN, WHICHEVER OCCURS FIRST.																									
MAINTENANCE OPERATION	MILES (Thousands)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	KILOMETERS (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	177	184	193
Emission Control Systems																									
Change Engine Oil and Oil Filter every 6 months OR ⑤		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Replace Spark Plugs								G					G						G						g
Replace Engine Coolant – every 36 months OR								G					G						G						g
Check Cooling System, Hoses and Clamps④																									
Replace Frame-Mounted Fuel Filter				G			G			G			G			G			G			G			G
Replace Air Cleaner Filter⑥							G						G						G						G
Replace Crankcase Emission Air Filter							G						G						G						G
Replace PCV Valve③													G												G
Replace Ignition Wires													G												G
Check Secondary Air Injection Hoses and Clamps①④													G												G
Inspect Drive Belt Condition			G			G			G			G			G			G			G			G	G
Other Systems																									
Change Rear Axle Lube⑧																					G				
Check Wheel Lug Nut Torque②		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Rotate Tires②		G		G			G			G			G												
Lubricate Automatic Transmission Linkage (Bellcrank System) and Inspect Fluid⑦		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Lubricate Steering Linkages, Driveshaft U-joint and Slip Yoke if Equipped with Fittings		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Inspect Disc Brake System and Lubricate Caliper Slide Rails and Knuckle Top and Bottom Inner Pad Slots				G			G			G			G												
Inspect Drum Brake Systems, Hoses and Lines				G			G			G			G												
Inspect and Lubricate Front Wheel Bearings							G						G												
Inspect Exhaust System for Leaks, Damage or Loose Parts							G						G												
Inspect and remove any foreign material trapped by exhaust system shielding		G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Inspect Engine Air Induction System (E-350 over 10,000 lbs. GVWR only)							G						G												
Inspect Fan and Fan Shroud (E-350 over 10,000 lbs. GVWR only)							G						G												
Inspect Parking Brake System for Damage and Operation							G						G												
Lubricate Throttle and Kickdown Lever Ball Studs							G						G												

Beyond 60,000 miles/96 000 km
continue recommended maintenance operations at
intervals indicated for 0-60,000 miles/96 000 km

① Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are not contingent upon the performance of emission related checks or inspections.

② Wheel lug nuts must be retightened to proper torque specifications at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles equipped with dual rear wheels). See your Owner Guide for proper torque specifications. Also retighten to proper torque specification at 500 miles/800 km after (1) any wheel change or (2) any other time the wheel lug nuts have been loosened.

③ At 60,000 miles/96 000 km, your dealer will replace the PCV Valve at no cost on 4.9L, 5.8L and 7.5L engines except California and Canada vehicles.

④ Check means a functional measurement of Systems' operation (performance, leaks or conditions of parts). Correct as required.

⑤ UNIQUE DRIVING CONDITIONS

If your driving habits **FREQUENTLY** include one or more of the following conditions:

- Short trips of **less** than 10 miles (16 km) when outside temperatures remain below freezing.
- Towing a trailer, using a camper, roof-top carrier or carrying maximum loads.
- Operating in severe dust conditions.
- Operating during **hot weather** in stop-and-go "rush hour" traffic.
- Extensive idling, such as police, taxi or door-to-door delivery service.
- High speed operation with a fully loaded vehicle (Max. GVW).

Change ENGINE OIL AND OIL FILTER every 3 months or 3,000 miles (4 800 km) whichever occurs first.

⑥ AIR CLEANER and CRANKCASE EMISSION AIR FILTERS

– If operating in severe dust conditions, ask your dealer for proper replacement intervals.

⑦ AUTOMATIC TRANSMISSION FLUID – Change each 30,000 miles (48 000 km) – if

your driving habits **frequently** include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.

- Towing a trailer.

- Door-to-door delivery, police or taxi.

⑧ EXTREME SERVICE ITEMS

If your vehicle is operated **off-highway**, perform the following items every 1,000 miles (1 600 km). If your vehicle is operated in mud and/or water, perform the following items daily.

- Lubricate front axle spindle pins, steering and clutch linkages, axle and driveshaft U-joints and slip yoke if equipped with fittings.
- Inspect front wheel bearings and lubrication.
- Inspect disc brake system, lube caliper slide rails.
- Inspect drum brake system, hoses and lines.
- Inspect exhaust system for leaks, damage or loose parts and remove any foreign material trapped by shielding.
- Lubricate clutch release lever pivot (7.5L).

⑨ Under normal driving conditions it is not necessary to check the rear drive axle lubricant. However, the lubricant should be changed every 100,000 miles (160 000 km) or if the rear axle has been submerged in water. OTHERWISE, THE REAR AXLE LUBRICANT SHOULD NOT BE CHECKED OR CHANGED UNLESS A LEAK IS SUSPECTED OR REPAIR IS REQUIRED.

CA13381-E

MAINTENANCE (Continued)

MAINTENANCE SCHEDULE E – VEHICLES EQUIPPED WITH 7.3L DIESEL ENGINES

SERVICE INTERVALS – PERFORM AT THE MONTHS OR THE DISTANCES SHOWN, WHICHEVER COMES FIRST																									
MAINTENANCE OPERATION	MILES (Thousands)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
	KILOMETERS (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96	105	113	121	129	137	145	153	161	169	177	185	193
Emission Control Systems																									
Change Engine Oil and Replace Oil Filter - every 6 months or at Mileage①		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Check Engine Idle Speed (Adjust as Required) ④			X		X			X			X			X		X			X			X			X
Check Throttle Operation and Idle Return Spring ④	X			X			X			X			X			X			X			X			X
Check Coolant Level in the Radiator and Overflow Bottle		MONTHLY																							
Check Coolant Condition and Protection, Cooling System/Hoses/Clamps (Prior to Cold Weather)		ANNUALLY																							
Replace Coolant Every 36 Months or at Mileage							X						X						X						X
Check and Inspect Drive Belt Condition and Tension⑤							X						X						X						X
Replace Air Cleaner Element②							X						X						X						X
Inspect Engine Air Induction System							X						X						X						X
Replace Fuel Filter②													X												
Drain Water from Fuel/Filter Bowl③	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

*Wheel lug nuts must be retightened to proper torque specification at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles with dual rear wheels or vehicles equipped for snowplowing). See your Owner Guide for proper torque specification. Also retighten to proper torque specification at 500 miles/800 km, after any wheel change, or any other time the wheel lug nuts have been loosened.

① SEVERE SERVICE OPERATION

When operating your vehicle under any of the following conditions, change engine oil and filter every three months or 2500 miles (4 000 km) whichever occurs first (every 265 gallons [1000 liters] of fuel can be substituted for the 2500 miles [4 000 km]). Use an engine oil conforming to Ford Specifications or the equivalent oil conforming to API service categories of both SG and CD. Do not use oil labeled as only SG or only CD, as they could cause engine damage. The oil should be of the proper viscosity (thickness) as identified on page 29.

- Sustained high speed driving at GVWR during hot weather (over 90°F/32°C).
- Operation in severe dust conditions.
- Trailer towing for long distances (over 1,000 miles/1 600 km).
- Frequent or extended idling (over 10 minutes per hour of normal driving). If the idling time is greater than 50% of the engine operation time, the oil and filter should be changed every 125 to 150 hours of engine operation.

② More often if operated in severe service or dust conditions. An instrument panel warning light will glow during normal engine operation when filter replacement is required. On vehicles equipped with E4OD transmission, make sure that the Throttle Position Sensor (TP/FIPL) connector is properly seated and that the sensor, connector, or wiring have not been damaged during fuel filter service.

③ More frequent intervals may be required dependent on fuel quality and vehicle usage. An instrument panel warning light will glow when servicing is required, or when the ignition key is in the START position.

④ Every 12 months or at mileage.

⑤ For severe service only change fluid every 30,000 miles. The definition of severe service for automatic transmission is as follows:

The automatic transmission fluid should be changed every 30,000 miles (48 000 km) if your vehicle(s) operate under any of the following conditions:

- Sustained high speed driving during hot weather (+90°F, +32°C).
- Towing a trailer for long distances.
- Accumulating 5,000 miles (8 000 km) or more per month.
- Continuous running service.

⑥ Inspect belt and check tension every 5000 miles on ambulance units.

⑦ HD MANUAL 5-SPEED (S5-42) TRANSMISSION FLUID – Change each 30,000 miles (48,000 km) – If driving habits frequently include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
- Towing a trailer or slide in camper.
- Operating a transmission mounted PTO.

⑧ For F-Super Duty, F-250 HD/F-350 with Ford Design rear axles, refer to the unique driving conditions noted in Maintenance Schedule G which creates the need for a 30,000 mile lube change interval; note also the extreme service conditions in Schedule G which create the need for a 3,000 mile/3 month lube change interval or the alternative use of synthetic 75W-140 rear axle lube meeting material specification WSL-M2C192-A.

⑨ Automatic C-6 Transmission: Vacuum Regulator Valve must be adjusted to specifications. Any setting outside the specified range may lead to transmission malfunction. Automatic E4OD transmission: Throttle Position Sensor (TP/FIPL) must be checked and adjusted to specifications every 50,000 miles. Any setting outside the specified range may lead to transmission malfunction.

CA13382-E

MAINTENANCE (Continued)

MAINTENANCE SCHEDULE E – VEHICLES EQUIPPED WITH 7.3L DIESEL ENGINES (Continued)

SERVICE INTERVALS – PERFORM AT THE MONTHS OR THE DISTANCES SHOWN, WHICHEVER COMES FIRST																									
MAINTENANCE OPERATION	MILES (Thousands)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
KILOMETERS (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	176	184	192	200
Other Systems																									
Change Rear Axle Lube ⁽⁶⁾																									
Check and Adjust Wheel Lug Nut Torque*		X	X	X	X	X	X	X	X	X	X	X	X												
Torque Front and Rear Spring U-Bolts (F-Super Duty Commercial and Motorhome Chassis)	^(a)			X			X			X			X												
Inspect Exhaust System/Shields/Joints for Leaks, Breakage, Looseness, and Corrosive Damage							X																		
Inspect Diesel Engine Mounted Noise Hardware for Damage or Oil/Fuel Saturation (i.e., Block Panels, Oil Pan Covers, Treated Valve Covers)							X																		
Inspect the Vehicle for Missing, Damaged, or Mislocated Chassis and Body Mounted Noise Shields							X																		
Inspect Fan and Fan Shroud (E- and F-350 Over 10,000 lbs. GVWR Only)				X			X			X															
Lubricate Driveshaft Slip Yoke if Equipped with Grease Fittings		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lubricate Steering Linkage (Only if Equipped with Grease Fittings)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lubricate Front Axle Spindle Pins (Econoline Only)		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Inspect and Lubricate Automatic Transmission Shift Linkage (Bellcrank System) ⁽¹⁾⁽⁷⁾		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lubricate Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins			B		B		B		B		B		B		B		B		B		B		B		B
Check Clutch Reservoir Fluid Level		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lubricate Clutch Release Lever Pivots		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Check Brake Master Cylinder Fluid Level							X																		
Inspect Disc Brake System, Lube Caliper Slide Rails and Knuckle Top and Bottom Inner Pads				X			X			X															
Inspect Parking Brake System for Damage and Operation				X			X			X															
Inspect Drum Brake Linings, Lines, Hoses				X			X			X															
Rotate Tires		X		X			X			X															
Lubricate Throttle Ball Stud							X																		
Inspect and Lubricate Front Wheel Bearings							X																		
Inspect Hub Lock Lubrication (4x4)							X																		
Inspect (4x4) Spindle Needle Bearing Lubrication							X																		
Change Transfer Case Oil (4x4)							X																		
Check Parking Brake Fluid Level (F-Super Duty Only)				X			X			X				X			X			X			X		X
Change Manual Transmission Lube ⁽⁷⁾													X												

NOTE: Checks, Inspections and Lubrication Intervals on Non-Emission Items (Other Systems) Should Be Continued at the Same Mileage Intervals

*Wheel lug nuts must be retightened to proper torque specification at 500 miles/800 km of new vehicle operation (100 miles/160 km and 500 miles/800 km for vehicles with dual rear wheels or vehicles equipped for snowplowing). See your Owner Guide for proper torque specification. Also retighten to proper torque specification at 500 miles/800 km, after any wheel change, or any other time the wheel lug nuts have been loosened.

^(a) Required at first 1,000 miles (1600 km) for initial service.

① SEVERE SERVICE OPERATION

When operating your vehicle under any of the following conditions, change engine oil and filter every three months or 2500 miles (4 000 km) whichever occurs first. Use an engine oil conforming to Ford Specifications or the equivalent oil conforming to API service categories of both SF and CD. Do not use oil labeled as only SF or only CD, as they could cause engine damage. The oil should be of the proper viscosity (thickness) as identified on page 29.

- Sustained high speed driving at GVWR during hot weather (over 90°F/32°C).
- Operation in severe dust conditions.
- Trailer towing for long distances (over 1,000 miles/1 600 km).
- Frequent or extended idling (over 10 minutes per hour of normal driving).

② More often if operated in severe service or dust conditions. An instrument panel warning light will glow during normal engine operation when filter replacement is required. On vehicles equipped with E4OD transmission, ensure that the Throttle Position Sensor (TP/FIPL) connector is properly seated and that the sensor, connector, or wiring have not been damaged during fuel filter service.

③ More frequent intervals may be required dependent on fuel quality and vehicle usage. An instrument panel warning light will glow when servicing is required, or when the ignition key is in the START position.

④ Every 12 months or at mileage.

⑤ For severe service only change fluid every 30,000 miles. The definition of severe service for automatic transmission is as follows:

The automatic transmission fluid should be changed every 30,000 miles (48 000 km) if your vehicle(s) operate under any of the following conditions:

- Sustained high speed driving during hot weather (+90°F, +32°C).
- Towing a trailer for long distances.
- Accumulating 5,000 miles (8 000 km) or more per month.
- Continuous running service.

⑥ Inspect belt and check tension every 5000 miles on ambulance units.

⑦ HD Manual 5-speed (S5-42) Transmission Fluid – Change each 30,000 miles (48,000 km) – if driving habits frequently include one or more of the following conditions:

- Operating during hot weather (above 90°F, 32°C) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
- Towing a trailer or slide in camper.
- Operating a transmission mounted PTO.

⑧ For F-Super Duty F-250 HD/F-350 with Ford Design rear axles, refer to the unique driving conditions noted in maintenance Schedule G which creates the need for a 30,000 mile lube change interval; note also the extreme service conditions in Schedule G which create the need for a 3,000 mile/3 month lube change interval or the alternative use of synthetic 75W-140 rear axle lube meeting material specification WSL-M2C192A.

⑨ Automatic C-6 Transmission: Vacuum Regulator Valve must be adjusted to specifications. Any setting outside the specified range may lead to transmission malfunction. Automatic E4OD transmission: Throttle Position Sensor (TP/FIPL) must be checked and adjusted to specifications every 50,000 miles. Any setting outside the specified range may lead to transmission malfunction.

CA15266-C

Owner Maintenance Checks

Listed below are vehicle maintenance checks and inspections that should be performed by the owner or qualified service technician at the indicated intervals. The Owner Guide contains supporting specifications and service information.

Any adverse conditions should be brought to the attention of the dealer or qualified service technician as soon as possible.

These owner maintenance checks are generally not covered by warranties and the owner may be charged for labor, parts and lubricants used.

MAINTENANCE (Continued)**When Stopping for Fuel**

- Check the engine oil level.
- Check the windshield washer fluid level.
- Look for low or under-inflated tires.
- Check coolant fill in recovery reservoir.

While Operating the Vehicle

- Note any changes in the sound of the exhaust or any smell of exhaust fumes in the vehicle.
- Check for vibrations in the steering wheel. Notice any increased steering effort or looseness in the steering wheel, or change in its straight ahead position.
- Notice if the vehicle constantly turns slightly or "pulls" to one side when traveling on smooth, level road.
- When stopping, listen and check for strange sounds, pulling to one side, increased brake pedal travel or "hard to push" brake pedal.
- If any slipping or changes in the operation of the transmission occurs, check the transmission occurs, check the transmission fluid level.
- Check automatic transmission PARK function.
- Check parking brake.
- Verify proper "Brake" and "Rear AntiLock" bulb check response when starting vehicle.

At Least Monthly

- Check and adjust tire pressure (cold).
- Check coolant level in the coolant recovery reservoir.
- Check operation of lights, horn, turn signals, windshield wipers and washers, and hazard warning flasher.
- Check for fluid leaks by inspecting the surface beneath the vehicle for oil, coolant, or other fluid drips. Clean water from the air conditioning system is normal.

At Least Twice a Year — Spring and Fall

- Check power steering reservoir fluid level.
 - Check radiator, heat and air-conditioning hoses for leaks or damage.
 - Check fluid level in clutch master cylinder.
 - Clean body and door drain holes.
 - Flush complete underside of vehicle.
 - Inspect underbody components for damage.
 - Check exhaust system for leaks or damage.
- NOTE: It is normal for a certain amount of moisture and staining to be present around the muffler seams. The presence of soot, light surface rust or moisture does not indicate a faulty muffler.
- Check parking brake system.

- Check headlamp alignment.
- Check seat and shoulder belt webbing, buckles and release mechanisms.
- Inspect seat back latches for proper operation.
- Check air pressure in spare tire.

At Least Once a Year

- Lubricate door hinges and checks and hood hinges.
- Lubricate door, hood and tailgate locks, and latches, including swing-away spare tire carrier latch and striker.
- Lubricate door rubber weatherstrips.
- Inspect and lubricate automatic transmission linkage / cable.
- Clean battery and terminals, check electrolyte level on low maintenance (auxiliary and replacement) batteries.
- Check manual transmission, 4x4 transfer case, and front drive axle. Rear axle fluid levels on Ford design rear axles should not be checked unless a leak is suspected or a repair is required.
- Check parking brake fluid level (F-Super Duty).

Tire Rotation

Tire rotation is recommended by all tire and vehicle manufacturers to improve wear life and to avoid abnormal wear.

- Rotate tires the first time between 5,000 and 7,500 miles (8,000-12,000 km) or earlier if there is any sign of uneven treadwear. The first rotation is most important.
- Subsequent tire rotations should be performed at 15,000 miles (24,000 km) maintenance intervals.

Lubrication

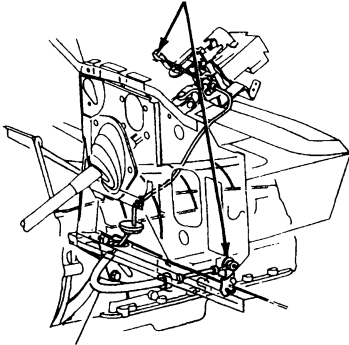
Important lubrication points for typical chassis and engines are shown in the following illustrations. Vehicles with optional equipment may have slightly different or additional lubrication points. When special equipment or accessories are installed on the truck, consult the manufacturer's literature for lubrication procedures. A table of recommended lubricants is included at the end of this section.

WARNING: THE AMERICAN PETROLEUM INSTITUTE (API) HAS ANNOUNCED THAT CONTINUOUS CONTACT WITH USED MOTOR OIL HAS CAUSED SKIN CANCER IN LABORATORY MICE. THE EFFECTS OF USED MOTOR OIL ON HUMANS HAS NOT BEEN ESTABLISHED. IT IS RECOMMENDED, HOWEVER, THAT AS A PRECAUTIONARY MEASURE, HUMANS PROTECT THEIR SKIN BY WASHING WITH SOAP AND WATER AFTER COMING IN CONTACT WITH USED MOTOR OIL.

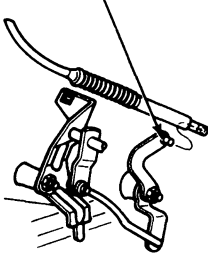
MAINTENANCE (Continued)

Lubrication Points, F-150-250-350 4x4 and Bronco Chassis

LUBRICATE WITH MULTI-PURPOSE GREASE
D7AZ-19584-AA (ESR-MIC59-A) OR PREMIUM
LONG-LIFE GREASE XG-1-C OR -K
(ESA-M1C75-B) OR EQUIVALENT



BALL STUD — LUBRICATE WITH
MULTI-PURPOSE GREASE
D7AZ-19584-AA OR
PREMIUM LONG-LIFE GREASE
XG-1-C (ESA-MIC75-B)
OR EQUIVALENT



THROTTLE VALVE (TV)
CABLE LINKAGE 5.0L
MFI AOD TRANSMISSION ONLY
KICKDOWN CABLE LINKAGE
4.9L MFI AND 7.5L MFI
C-6 TRANSMISSION ONLY



TRANSMISSION
DIPSTICK
(AUTOMATIC)

CHECK FRONT AXLE
LUBRICANT LEVEL

GREASE
FITTING

PITMAN ARM
CONNECTION
GREASE FITTING

STEERING LINKAGE
GREASE FITTINGS
(4 PLACES) IF SO EQUIPPED

* REPACK FRONT WHEEL
BEARING AND LOCKING
HUBS (BOTH SIDES)
LUBRICATE DISC BRAKE
CALIPER SLIDE RAILS AND
KNUCKLE INNER PAD SLOT

LUBRICATE FRONT SPINDLE
NEEDLE BEARINGS

LUBRICATE UNIVERSAL JOINT
FITTINGS AND
SPLINE FITTING (SLIP YOKE)
(IF SO EQUIPPED)

LUBE CLUTCH
RELEASE LEVER

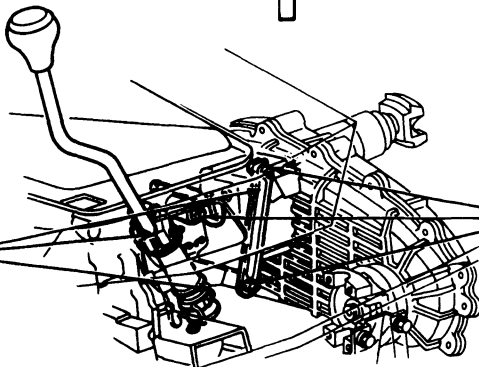
LUBRICATE
SLIP YOKE SPLINE
FITTING IF SO
EQUIPPED

MANUAL
TRANSMISSION
FILL PLUG
CHECK LEVEL
(ON DRIVER'S SIDE)
(ON PASSENGER
SIDE FOR 4-SPEED)

CHECK FLUID LEVEL
TRANSFER CASE
*DRAIN AND REFILL
TRANSFER CASE

REAR AXLE
FILL PLUG

*LUBRICATE
TRANSFER CASE
SHIFT LEVER PIVOT
BOLT AND CONTROL
ROD CONNECTING PINS



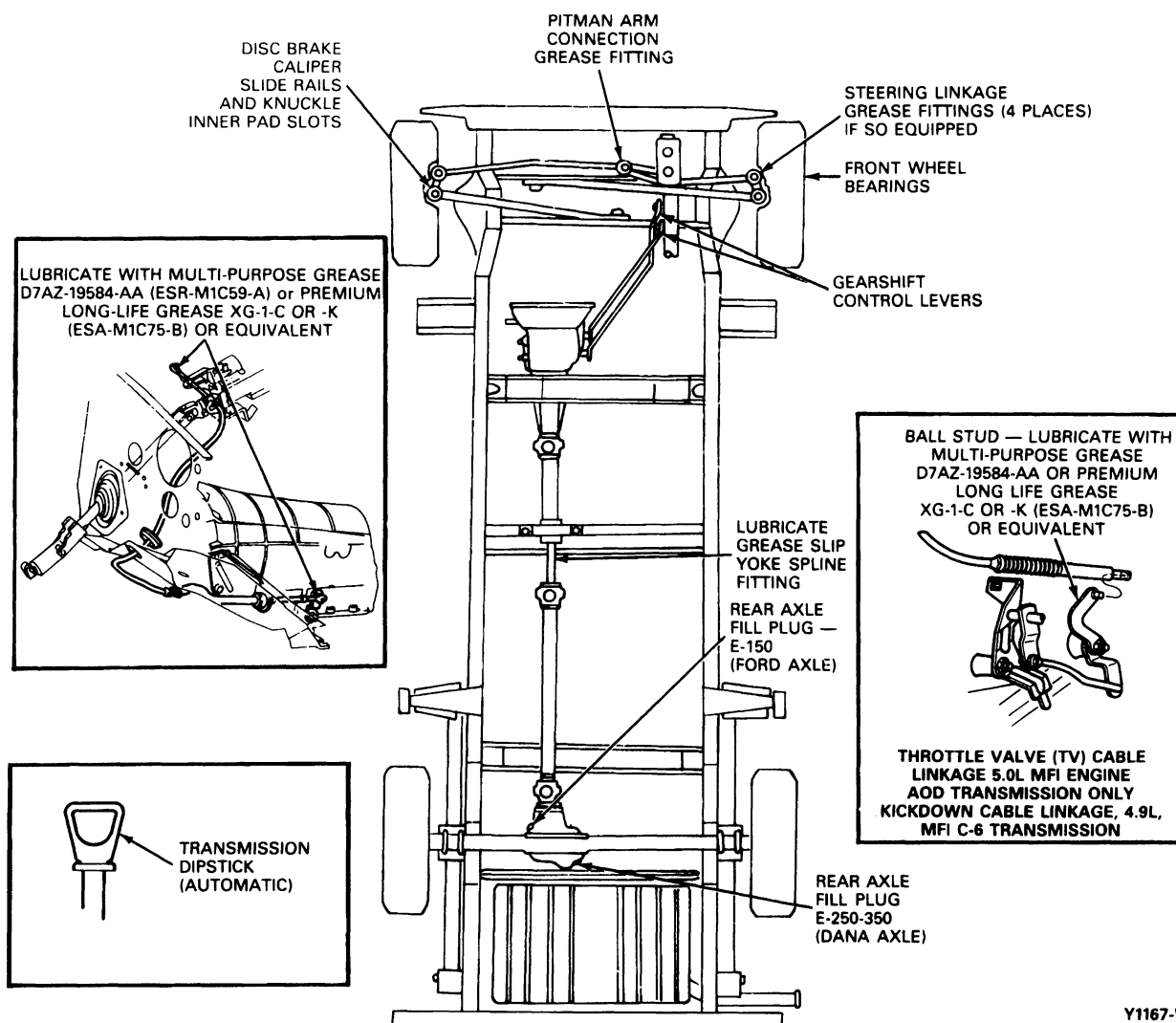
LUBE
POINTS

*DAILY WHEN OPERATING IN DEEP WATER

Y1031-Z

MAINTENANCE (Continued)

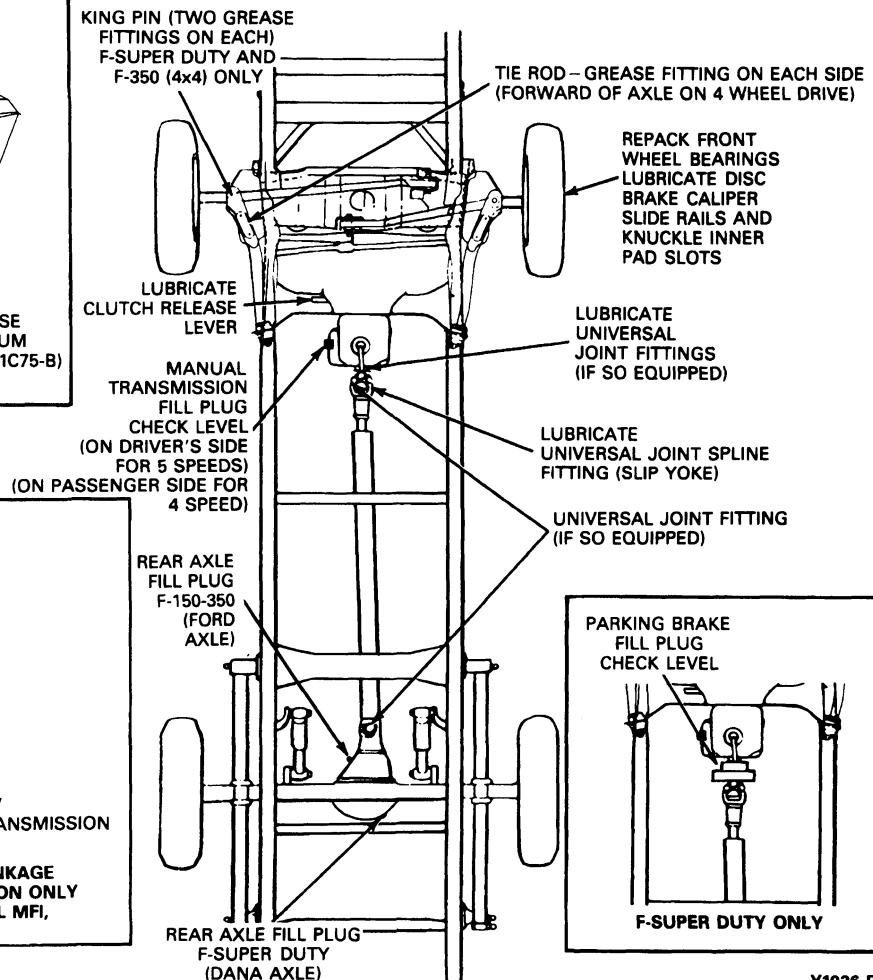
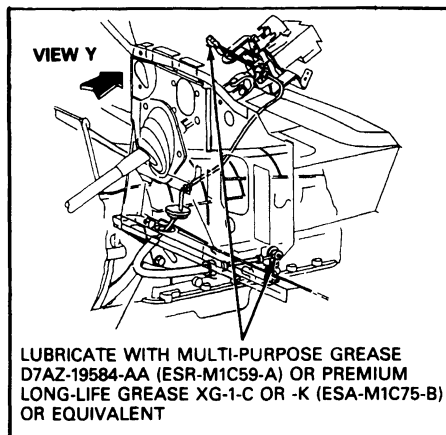
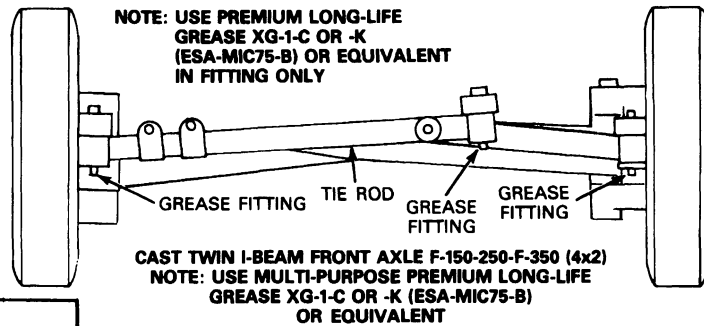
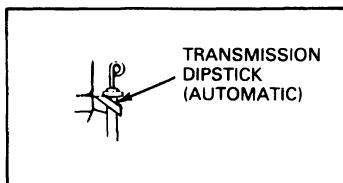
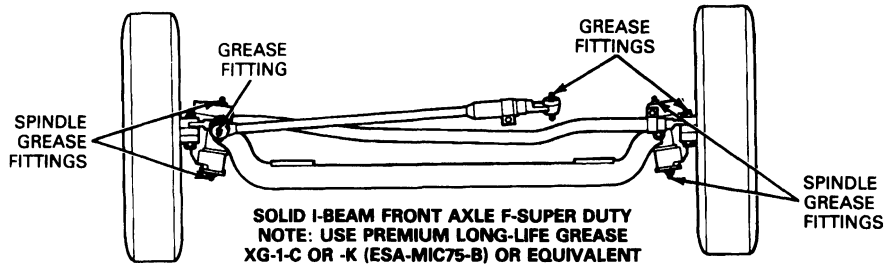
Lubrication Points, E-150-250-350 Typical Chassis



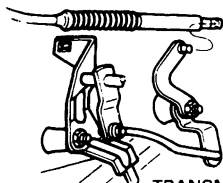
Y1167-W

MAINTENANCE (Continued)

Lubrication Points, F-150-250-350 4x2 and F-Super Duty Chassis



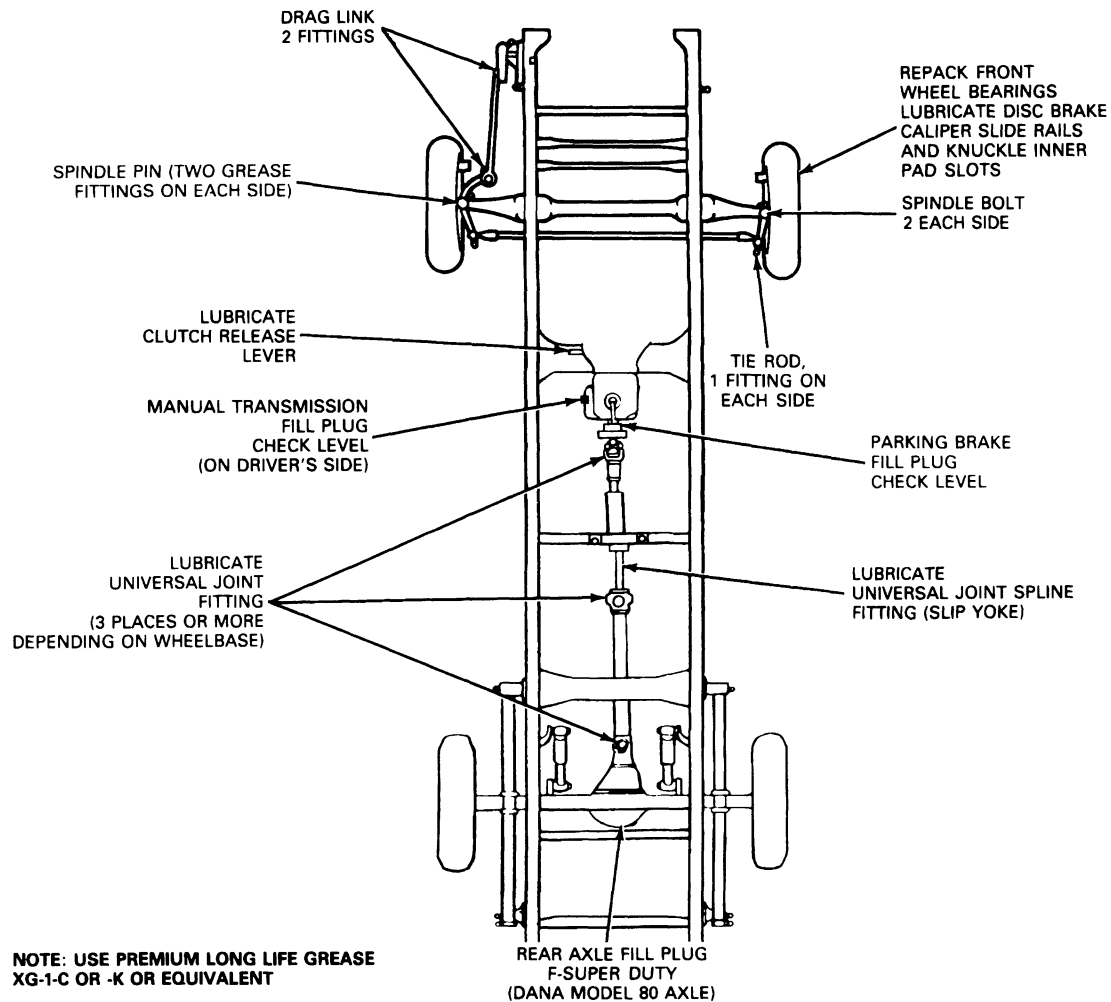
BALL STUD
LUBRICATE WITH MULTI-PURPOSE GREASE D7AZ-19584-AA OR PREMIUM LONG-LIFE GREASE XG-1-C OR -K (ESA-MIC75-B) OR EQUIVALENT



TRANSMISSION T-V LEVER PART OF TRANSMISSION REFERENCE

THROTTLE VALVE (TV) CABLE LINKAGE
5.0L MFI ENGINE AOD TRANSMISSION ONLY
KICKDOWN CABLE LINKAGE, 4.9L MFI, 5.8L MFI, 7.5L MFI

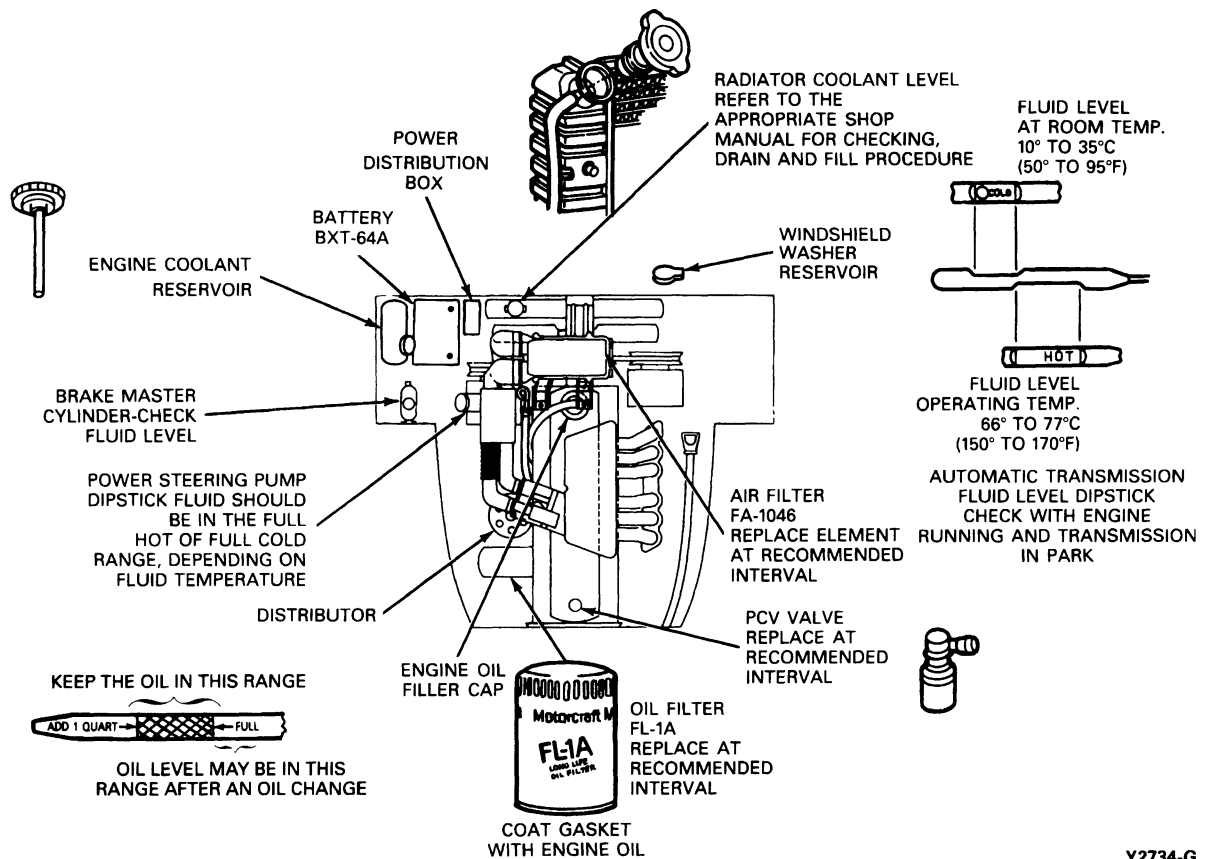
Y1026-R

MAINTENANCE (Continued)**Lubrication Points, F-Super Duty Commercial and Motorhome Chassis**

Y4153-F

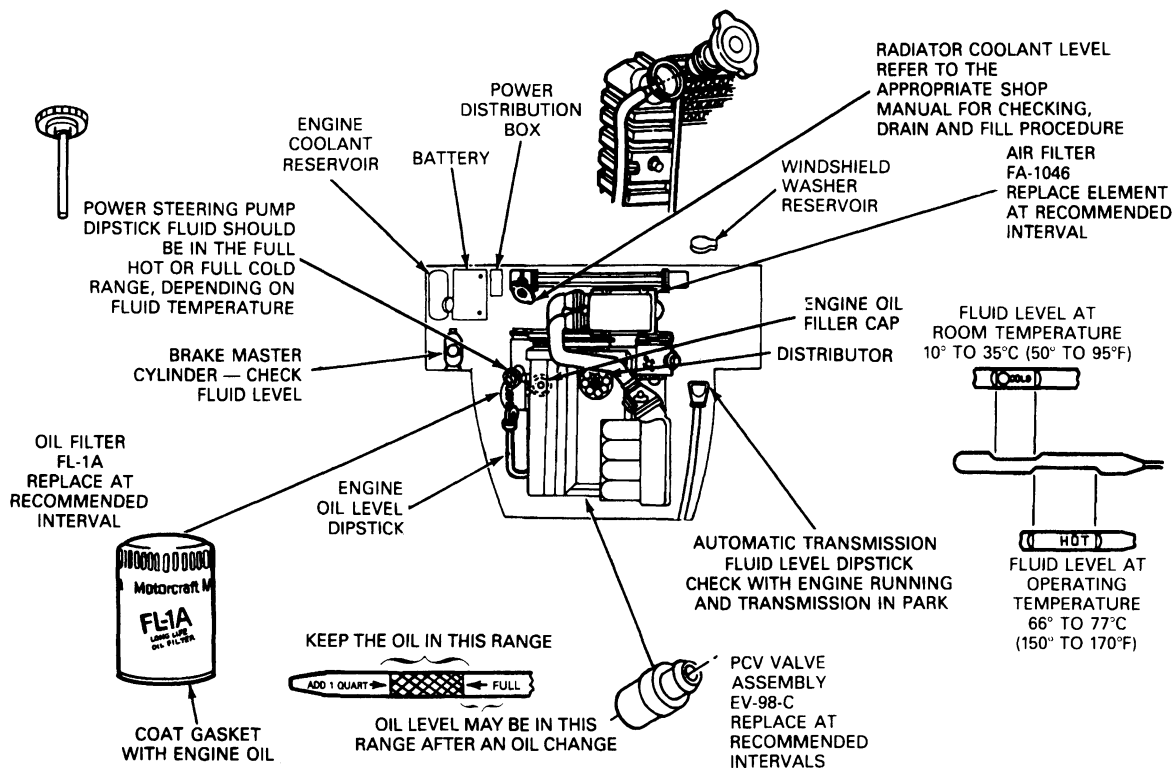
MAINTENANCE (Continued)

Service Points, 4.9L Engine, Econoline

**Y2734-G**

MAINTENANCE (Continued)

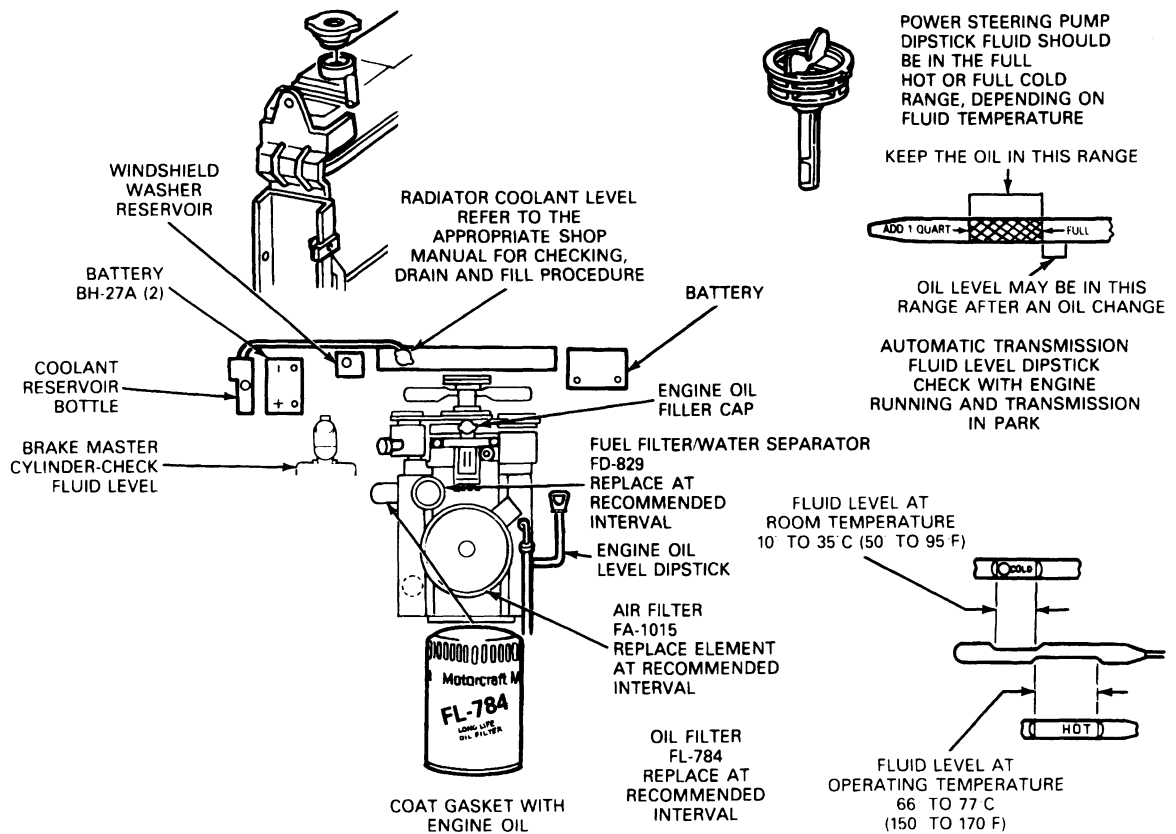
Service Points, 5.0L and 5.8L Engine, Econoline



Y2735-H

MAINTENANCE (Continued)

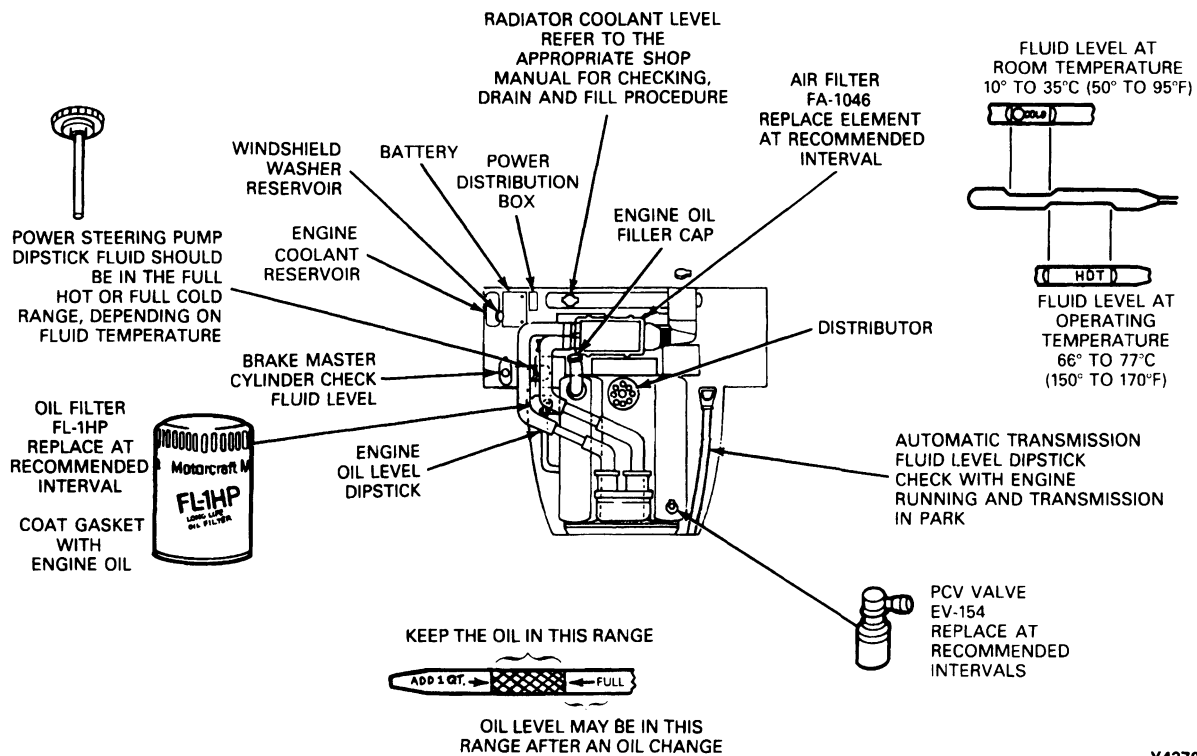
Service Points, 7.3L Diesel Engine, Econoline



Y2736-H

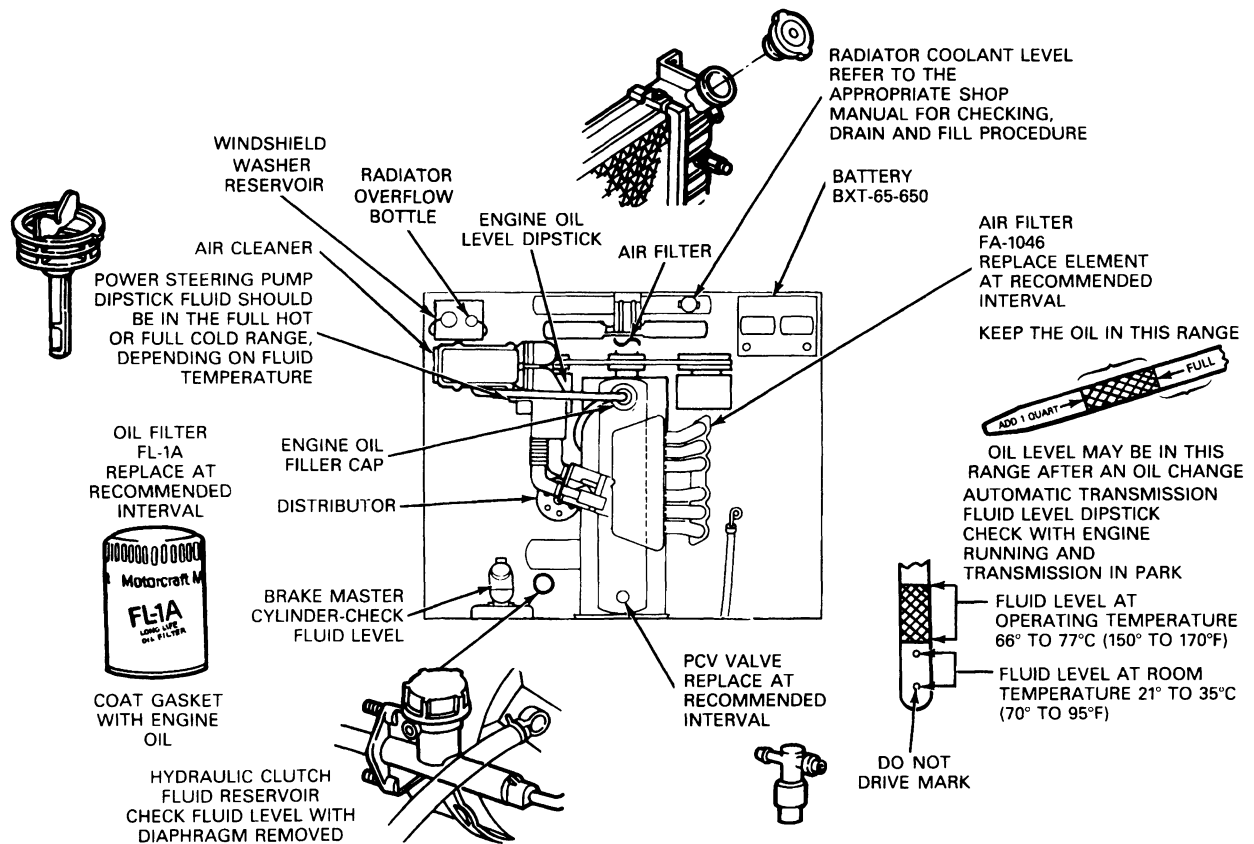
MAINTENANCE (Continued)

Service Points, 7.5L Engine, Econoline

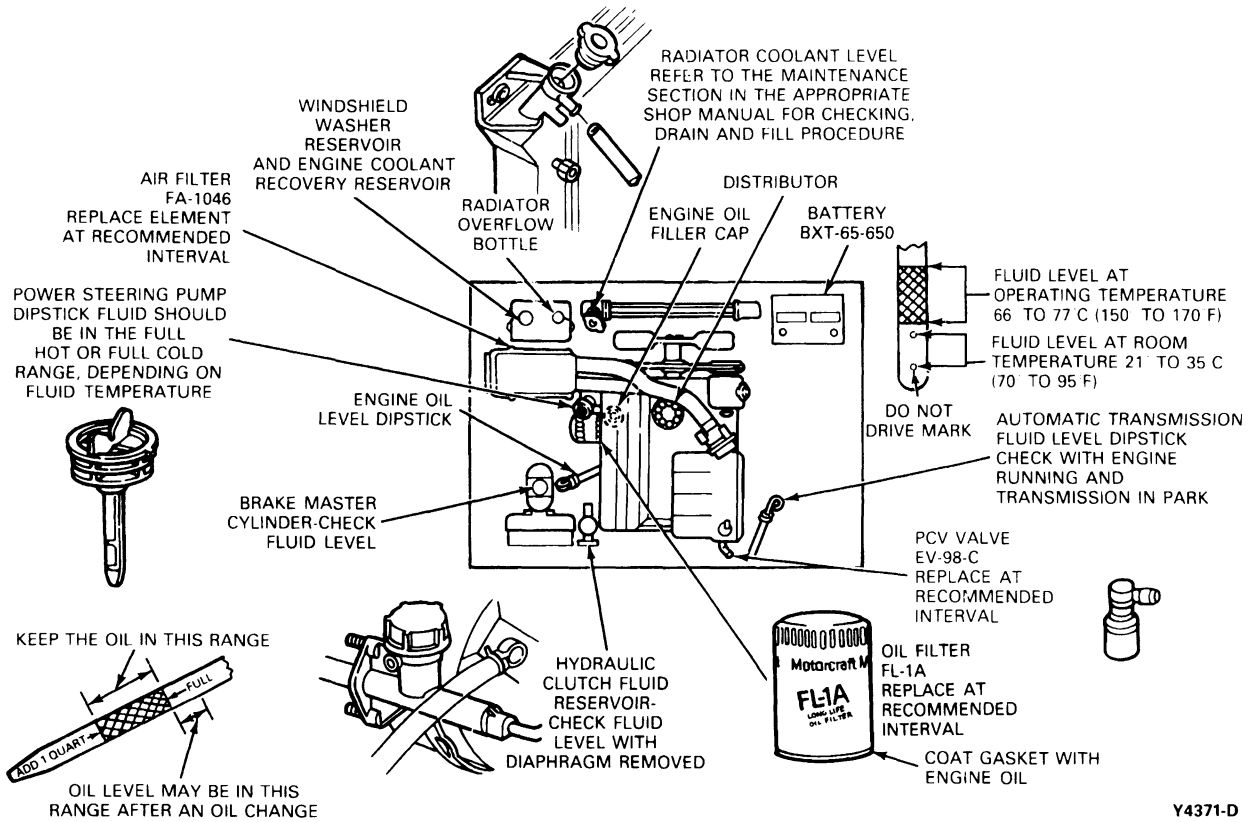


MAINTENANCE (Continued)

Service Points, 4.9L Engine, F-Series



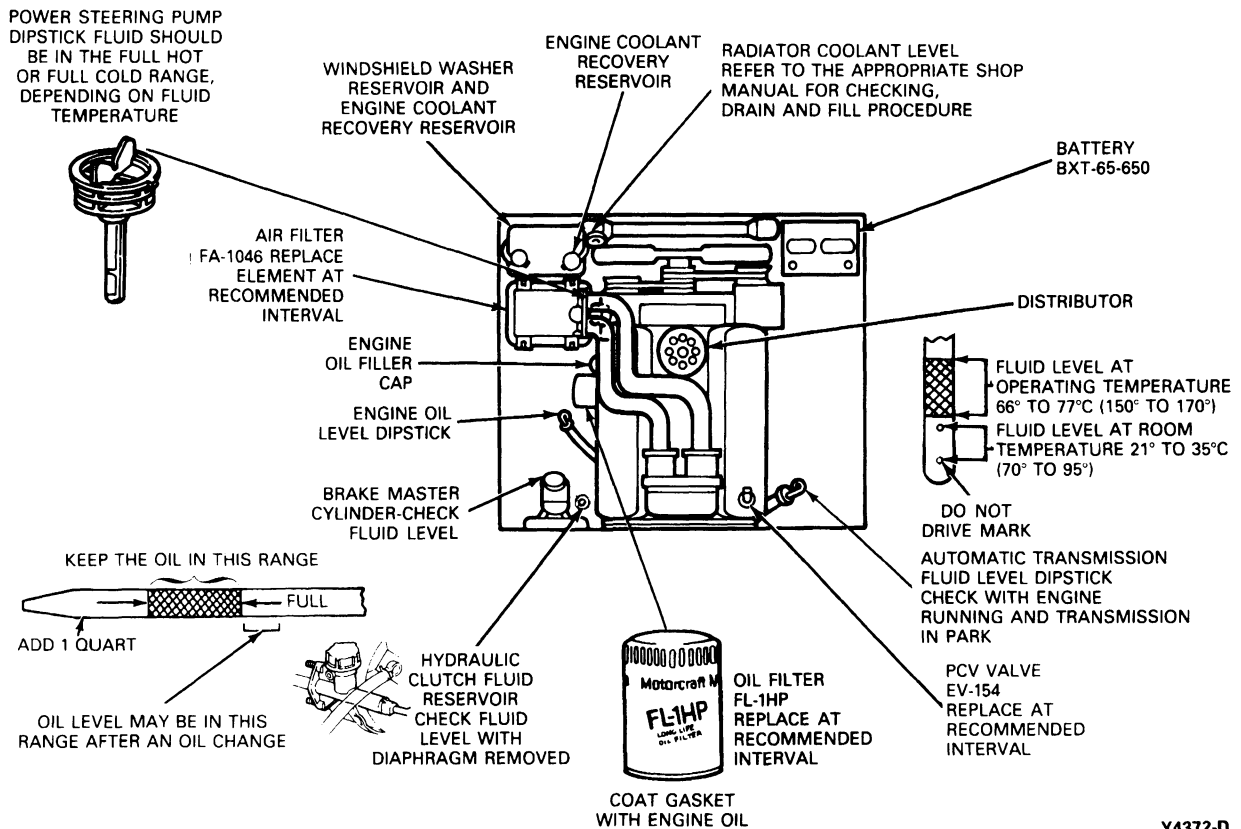
Y2737-H

MAINTENANCE (Continued)**Service Points, 5.0L and 5.8L Engine, F-Series and Bronco (5.8 Lightning, Similar)**

Y4371-D

MAINTENANCE (Continued)

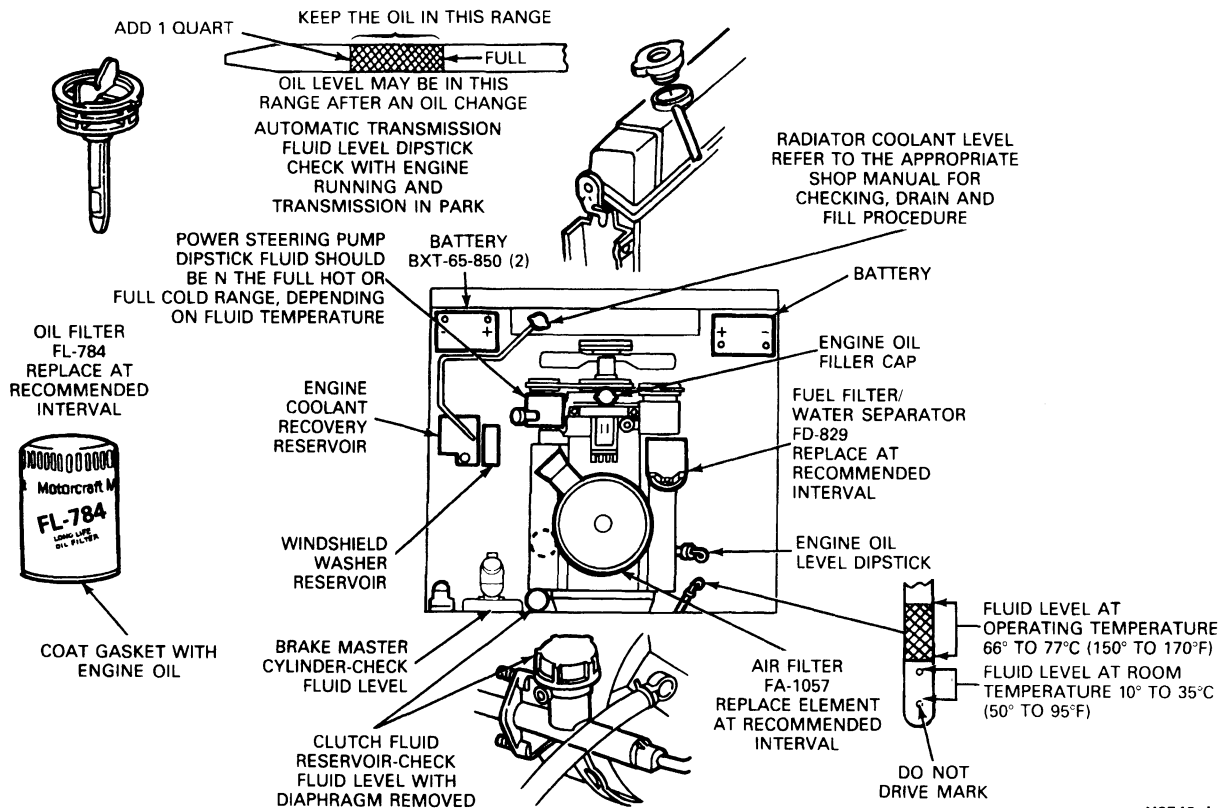
Service Points, 7.5L Engine, F-Series



Y4372-D

MAINTENANCE (Continued)

Service Points, 7.3L Diesel Engine, F-Series



Y2740-J

SPECIFICATIONS

Refer to the following charts for lubricant specifications.

LUBRICANT SPECIFICATIONS – E-150-250-350, F-150-250-350, F-SUPER DUTY AND BRONCO

Item	Ford Part Name	Ford Part Number	Ford Specification
Windshield Washer Reservoir	Ultra-Clear Windshield Washer Solvent	C9AZ-19550-AA or BA	ESR-M17P5-A
Body Hinges, Latches, Door Striker Plates and Rotor, Seat Tracks, Door Tracks and Checks, Hood Latch and Auxiliary Latch, Spare Tire Carrier Latch	Multi-Purpose Grease	D7AZ-19584-AA	ESR-M1C159-A
Lock Cylinders, Outside Spare Tire Lock	Lock Lubricant	D8AZ-19587-AA	ESB-M2C20-A
Front Axle Spindle Pins, Front and Rear Spring Shackles, Pins, Steering Column U-Joints, Clutch Linkage Fittings, Universal Joints, Joints with Zerk Fittings, and Slip Yoke Pivots, Parking Brake Linkage Pivots and Clevises, Transmission Control Linkage Pivots	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Front Wheel Bearings and Rear Wheel Bearings Brake and Clutch Pedal Shaft	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
4x4 Front Drive Axle, U-Joints, Wheel Bearings and Spindle Needle Bearings	High Temperature 4x4 Front Axle and Wheel Bearing Grease	E8TZ-19590-A	ESA-M1C198-A
Power Steering Reservoir	Premium Power Steering Fluid	E6AZ-19582-AA	ESW-M2C33-F
Clutch Release Lever at Pivots	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Engine Oil – All Gasoline Engines	Motorcraft Motor Oil 5W30 and 10W30 Super Premium	XO-5W30-QSP XO-10W30-QSP	ESE-M2C153-E and API SG/CC, SG/CD or SG/CC
Engine Oil – Diesel ⁽²⁾ (Consult respective engine owners guide for recommendations)	Motorcraft Motor Oil 15W40 Super Duty SAE-30 Super Duty	XO-15W40-QSD XO-30-QSD	API SG/CE or SG/CD and ESE-M2C153-E
Engine Oil Filter – Diesel (7.3L)	Oil Filter	E3TZ-6731-A (FL-784)	–
Engine Oil Filter – Gasoline, 4.9, 5.0, 5.8L	Motorcraft Long-Life Oil Filter	D9AZ-6731-A (FL-1A)	ES-E1ZE-6714-AA
Engine Oil Filter – Gasoline, 7.5L		7.5L – E7TZ-6731-A (FL-1HP)	
C6, E4OD and AOD Automatic Transmission	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX E4AZ-19582-B	MERCON® ESP-M2C166-H
Accelerator Control Kickdown (Automatic 6 Cyl.)	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Speedometer, Parking Brake Cable	Speedometer Cable Lubricant	E6TZ-19581-A	ESF-M1C60-A
Steering Linkage – Lubricate only where equipped with grease fittings	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Accelerator Linkage – Ball Socket	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Ford Axles (Conventional and Limited-Slip) ⁽³⁾⁽⁵⁾	Premium Rear Axle Lubricant	XY-90-QL	ESP-M2C154-A
Transfer Case – Four-Wheel Drive	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX E4AZ-19582-B	MERCON® ESP-M2C166-H
Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Rear Dana Axles and Dana Limited Slip Rear Axles ⁽¹⁾	Premium Rear Axle Lubricant	C6AZ-19580-E	ESW-M2C105-A
Front Dana Axles 44 and 55	4x4 Gear Oil	F1TZ-19580-A	WSL-M2C191-A
Service Fill for Severe Use Dana Econoline and F-Super Duty Rear Axles	75W-140 Synthetic Rear Axle Lube	F1TZ-19580-B	WSL-M2C192-A
4-Speed Manual Transmission – Warner T18 ⁽⁴⁾	MERCON®	XT-2-QDX	MERCON®
Release Bearing for Clutches with Concentric Slave Cylinders	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Release Bearing for Conventional Systems	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
5-Speed Manual Overdrive Transmission – Mazda	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX E4AZ-19582-B	MERCON® ESP-M2C166-H

⁽¹⁾ Add 4 oz. of Friction Modifier C8AZ-19B546-A (EST-M2C118-A or equivalent) to refill Dana limited slip axles.

⁽²⁾ For arctic winter operation below –25°C (–10°F) but not above –7°C (20°F), use engine oil SAE 5W-30 SG/CD or SG/CE.

⁽³⁾ For Ford design rear axles: Add 4 oz. of Friction Modifier C8AZ-19B546-A (EST-M2C118-A) for complete refill of 8.8 inch ring gear limited slip rear axles. For F-250, F-350 with 10.25 inch ring gear limited slip rear axles add 8 oz. of Friction Modifier C8AZ-19B546-A (EST-M2C118-A).

⁽⁴⁾ Requires 6.5 pints.

⁽⁵⁾ Synthetic High Performance Rear Axle Lubricant F1TZ-19580-B (WSL-M2C192-A) may be substituted but only after axle assembly is completely drained.

CY4689-C

SPECIFICATIONS (Continued)

LUBRICANT SPECIFICATIONS – E-150-250-350, F-150-250-350, F-SUPER DUTY AND BRONCO (Cont'd.)

Item	Ford Part Name	Ford Part Number	Ford Specification
5-Speed Manual Overdrive Transmission ZF(S5-42)①	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX E4AZ-19582-B	MERCON® ESP-M2C166-H
Automatic Transmission Shift Linkage (F-Super Duty)	Multi-Purpose Grease	D7AZ-19584-AA	ESR-M1C159-A
Transmission Throttle Valve (TV) Lever – AOD Only Transmission Kickdown Lever C6 (MFI Engines)	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Disc Brake, Caliper Slide Rails and Knuckle Inner and Outer Pad Slots	Disc Brake Caliper Slide Grease	D7AZ-19590-A	ESA-M1C172-A
F-Super Duty Parking Brake	Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid	XT-2-QDX or DDX E4AZ-19582-B	MERCON® ESP-M2C166-H
Hydraulic Brake Master Cylinder – Hydraulic Clutch Master Cylinder②	Heavy-Duty Brake Fluid	C6AZ-19542-AA or BA	ESA-M6C25-A
Brake and Clutch Pedal Pivots and Clevises	Engine Oil SAE-10W	–	ESE-M2C153-E API-SG
Manual Locking Hubs On 4x4	Steering Gear Grease	C3AZ-19578-A	ESW-M1C87-A
Driveshaft, Slip Yoke and Spring Stud Shackles Except Stripped Chassis and Motorhome Chassis	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Driveshaft, Universal Joints and Slip Yoke F-Super Duty Stripped Chassis and Motorhome Chassis	High Temperature Grease NLGI, No. 2	–	ESL-M1C173-A
Exhaust Control Valve	Rust Penetrant and Inhibitor	D7AZ-19A501-AA	ESR-M99C56-A
Engine Coolant	Premium Cooling System Fluid	E2FZ-19549-AA	ESE-M97B44-A
Door Weatherstrips	Silicone Lubricant Jell	C0AZ-19553-AA	ESR-M13P4-A
Driveshaft, Slip Yoke, Double Cardan Joint Center Ball	Premium Long-Life Grease	XG-1-C	ESA-M1C75-B
Automatic Locking Hubs – 4x4	Automatic Hublock Grease	E1TZ-19590-A	ESL-M1C193-A

① Synthetic MERCON (E6AZ-19582-B) should be considered when operating under the following extreme conditions:

- Extensive idle time with transmission temperatures below –20°F (–29°C).
- Operating at maximum GCW (F-Super Duty) in hilly terrain with temperatures above 100°F (38°C).
- Continuous (30 minutes) PTO operations.

② As the clutch disc wears, the fluid level in the reservoir will rise. Fluid level above the "step" is an indication of disc wear, NOT overfill.

CY4690-C

ENGINE TRANSMISSION MOUNTING

GROUP 02

SECTION 02-03 Engine Transmission Mounting

SUBJECT	PAGE	SUBJECT	PAGE
REMOVAL AND INSTALLATION		REMOVAL AND INSTALLATION (Cont'd.)	
Crossmember Transmission Support Bracket, Typical	02-03-2	Transmission Noise Shield, F-350 (Over 10,000 Pounds GVW) and F-Super Duty with 7.3L Diesel Engine and Manual Transmission.....	02-03-2
Engine Supports, Typical	02-03-1	Transmission Supports	02-03-2
Noise Shield, E-350 (Over 10,000 Pounds GVW) with 7.3L Diesel Engine and E4OD Automatic Transmission	02-03-2	VEHICLE APPLICATION	02-03-1

VEHICLE APPLICATION

F-150-250-350, F-Super Duty Chassis Cab and Bronco

REMOVAL AND INSTALLATION

Engine Supports, Typical

Removal

1. Remove the rubber overflow tube from the coolant recovery bottle and detach it from the shroud (where appropriate).
2. Remove the fan shroud attaching screws and lift the shroud back and drape it onto the fan.
3. Support the engine using a wood block and a jack placed under the oil pan.
4. Remove the nuts and washers attaching the insulators to the crossmember brackets. Lift the engine sufficiently to disengage the insulator stud from the crossmember engine bracket(s).
5. Remove bolt attaching fuel pump shield to left engine bracket, if required.
6. Remove insulator-to-engine or engine bracket attaching nut and washer assembly. Remove engine mount.

Installation

1. Install the engine mount to the engine.
2. Install the bolt attaching fuel pump shield to left bracket, if required. Tighten to specification.
3. Lower the engine until the insulator stud engages in the slot / hole of crossmember bracket. Install attaching nuts and tighten to specification.
4. Remove the jack and wood block from the engine oil pan.
5. Position the fan shroud to the radiator and install the fan shroud attaching screws and tighten to specifications.
6. Install the rubber overflow tube to the coolant recovery bottle and attach it to the shroud (where appropriate).

REMOVAL AND INSTALLATION (Continued)**Crossmember Transmission Support Bracket, Typical****Removal and Installation**

1. Support the engine using a wood block and jack placed under the oil pan.
2. Remove the nuts and washers attaching the insulators to the crossmember bracket(s). Lift the engine sufficiently to disengage the insulator stud from the crossmember engine bracket(s).
3. Remove the bolts and nuts holding the support bracket(s) to the crossmember.
4. Remove the support bracket(s) from the crossmember.

For installation, follow removal procedures in reverse order. Refer to the appropriate illustration for tightening specifications.

3. Lower the transmission and install the damper assembly and insulator-to-crossmember attaching nuts. Tighten to specification.
4. Remove the jack and wood block from under the transmission.

Transmission Noise Shield, F-350 (Over 10,000 Pounds GVW) and F-Super Duty with 7.3L Diesel Engine and Manual Transmission**Removal and Installation**

1. Raise the vehicle on a hoist.
2. Remove the transmission noise shield attaching screw and washer assemblies.
3. Remove the transmission noise shield from the vehicle.

For installation, follow removal procedures in reverse order. Tighten screw and washer assemblies to 21-29 N·m (15-21 ft-lb).

Transmission Supports**Removal**

1. Place a block of wood and a jack under the transmission.
2. Remove the two nuts attaching the insulator to the crossmember. Remove the damper assembly from the transmission crossmember. Raise the transmission sufficiently to lift the insulator from the crossmember.
3. On vehicles so equipped, remove the fasteners attaching the exhaust hanger to the rear engine mount.
4. Remove the two bolts attaching the insulator to the transmission and remove the insulator and retainer assembly.

Installation

1. Position the insulator and retainer assembly to the transmission. Install the two attaching bolts and tighten to specification.
2. If so equipped, install the fasteners attaching the exhaust hanger to the insulator. Tighten to specification listed in Section 09-00, Exhaust Pipes, Mufflers and Converters.

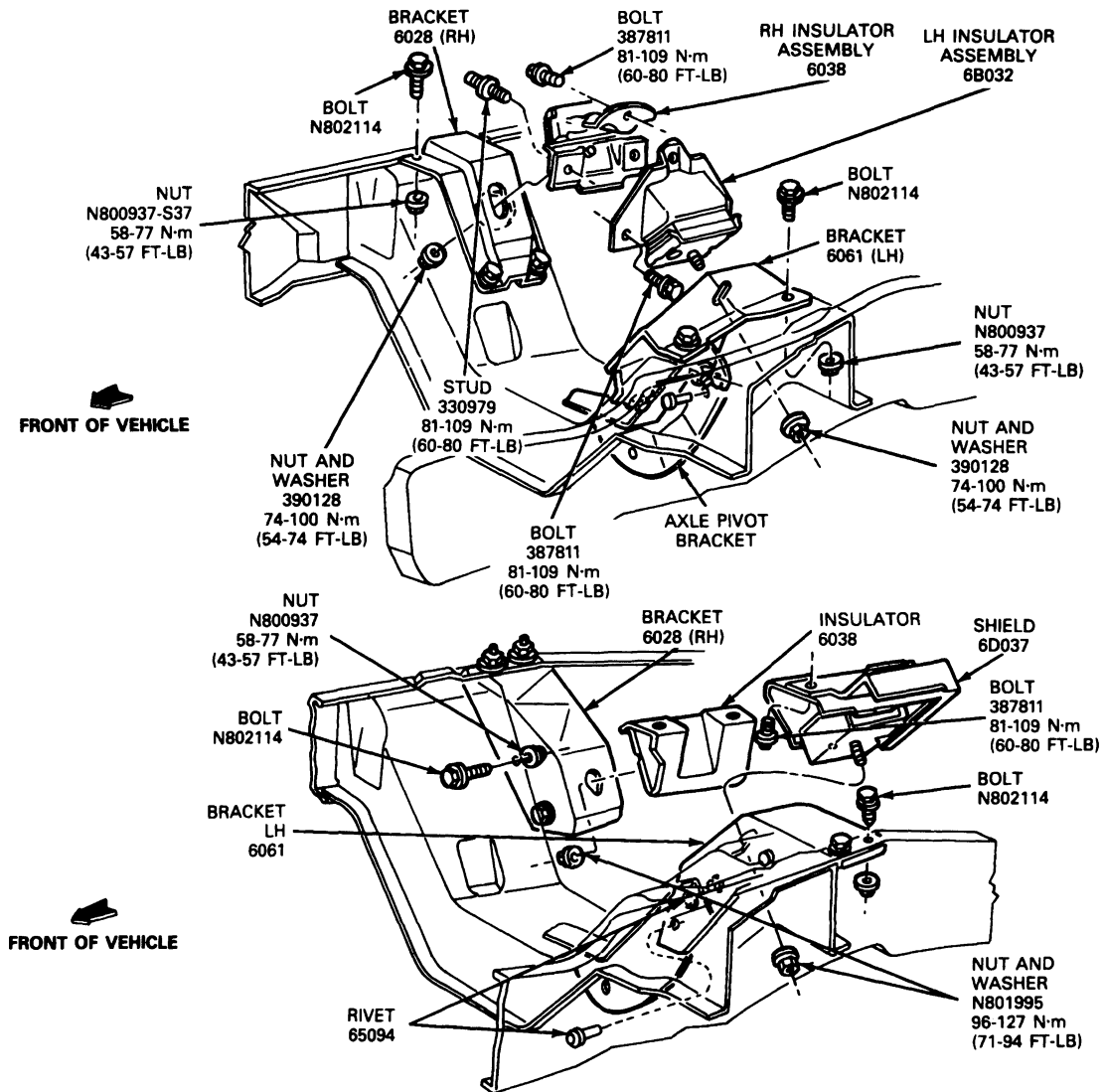
Noise Shield, E-350 (Over 10,000 Pounds GVW) with 7.3L Diesel Engine and E40D Automatic Transmission**Removal and Installation**

1. Raise the vehicle on a hoist.
2. Remove the noise shield attaching screw and washer assemblies.
3. Remove the noise shield from the vehicle.

For installation, follow removal procedures in reverse order. Tighten screw and washer assemblies to 37-50 N·m (27-36 ft-lb).

REMOVAL AND INSTALLATION (Continued)

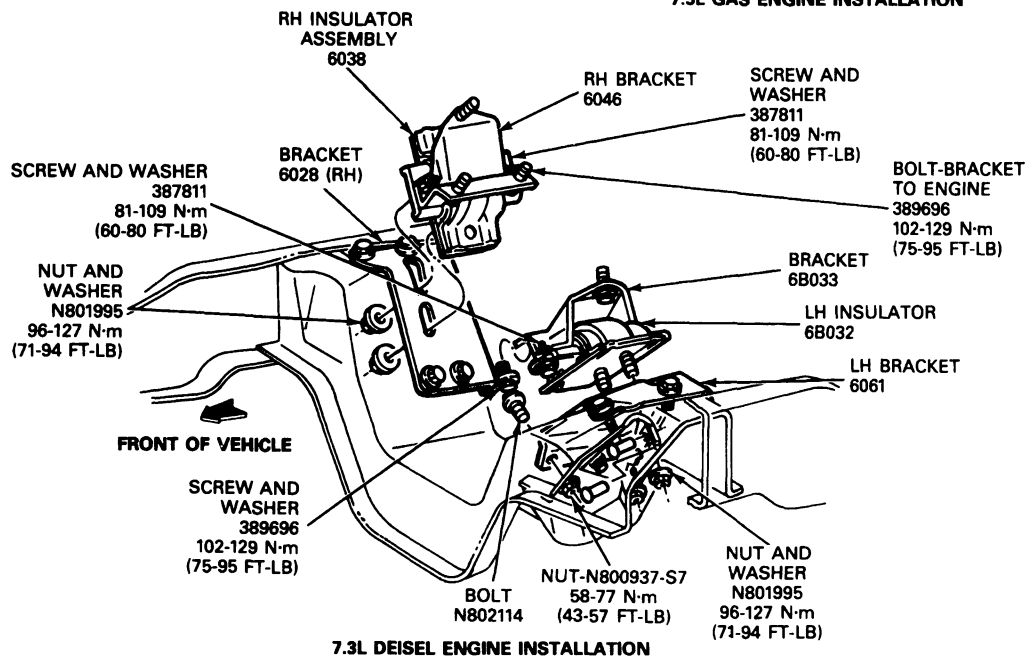
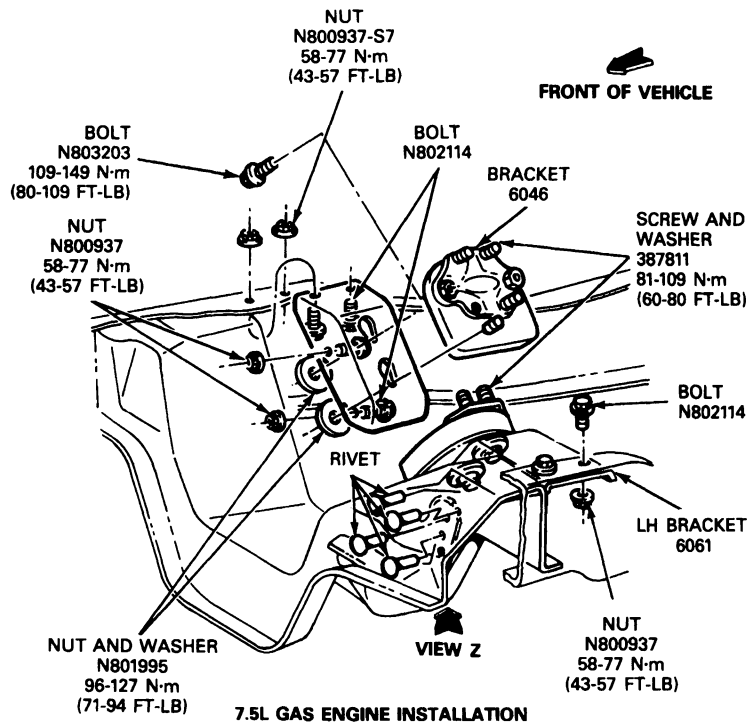
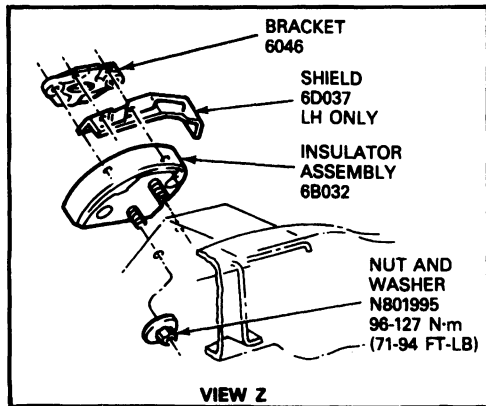
Engine Front Supports and Insulator Assembly, F-150-250-350 and Bronco with 5.0L and 5.8L Engine



N8416-B

REMOVAL AND INSTALLATION (Continued)

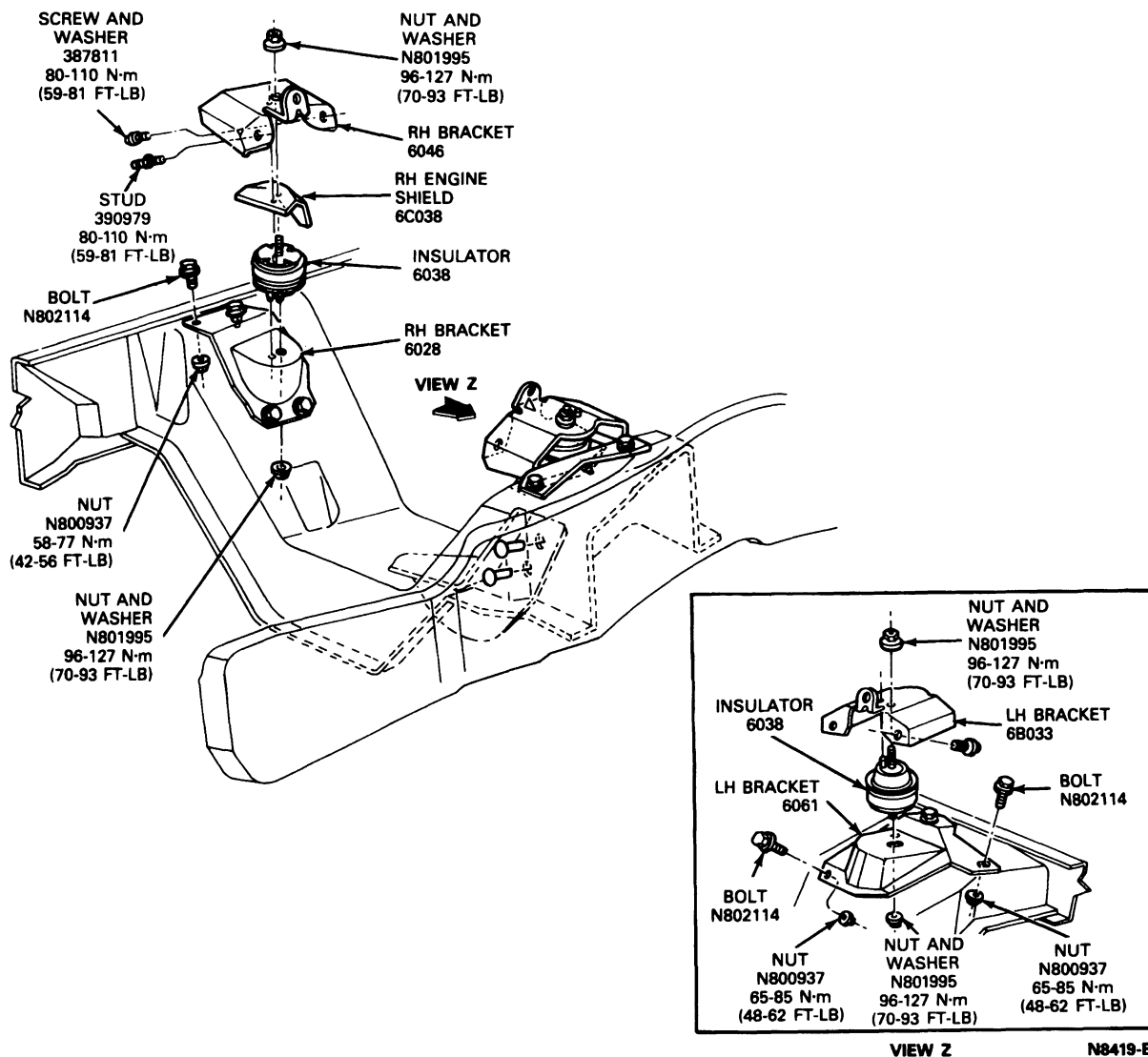
Engine Front Supports and Insulator Assembly, F-250-350 and F-Super Duty with 7.5L Gasoline Engine and 7.3L Diesel Engine



N8418-B

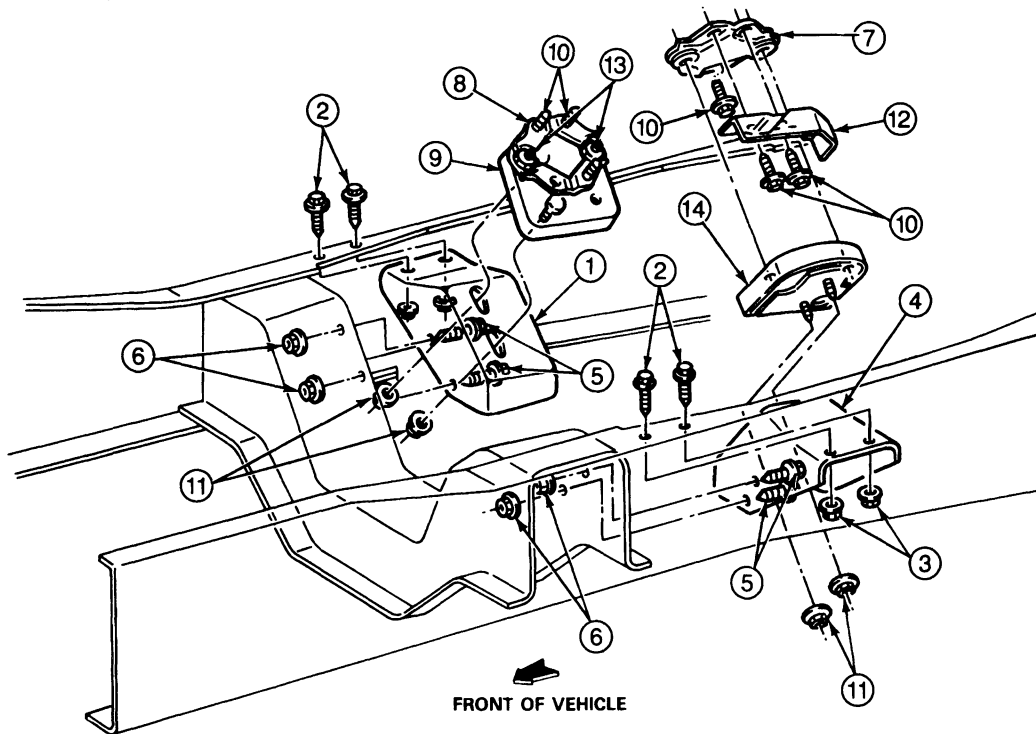
REMOVAL AND INSTALLATION (Continued)

Hydroelastic Front Engine Mounts, F-150-250-350 and Bronco with 4.9L Engine



REMOVAL AND INSTALLATION (Continued)

Engine Mounts, F-Super Duty Motorhome Chassis, 7.5L Engine

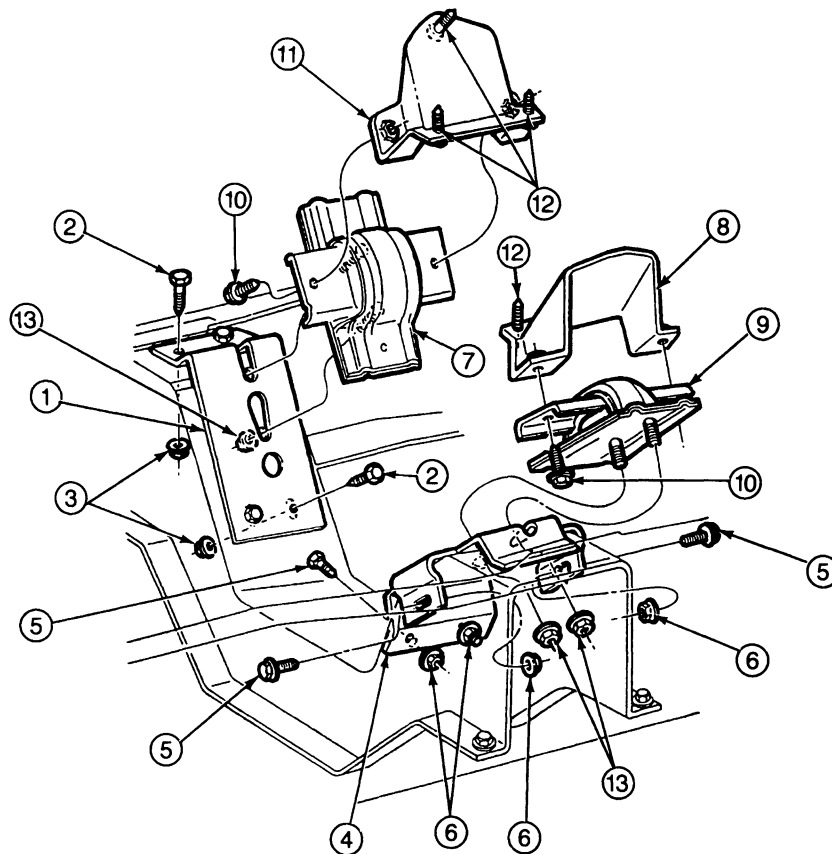


N9724-A

Item	Part Number	Description
1	6037	Front Support Bracket (RH)
2	N802114-S2	Bolt
3	N800937-S7	Nut 60-95 N·m (44-70 Ft-Lb)
4	6061	Front Support Bracket (LH)
5	N802114-S2	Bolt
6	N800937-S7	Nut 60-95 N·m (44-70 Ft-Lb)
7	6038	Insulator Assembly (LH)
8	6046	Insulator Bracket

(Continued)

Item	Part Number	Description
9	6B032	Insulator Assembly (RH)
10	387811-S100	Screw and Washer 81-109 N·m (60-80 Ft-Lb)
11	N802320-S2	Nut and Washer 80-120 N·m (59-88 Ft-Lb)
12	6D037	Shield
13	N803203-S100	Bolt 100-140 N·m (75-105 Ft-Lb)
14	6B032	Insulator Assembly (LH)

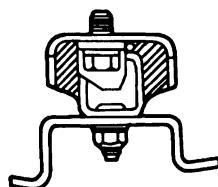
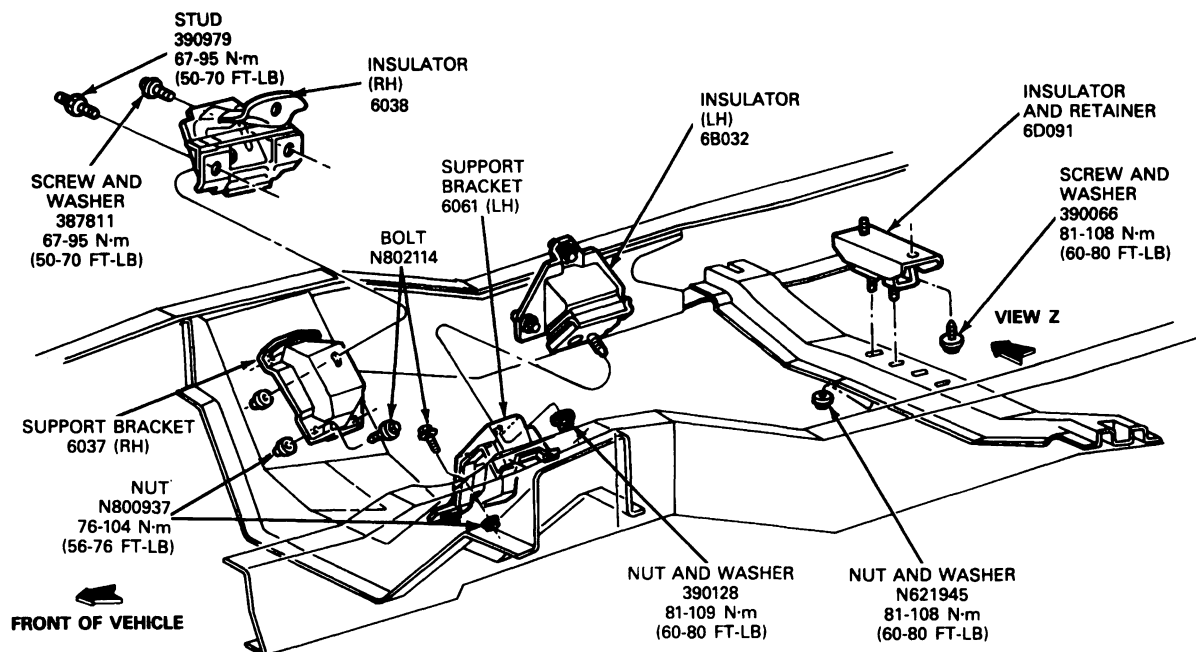
REMOVAL AND INSTALLATION (Continued)**Engine Mounts, F-Super Duty Commercial Chassis, 7.3L Engine**

N9726-A

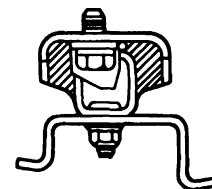
Item	Part Number	Description
1	6037	Front Support (RH)
2	N802114-S2	Bolt
3	N800937-S7	Nut 60-95 N·m (44-70 Ft-Lb)
4	6061	Front Support Bracket (LH)
5	N802114-S2	Bolt
6	N800937-S7	Nut 60-95 N·m (44-70 Ft-Lb)
7	6038	Insulator Assembly (RH)

(Continued)

Item	Part Number	Description
8	6B033	Front Support Bracket (LH)
9	6B032	Insulator Assembly (LH)
10	387811-S100	Screw and Washer 81-109 N·m (60-80 Ft-Lb)
11	6046	Front Support Bracket (RH)
12	389696-S100	Screw and Washer 100-140 N·m (75-105 Ft-Lb)
13	N802320-S2	Nut and Washer 80-120 N·m (59-88 Ft-Lb)

REMOVAL AND INSTALLATION (Continued)**Engine Mounts, E-150-250-350 with 4.9L Engine, All Transmissions**

VIEW Z
SHOWING INSTALLATION
OF REAR ENGINE
MOUNT WITH AUTO & AOD
TRANSMISSIONS

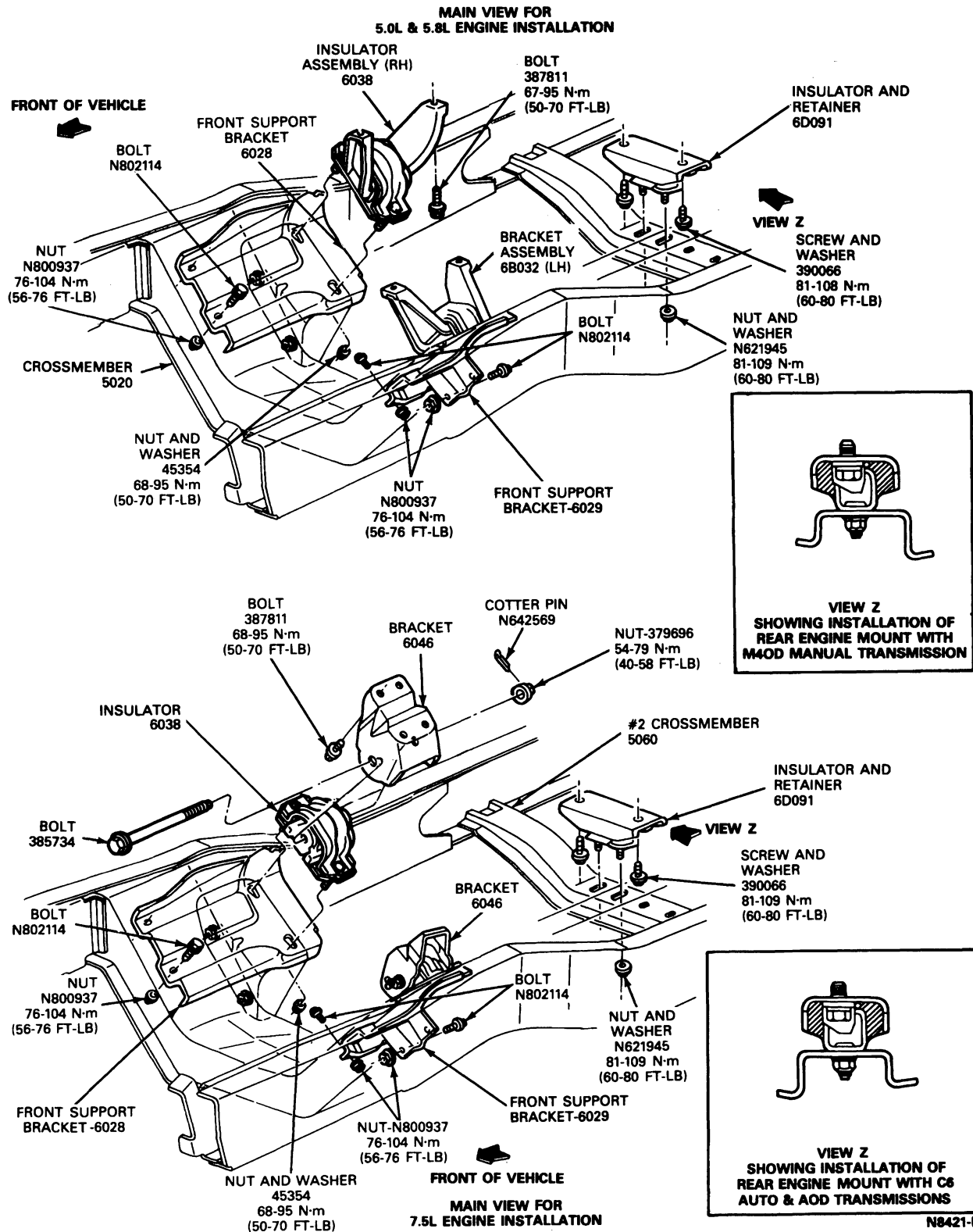


VIEW Z
SHOWING INSTALLATION
OF REAR ENGINE
MOUNT WITH MANUAL
TRANSMISSION

N8420-B

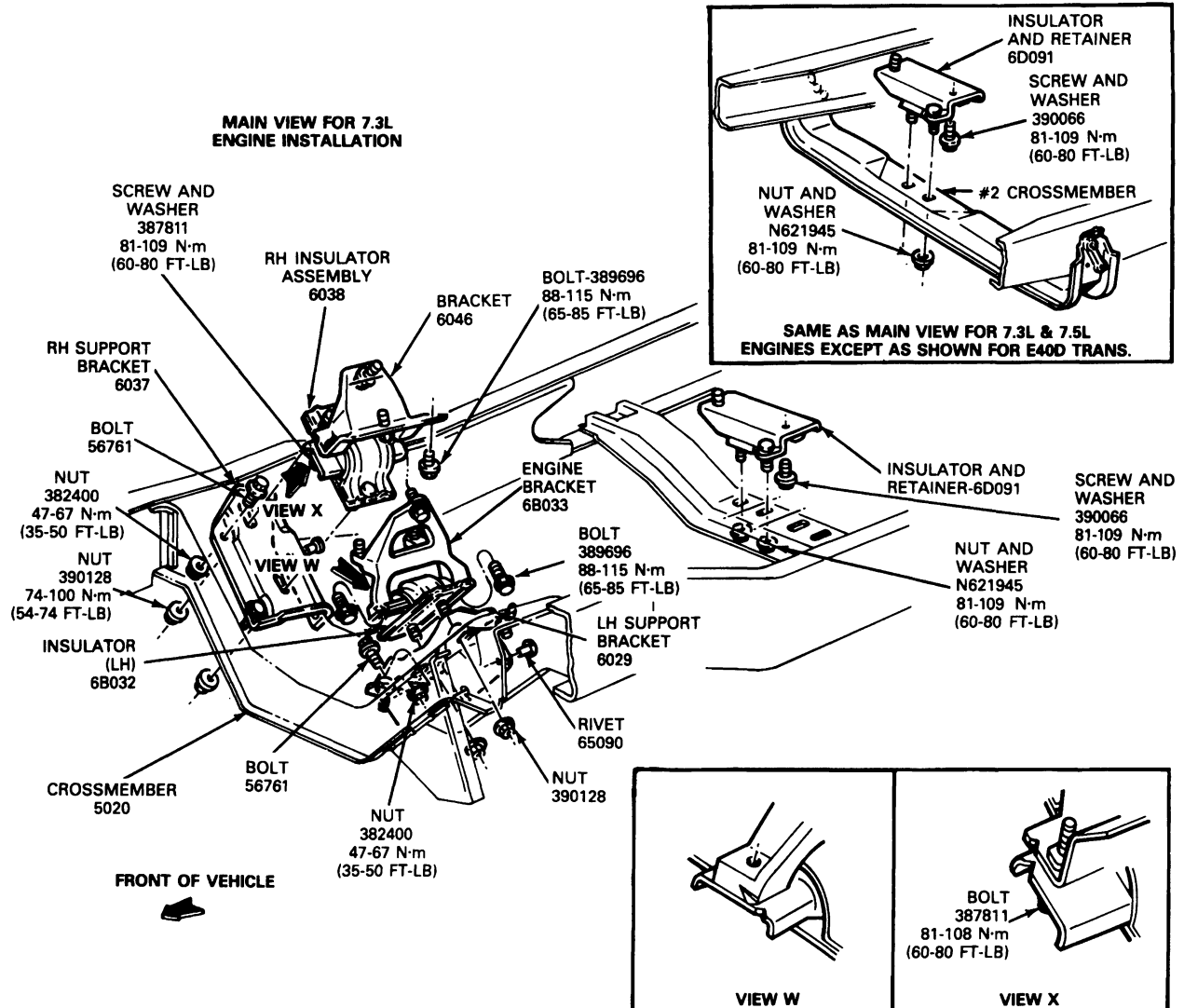
REMOVAL AND INSTALLATION (Continued)

Engine Mounts, E-150-250-350 with 5.0L, 5.8L and 7.5L Gasoline Engines



REMOVAL AND INSTALLATION (Continued)

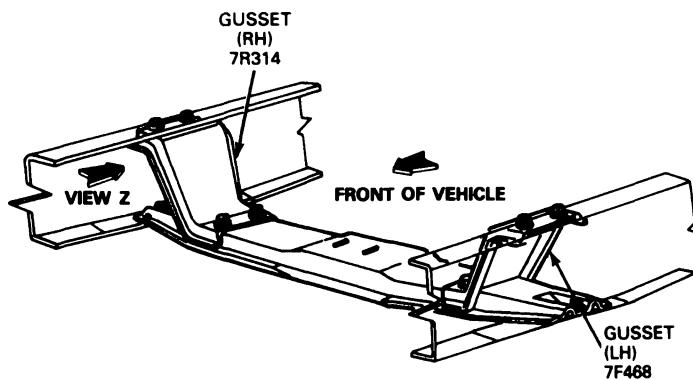
Engine Mounts, E-250-350 with 7.3L Diesel Engine



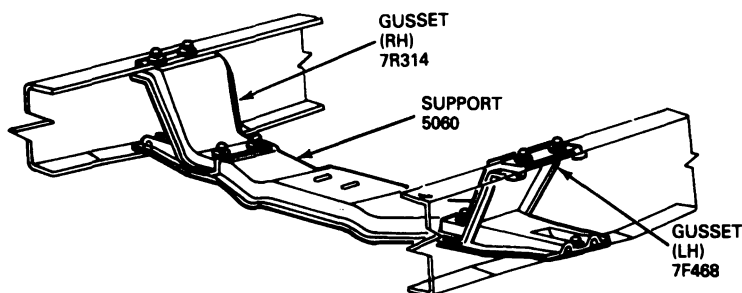
N8422-B

REMOVAL AND INSTALLATION (Continued)

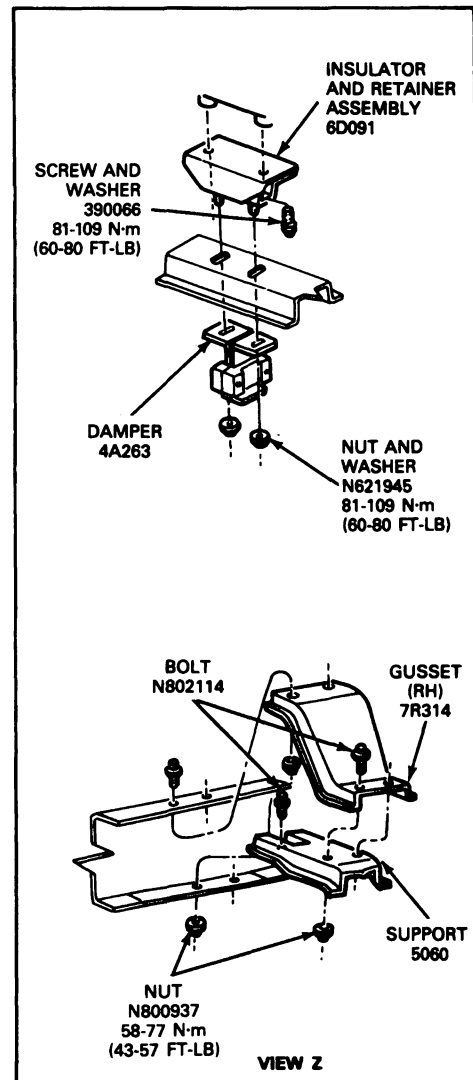
Transmission Support, F-150-250-350 Regular Cab, SuperCab and F-Super Duty 4x2, All Transmissions Except E4OD



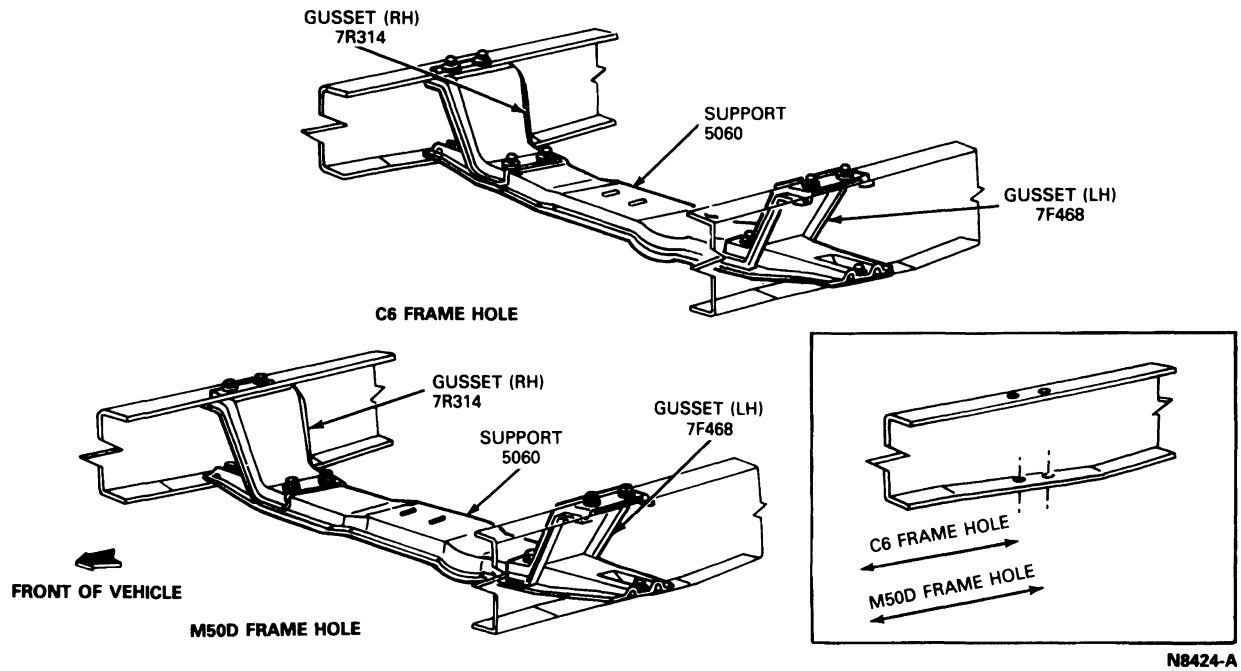
VIEW FOR C6, AOD AUTOMATIC TRANSMISSION
AND M60D MANUAL TRANSMISSION



VIEW FOR T-18
MANUAL TRANSMISSION

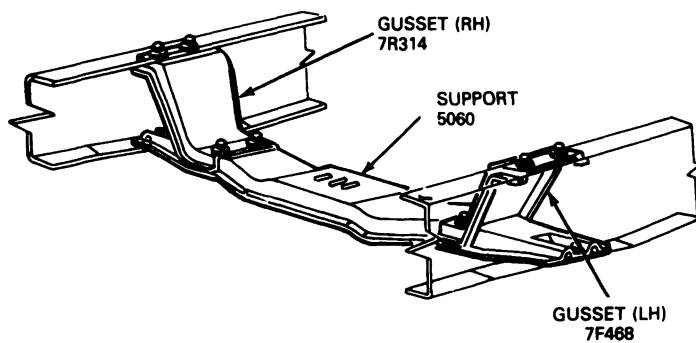
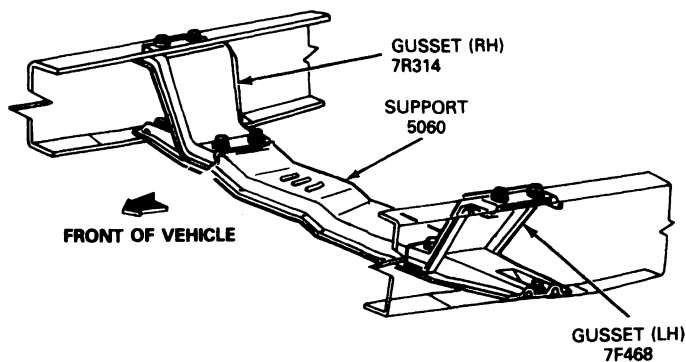
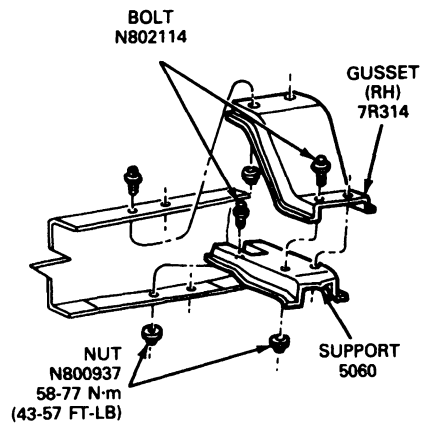
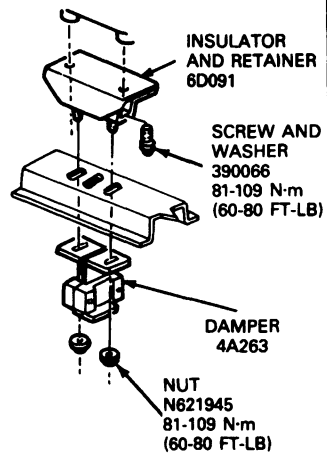


N8423-B

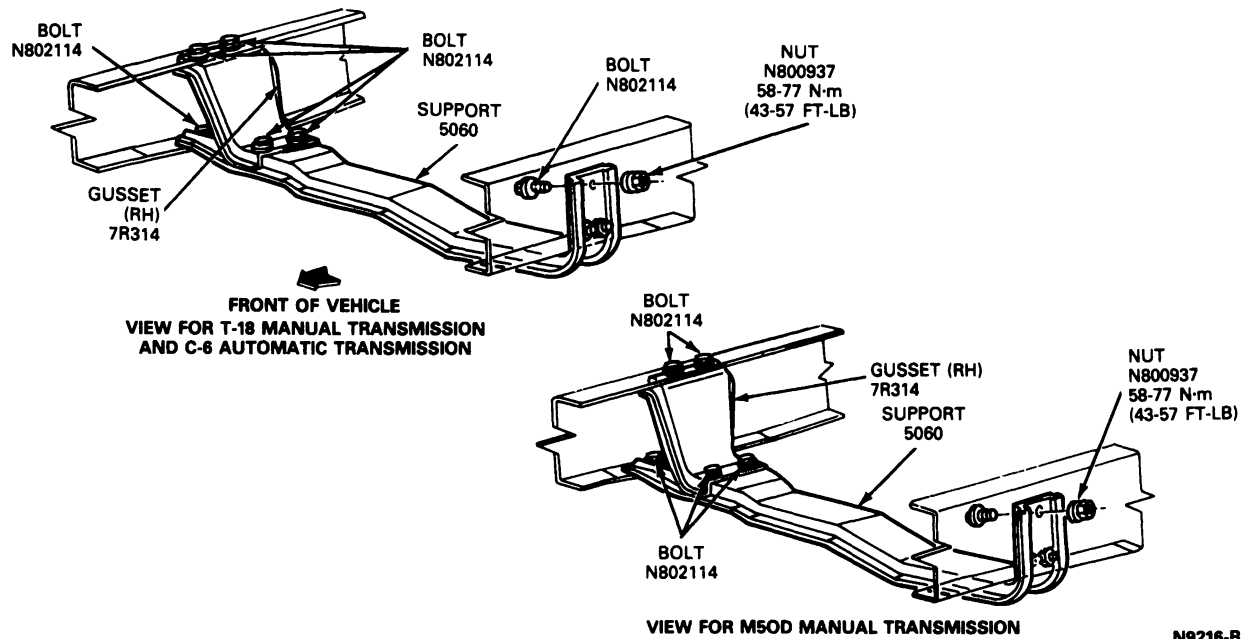
REMOVAL AND INSTALLATION (Continued)**Transmission Support, F-350 Chassis Cab and F-Super Duty Chassis Cab, All Transmissions Except E40D**

REMOVAL AND INSTALLATION (Continued)

Transmission Support, F-150-250 and Bronco 4x4, All Transmissions Except E40D

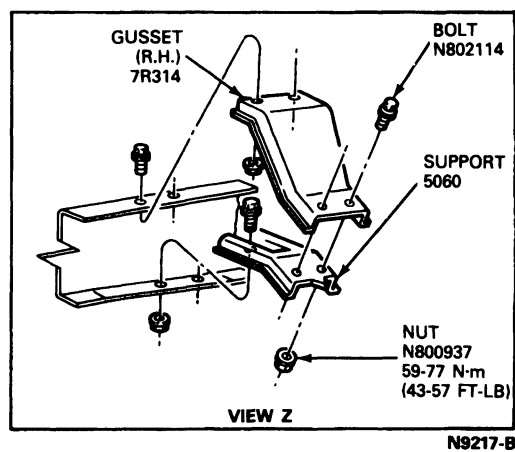
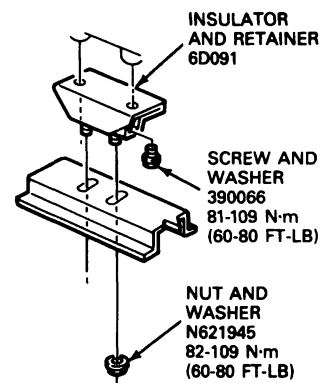
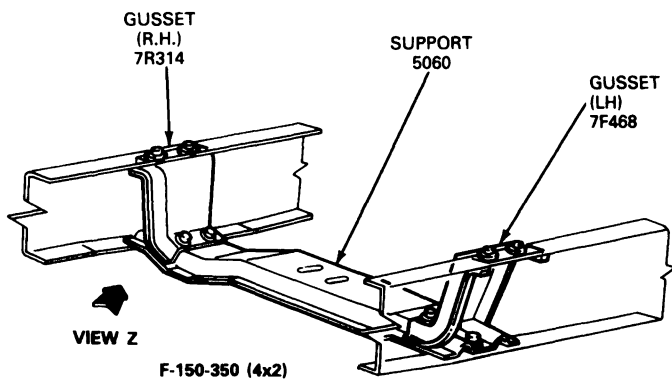
VIEW FOR M50D
MANUAL TRANSMISSIONVIEW FOR C6, AOD AUTOMATIC TRANSMISSION
AND T-18 MANUAL TRANSMISSION

N8425-B

REMOVAL AND INSTALLATION (Continued)**Transmission Support, F-350 Chassis Cab 4x4, All Transmissions Except E40D**

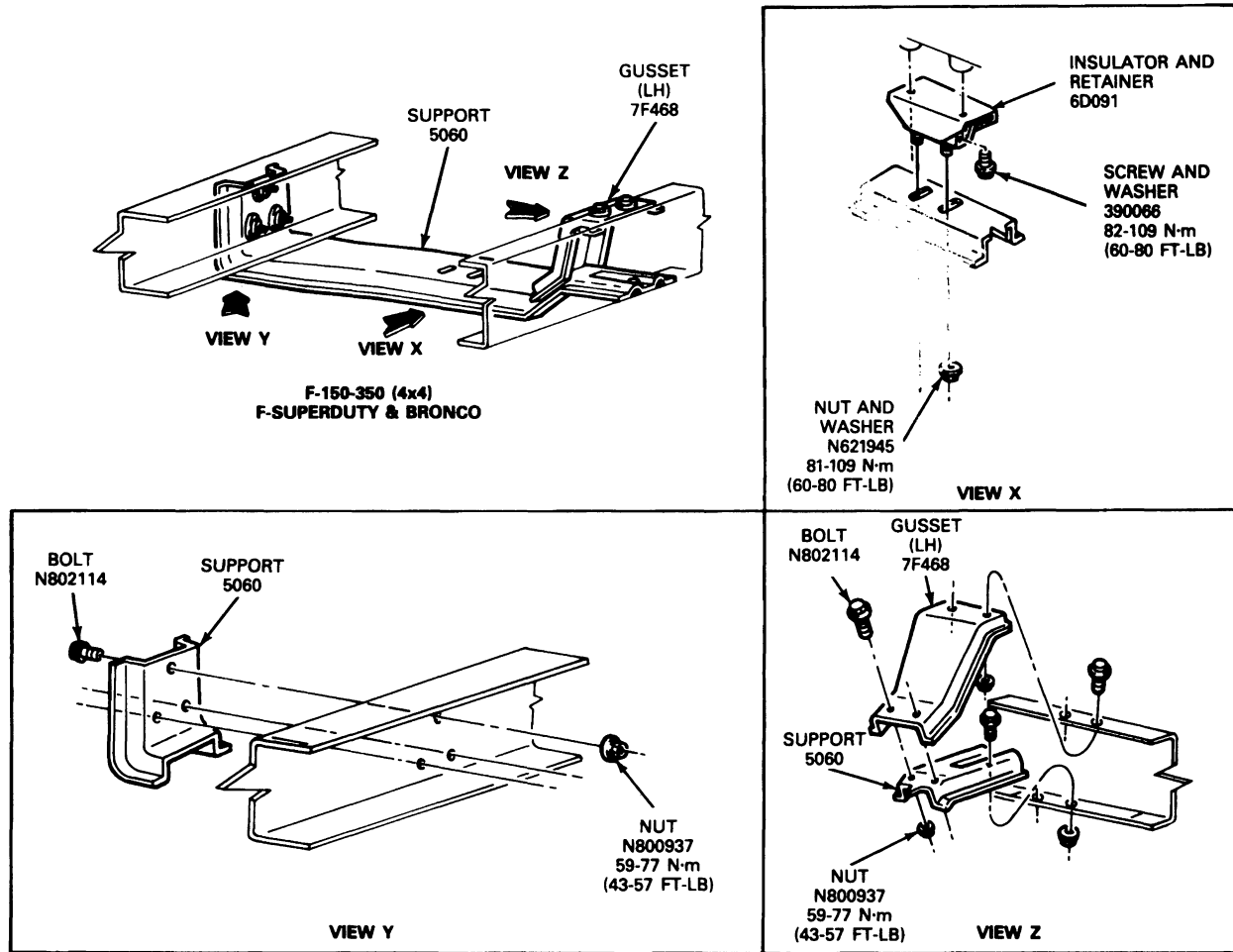
REMOVAL AND INSTALLATION (Continued)

Transmission Support, F-150-250-350, F-Super Duty and Bronco with E4OD Transmission



REMOVAL AND INSTALLATION (Continued)

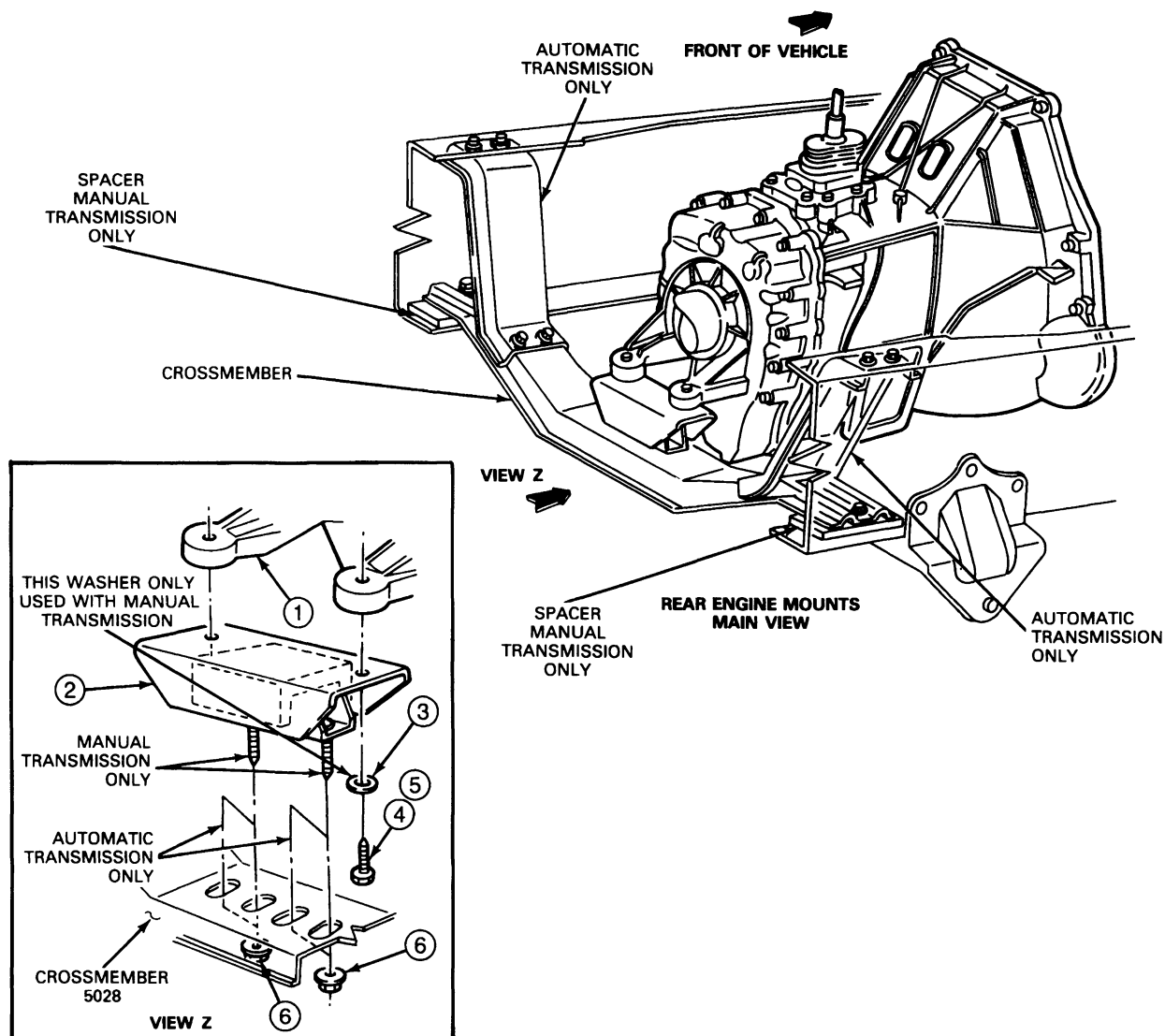
Transmission Support, F-150-250-350, F-Super Duty and Bronco with E4OD Transmission (Continued)



N9218-B

REMOVAL AND INSTALLATION (Continued)

Transmission Support, F-Super Duty Commercial and Motorhome Chassis



N9728-A

Item	Part Number	Description
1	Ref.	Transmission Assembly Manual M50D Shown — Typical of Others
2	6D091	Insulator and Retainer Assembly
3	44879	Washer (Used on Manual Transmission Only)

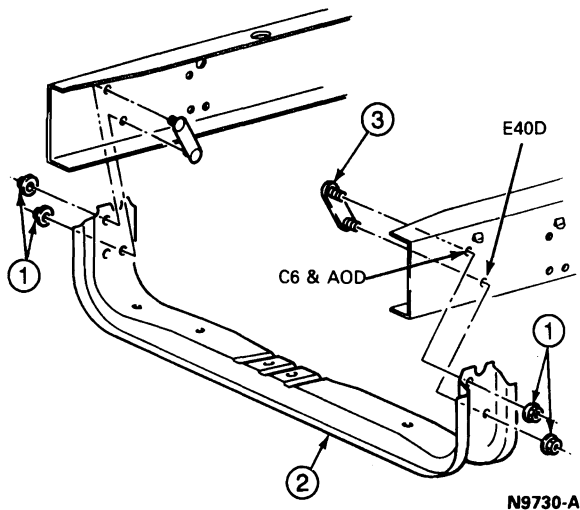
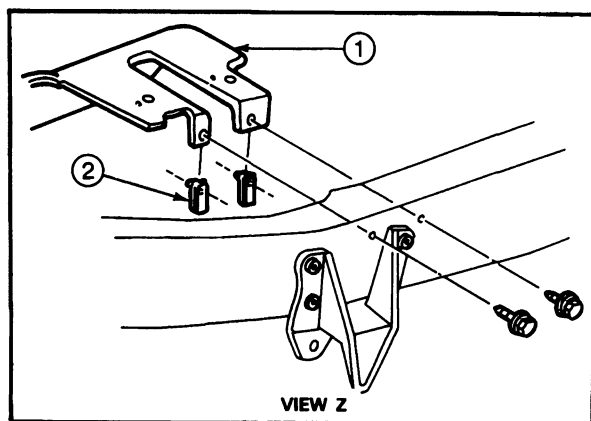
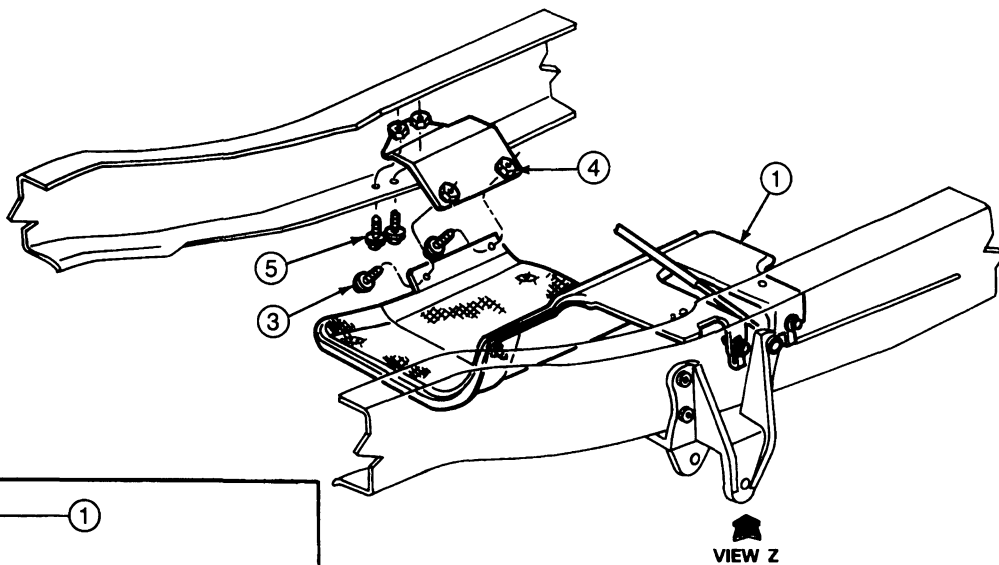
(Continued)

Item	Part Number	Description
4	390066-S2	Screw and Washer 67-95 N·m (50-70 Ft-Lb) (Used on Automatic Transmission Only)
5	58679	Bolt 67-95 N·m (50-70 Ft-Lb) (Used on F-Super Duty Commercial Chassis Only)
6	N62 1945-S2	Nut and Washer 67-95 N·m (50-70 Ft-Lb)

REMOVAL AND INSTALLATION (Continued)**Transmission Support, E-150-250-350, All Transmissions****TRANSMISSION SUPPORT — E-150-E-350 — ALL TRANSMISSIONS (LEGEND)**

Item No.	Part Number	Description
1	379696-S2	Nut and Washer 75-102 N·m (55-75 Ft·Lb)
2	5060	Crossmember #2
3	5R132	U-Bolt

CN9731-A

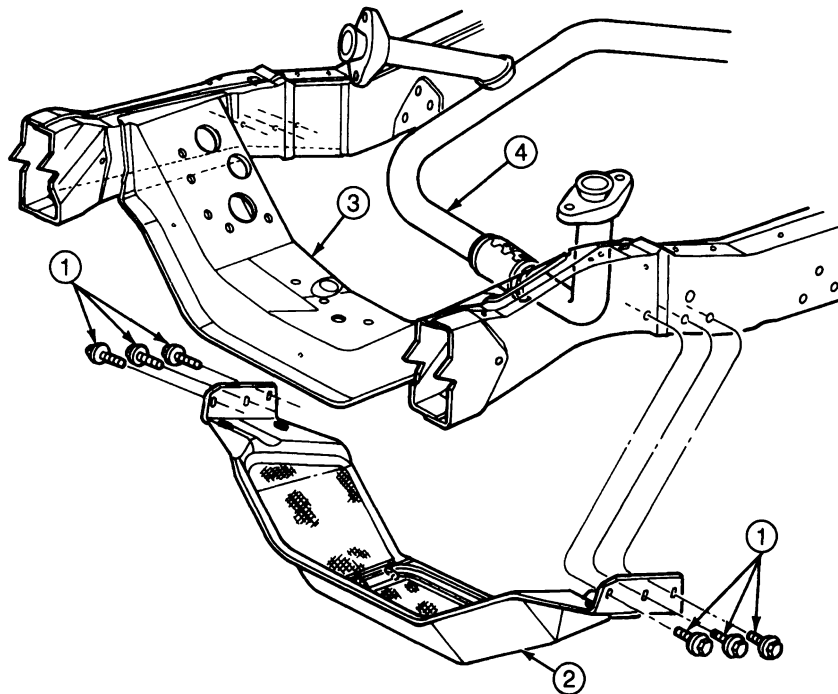
**Transmission Noise Shield, F-350 (Over 10,000 Pounds GVW) and F-Super Duty with 7.3L Diesel Engine and Manual Transmission**

N9732-A

REMOVAL AND INSTALLATION (Continued)**TRANSMISSION NOISE SHIELD — F-350 (OVER 10,000 LBS. GVW) AND F-SUPER DUTY WITH 7.3L DIESEL ENGINE AND MANUAL TRANSMISSION (LEGEND)**

Item No.	Part Number	Description
1	7L249	Noise Shield
2	N804340-S2	Nut
3	N606689-S2	Screw and Washer 21-29 N·m (15-21 Ft-Lb)
4	7A255	Transmission Support Bracket
5	N605906-S36	Bolt 21-29 N·m (15-21 Ft-Lb)

CN9733-A

Noise Shield, E-350 (Over 10,000 Pounds GVW) with 7.3L Diesel Engine and E4OD Automatic Transmission

N9734-A

NOISE SHIELD — E-350 (OVER 10,000 LBS. GVW) WITH 7.3L DIESEL ENGINE AND E4OD AUTOMATIC TRANSMISSION (LEGEND)

Item No.	Part Number	Description
1	N802970-S2	Screw and Washer 37-50 N·m (27-36 Ft-Lb)
2	6E027	Noise Shield
3	5020	Crossmember
4	Ref.	Exhaust Pipe

CN9735-A

GROUP

ENGINE 03

SECTION TITLE	PAGE	SECTION TITLE	PAGE
ACCESSORY DRIVE.....	03-05-1	ENGINE, 7.5L MFI V-8.....	03-01C-1
AIR INTAKE	03-12-1	FUEL CHARGING AND CONTROLS,	
DIESEL, ENGINE, 7.3L V-8.....	03-01D-1	GENERAL	03-04-1
ENGINE COOLING	03-03-1	FUEL CHARGING AND CONTROLS, 4.9L	03-04B-1
ENGINE EMISSION CONTROL	03-08-1	FUEL CHARGING AND CONTROLS, 5.0L AND	
ENGINE IGNITION GENERAL SERVICE	03-07-1	5.8L	03-04A-1
ENGINE SERVICE, GASOLINE	03-00-1	FUEL CHARGING AND CONTROLS, 7.5L	03-04C-1
ENGINE, 4.9L SIX-CYLINDER	03-01A-1	STARTER, GEAR REDUCTION.....	03-06B-1
ENGINES, 5.0L MFI V-8 AND 5.8L MFI W-V-8	03-01B-1	STARTER, PERMANENT MAGNET	03-06A-1
ENGINE, 5.8L HO.....	03-01E-1		

SECTION 03-00 Engine Service, Gasoline

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		DIAGNOSIS AND TESTING (Cont'd.)	
Camshaft.....	03-00-16	Flywheel Runout (Manual Transmission).....	03-00-11
Cleaning the Engine.....	03-00-12	Positive Closed-Type Crankcase Ventilation	
Connecting Rods	03-00-15	System.....	03-00-3
Crankshaft	03-00-14	Possible Leakage Points.....	03-00-4
Cylinder Block	03-00-13	Pressure Method	03-00-4
Cylinder Heads	03-00-18	Static Engine Off Valve Train Analysis	03-00-8
Exhaust Manifold	03-00-19	OVERHAUL	
Flywheel, Automatic Transmission.....	03-00-20	Cylinder Block	03-00-20
Hydraulic Tappets.....	03-00-16	Cylinder Head Flatness.....	03-00-24
Intake Manifold.....	03-00-19	Cylinder Heads	03-00-24
Main and Connecting Rod Bearings.....	03-00-14	Cylinder Walls, Refinishing.....	03-00-20
Oil Pan.....	03-00-18	Fitting Main or Connecting Rod Bearings with	
Oil Pump.....	03-00-17	Plastigage.....	03-00-21
Pistons, Pins and Rings	03-00-15	Flywheel Service Repair: Re-Machine Clutch	
Push Rods	03-00-19	Surface	03-00-27
Valve Rocker Arm	03-00-18	Pistons, Pins and Rings.....	03-00-22
DESCRIPTION		Service Limit Specifications.....	03-00-20
Engine Identification	03-00-2	Valve Guides, Reaming	03-00-26
Engine Oil Level Check	03-00-3	Valve Seat Runout.....	03-00-25
Exhaust Emission Control System.....	03-00-2	Valve Seats, Refacing	03-00-26
DIAGNOSIS AND TESTING		Valve Stem-to-Guide Clearance.....	03-00-25
Camshaft End Play.....	03-00-10	Valves	03-00-27
Camshaft Lobe Lift	03-00-8	Valves, Refacing	03-00-27
Compression Test	03-00-5	Valves, Select Fitting	03-00-25
Crankshaft End Play	03-00-11	REMOVAL AND INSTALLATION	
Dynamic Valve Train Analysis.....	03-00-8	Core Plugs.....	03-00-11
Engine Oil Leaks	03-00-4	SPECIAL SERVICE TOOLS/EQUIPMENT	03-00-28
Excessive Engine Oil Consumption	03-00-6	VEHICLE APPLICATION	03-00-2
Fluorescent Oil Additive Method	03-00-4		

VEHICLE APPLICATION

All Light Truck Vehicles Equipped with 4.9L, 5.0L, 5.8L or 7.5L Gasoline Engines

DESCRIPTION

This section covers various engine tests, adjustments, service procedures and cleaning/inspection procedures. Engine assembly and service specifications appear at the end of each engine section in Group 03.

For engine removal, disassembly, assembly, installation, adjustment procedures and specifications, refer to the appropriate engine section in Group 03.

These engines incorporate a closed-type crankcase ventilation system and exhaust emission control system. All engine/emission control systems are covered in the Powertrain Control/Emissions Diagnosis Manual.¹

To maintain the required exhaust emission levels, the fuel system, ignition system and engine must be kept in good operating condition and meet recommended adjustment specifications.

When performing tests, adjustment or service to the engine, system or fuel ignition system, it is essential to follow the procedures and specifications in the appropriate repair group in this manual, and in the Powertrain Control/Emissions Diagnosis Manual.¹

Before replacing damaged or worn engine components such as the crankshaft, cylinder heads, valve guides, valves, camshafts or cylinder block, make sure that part(s) is not serviceable.

WARNING: TO AVOID THE POSSIBILITY OF PERSONAL INJURY OR DAMAGE TO THE VEHICLE, DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS FIRST BEEN EXAMINED FOR POSSIBLE CRACKS AND SEPARATION.

Exhaust Emission Control System

Operation, removal, installation and required maintenance of the exhaust emission control devices used on these engines are covered in the Powertrain Control/Emissions Diagnosis Manual.¹

Engine Identification

For quick engine identification, refer to the safety certification decal. The decal is mounted on the left front door lock face panel. Find the engine code (letter or number) on the decal, then refer to the engine identification chart to determine the engine type and size. An engine identification label is also attached to the engine. The symbol code on the identification tag identifies each engine for determining parts usage, for instance, engine displacement and model year. Engine decal information is located in the appropriate engine section in Group 03.

Safety Certification Decal

1FTEF25H5PLA00001									
VEHICLE IDENTIFICATION NUMBER									
MFD. BY FORD MOTOR CO. IN U.S.A.									
DATE: 9-87					GVWR: 5347 LB - 2425 KG				
FRONT GAWR: 2714 LB 1231 KG					REAR GAWR: 2683 LB 1216 KG				
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY AND BUMPER STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.									
VEH. IDENT. NO. 1FTEF25H5PLA00001									
TYPE PASSENGER									
3H									
EXTERIOR PAINT COLORS									
F0276 R0141 482450 DSO									
BODY	VR	MDG.	INT. TRM	A/C	R	S	AX	TR	
54K	YB	34A	GB	A	2	B	8	XBBBB	
ENGINE CODE (8th CHARACTER)				MODEL YEAR					


A17628-A

Emission Calibration Label

The emission calibration number label is located on the left door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.

Engine Emission Calibration Number Label

CALIBRATION		
ÉTALONNAGE		
CALIBRACIÓN		
8-25F-R00		E8AE-6E061-AAA
CALIBRATION REVISION NUMBER		

A14130-1A

¹ Can be purchased as a separate item.

DESCRIPTION (Continued)

Always refer to these labels when replacement parts are required or when checking engine calibrations. Engine parts often differ within a liter (or CID) family. Verification of identification codes will make sure that the proper parts are obtained. The codes contain all pertinent information relating to dates, optional equipment and revisions. The Ford Master Parts Catalog contains a complete listing of the codes and their application.

Engine Oil Level Check

Although the amount of oil an engine will use will vary with the type and size of the engine and the way the vehicle is driven, it is normal to add some oil between changes. Therefore, it is important to check the oil level in your vehicle at regular intervals and add oil when necessary.

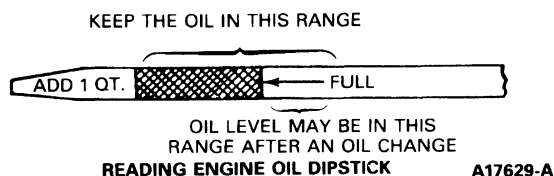
Materials:

- Motorcraft oil (if required)

Tools:

- Wiping cloth

1. Make sure the vehicle is parked on level ground and the parking brake is set. If the engine has been running, allow several minutes for the oil to drain into the sump (oil pan) before checking level. **DO NOT** check your engine oil while the engine is running.
2. Open the hood and install the fender cover, then locate and remove the engine oil dipstick from the tube.
3. Wipe the dipstick with a clean rag and replace it in the tube. Make sure the dipstick is fully seated.
4. Remove the dipstick and check to see if the oil level marking is within the **SAFE** range marked on the dipstick. Add oil **only** if the level is below the **ADD** mark and not over the **FULL** mark. On all engines, the oil level should be within the **SAFE** range on the dipstick. Replace the dipstick in the tube.



NOTE: To choose the right oil, you must consider the temperatures in which you will be driving your vehicle.

5. To add oil, remove the oil filler cap and add the required amount of recommended oil. One full quart is required to bring the oil level from the **ADD** line to the **FULL** line of the dipstick.
6. Wait three to five minutes for the oil to drain into the sump. Then remove the dipstick and check the level again. Add more oil only if required. Do not add oil if the level is over the **FULL** mark. **DO NOT OVERFILL.**

7. Wipe any spilled oil from the surrounding surfaces and install the oil filler cap.

NOTE: On some engines, a crankcase ventilation hose is attached to the oil filler cap. Be sure this hose is connected after replacing the cap.

8. Replace the dipstick, making sure it is fully seated. Remove the fender cover and close the hood.

DIAGNOSIS AND TESTING**Positive Closed-Type Crankcase Ventilation System**

A malfunctioning closed crankcase ventilation system may be indicated by loping or rough engine idle. Do not attempt to compensate for this idle condition by disconnecting the crankcase ventilation system and making an air by-pass or idle speed adjustment. **The removal of the crankcase ventilation system from the engine will adversely affect the fuel economy and engine ventilation with resultant shortening of engine life.** To determine whether the loping or rough idle condition is caused by a malfunctioning crankcase ventilation system, refer to the Powertrain Control / Emissions Diagnosis Manual.²

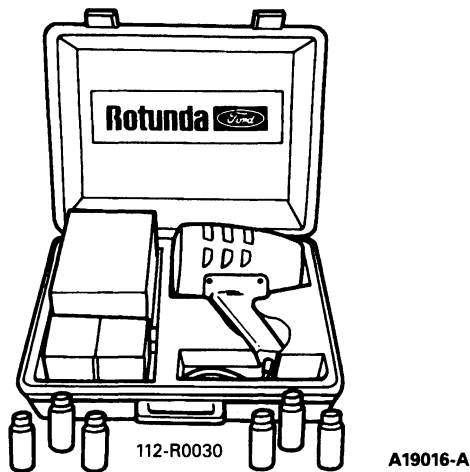
² Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Engine Oil Leaks**

When diagnosing engine oil leaks, it is important that the source and location of the leak be positively identified prior to service. There are two methods of diagnosing engine oil leaks. The following procedure has been found to be very effective and requires only a minimum of equipment.

NOTE: Prior to using this procedure, it is important to clean the cylinder block, cylinder head(s), rocker cover(s), oil pan and flywheel housing areas with a suitable solvent to remove all traces of oil.

To perform oil leak diagnosis use Rotunda Oil Leak Detector Kit 112-R0030 or equivalent, and the following procedure.

**Fluorescent Oil Additive Method**

1. Clean engine with a suitable solvent to remove all traces of oil.
2. Drain engine oil crankcase and refill with recommended oil, premixed with Fluorescent Oil Additive 112-R0015 or equivalent. Use 29.6ml (1 fluid ounce) of fluorescent additive. If oil is not premixed, fluorescent additive must be added to crankcase first.
3. Run engine for 15 minutes. Stop engine and inspect all seal and gasket areas for leaks using Rotunda Oil Leak Detector Lamp 112-R0021 (part of 112-R0030 Kit) or equivalent. A clear bright yellow or orange area will identify leak. For extremely small leaks, several hours may be required for the leak to appear.
4. If necessary, pressurize main oil gallery system to locate leaks due to improperly sealed, loose or cocked plugs. If flywheel bolts leak oil, look for sealer on threads.
5. Service all leaks as required.

Pressure Method

As an alternative testing procedure, the crankcase can be pressurized to locate oil leaks. The following materials are required to fabricate the tool to be used.

1. Air supply and air hose.
2. Air pressure gauge that registers pressure in increments of one psi.
3. Air line shutoff valve.
4. Appropriate fittings to attach above parts to oil fill, PCV grommet holes and rocker arm cover tube.
5. Appropriate plugs to seal any openings leading to crankcase.
6. A solution of liquid detergent and water to be applied with a suitable applicator such as a squirt bottle or brush.

Fabricate the air supply hose to include the air line shutoff valve and the appropriate adapter to permit the air to enter the engine through the rocker arm cover tube. Fabricate the air pressure gauge to a suitable adapter for installation on the engine at the oil fill opening.

Testing Procedure

CAUTION: Use extreme caution when pressurizing crankcase. Applying air pressure above specified pressure risks damage to seals, gaskets and core plugs. Under no circumstances should pressure be allowed to exceed 27 kPa (4 psi).

1. Open air supply valve until pressure gauge maintains 20 kPa (3 psi).
2. Inspect sealed and / or gasketed areas for leaks by applying Snoop Pressure Check or a solution of liquid detergent and water over areas for formation of bubbles, which indicates leakage.

Possible Leakage Points

Examine the following areas for oil leakage.

Underhood

- Rocker cover gaskets
- Intake manifold gaskets / end seals
- Cylinder head gaskets
- Oil filter
- Distributor O-ring
- Oil level indicator (dipstick) tube connection
- Oil pressure sending unit
- Cup plugs and / or pipe plugs at end of oil passages

DIAGNOSIS AND TESTING (Continued)**Under Engine, With Vehicle on Hoist**

- Oil pan gasket
- Oil pan front and rear end seals
- Crankshaft front seal
- Crankshaft rear seal

With Transmission and Flywheel Removed

- Crankshaft rear seal

Air leakage in area around a crankshaft rear oil seal does not necessarily indicate a rear seal leak. However, if no other cause can be found for oil leakage, it can be assumed that rear seal is the cause of the oil leakage.

- Rear main bearing cap parting line.
- Rear main bearing cap and seals.
- Flywheel mounting bolt holes.
- Rear cup plugs and / or pipe plugs at the end of oil passages.

Oil leaks at crimped seams in sheet metal parts and cracks in cast or stamped parts can be detected when pressurizing the crankcase.

NOTE: Light foaming equally around rocker arm cover bolts and crankshaft seals is not detrimental and no corrections are required in such cases.

Compression Test**Compression Gauge Check**

1. Make sure oil in crankcase is of the correct viscosity and at proper level and battery is properly charged. Operate vehicle until engine is at normal operating temperature. Turn off ignition switch, then remove all spark plugs.
2. Set throttle plates in wide-open position.
3. Install a compression gauge such as Rotunda Compression Tester 059-R0009 or equivalent in No. 1 cylinder.

4. Install an auxiliary starter switch in starting circuit. With ignition switch in the OFF position, and using auxiliary starter switch, crank engine at least five compression strokes and record highest reading. Note the approximate number of compression strokes required to obtain the highest reading.
5. Repeat test on each cylinder cranking the engine approximately the same number of compression strokes.

Test Conclusion

The indicated compression pressures are considered within specification if the lowest reading cylinder is within 75 percent of the highest. Refer to the chart below.

Compression Pressure Limit Chart

Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI
134	101	164	123	194	145	224	168
136	102	166	124	196	147	226	169
138	104	168	126	198	148	228	171
140	105	170	127	200	150	230	172
142	107	172	129	202	151	232	174
144	108	174	131	204	153	234	175
146	110	176	132	206	154	236	177
148	111	178	133	208	156	238	178
150	113	180	135	210	157	240	180
152	114	182	136	212	158	242	181
154	115	184	138	214	160	244	183
156	117	186	140	216	162	246	184
158	118	188	141	218	163	248	186
160	120	190	142	220	165	250	187
162	121	192	144	222	166		

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DIAGNOSIS AND TESTING (Continued)

If one or more cylinders read low, squirt approximately one tablespoon of SAE 50 weight or equivalent engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

1. If compression improves considerably, piston rings are at fault.
2. If compression does not improve, valves are sticking or seating poorly.
3. If two adjacent cylinders indicate low compression pressures and squirting oil on pistons does not increase compression, cause may be a cylinder head gasket leak between cylinders. Engine oil and / or coolant in cylinders could result from this problem.

It is recommended the Compression Pressure Limit Chart be used when checking cylinder compression so that the lowest reading number is 75 percent of the highest reading.

Example

If, after checking the compression pressures in all cylinders, it was found that the highest reading obtained was 196 psi and the lowest pressure reading was 155 psi, the engine is within specification and the compression is considered satisfactory.

Excessive Engine Oil Consumption

The amount of oil an engine uses will vary with the way the vehicle is driven in addition to normal engine-to-engine variation. This is especially true during the first 12,000 km (7,500 miles), when a new engine is being broken in or until certain internal engine components become conditioned. Vehicles used in heavy duty operation (severe service) may use more oil. The following are examples of heavy-duty operation:

- Trailer towing applications
- Severe loading applications
- Sustained high speed operation

Engines need oil to lubricate the following internal components:

- Engine block cylinder walls
- Pistons and piston rings
- Intake and exhaust valve stems
- Intake and exhaust valve guides
- All internal engine components

When the pistons move downward, a thin film of oil is left on the cylinder walls. The thin film of oil is burned away on the firing stroke during combustion. If an engine burned a drop of oil during each firing stroke, oil consumption would be about one (1) quart for every mile traveled. Fortunately modern engines use much less oil than this example. However, even efficient engines will use some oil or they would quickly wear out. Additionally as the vehicle is operated, some oil is drawn into the combustion chambers past the intake and exhaust valve stem seals and burned.

Many different conditions can affect oil consumption rates. A partial list of those conditions includes:

- Operator driving habits
- Ambient temperature
- Quality and viscosity of the oil
- Vehicle load and driving terrain

Operation under certain conditions can create a false impression of excessive oil consumption. Most commonly, this happens when the vehicle has been operated for repeated short trips at low ambient temperatures. Under these conditions, substantial amounts of condensed water and fuel can build up in the oil. If the vehicle is then run for a significant time at highway speeds and / or with heavy loads, much of the accumulated water and fuel can be removed by the engine ventilation system. Removing the water and fuel in a relatively short time will often create the appearance of an excessive consumption rate for the customer. In this situation, the customer could be assured that these events are normal for the conditions noted. The customer might also be advised to change oil and filter more frequently, especially prior to starting a long trip in cold weather if unduly concerned about this condition.

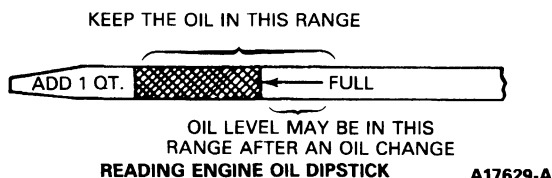
Make sure the selected engine oil meets the recommended API performance category "SG" and SAE viscosity grade as shown in the vehicle Owner Guide. It is also important that the engine oil is changed at the intervals specified for the typical operating conditions. Refer to Section 00-03.

The following diagnostic procedure is intended to be used to determine the source of excessive internal oil consumption.

1. Determine what the customer considers excessive oil consumption to be. Note vehicle mileage and the following observations:
 - How many miles are typically driven per quart of oil used?
 - How is the vehicle being used (e.g., sustained high speed operation, heavy loads, trailer towing, high ambient temperature, etc.)?
 - What does the customer expect normal oil consumption to be?
2. Verify that the engine has no external oil leak as described under Engine Oil Leaks in this section.

DIAGNOSIS AND TESTING (Continued)

3. Verify that the engine has the proper engine oil dipstick by comparing the part number stamped on it against the Ford Master Parts Catalog. Verify that the dipstick and tube are unmodified and in good condition. Verify that the tube is properly seated in the block, and the dipstick seats properly in the tube.
4. Verify that the engine is not being run in an overfilled condition. Check the oil level at least five minutes after a hot shutdown with the vehicle parked in a level area. Under no circumstances should the oil level be above the letter F in the word FULL. If a significant overfill is indicated, perform Steps 5a through 5d to verify the dipstick calibration. If the dipstick calibration checks OK, instruct the customer to avoid overfilling the engine and return the vehicle to service. To verify the vehicle's actual oil consumption, perform Steps 5e and 5f only after the dipstick has been calibrated.



5. Perform engine oil consumption test as follows:
 - a. Drain engine oil. Remove and replace oil filter. Using one quart less than recommended, refill crankcase with recommended quality of oil.
 - b. Run the engine for three minutes (ten minutes if cold) then turn engine off. Allow oil to drain into the oil pan for an additional five minutes (vehicle should be on level ground).
 - c. Remove engine oil dipstick and wipe clean. Do not wipe with anything contaminated with silicone compounds. Re-install dipstick being sure to seat the dipstick firmly in the tube. Remove the dipstick and scribe a mark on the back (unmarked) surface at the indicated oil level. This should be about the same level as the ADD mark on the face of the dipstick.
 - d. Add one U.S. quart of oil. Restart the engine and allow it to idle for at least two minutes. Shut down and allow oil to drain back for at least five minutes. Mark the dipstick using the procedure above. This level may range from slightly below the top of the cross-hatched area to slightly below the letter F in FULL.
 - e. Instruct the customer to drive the vehicle as usual and:
 - Check the oil level regularly at intervals of 160 to 240 km (100 to 150 miles).
 - Return to the service facility when the oil level drops below the lower (ADD) mark scribed on the dipstick by the technician.

- In an emergency, add only full quarts of the same oil and note the mileage at which the oil was added.
- f. Check the oil level under the same conditions as in Steps 5c and 5d, reading the back of the dipstick where the scribe marks are located.
 - Measure the distance from the oil level to the upper scribe mark on the dipstick and record.
 - Measure the distance between the two scribe marks and record.
 - Divide the first measurement by the second. Add one to this total for every quart added by the customer as instructed in Step 5e.
 - Divide the distance driven during the oil test by the result. This quantity is the approximate oil consumption rate in miles per quart (MPQ).
 - g. If the calculated oil consumption rate is unacceptable, proceed to Step 6.
6. Check PCV valve system. Make sure system is not plugged and PCV valve is functioning properly.
 7. Check for plugged oil drain-back holes in cylinder head(s), and cylinder block.
 8. If condition still exists, perform a cylinder compression test as outlined and / or perform a cylinder leak detection test with Tester 014-00705. This can be helpful in determining source of oil consumption, i.e., valves, piston rings, etc.
 9. Check valve guides for excessive guide clearance. Replace all valve stem / guide seals after correct valve guide clearance has been verified.
 10. Worn or damaged internal engine components can cause excessive oil consumption. Small deposits of oil on tip of spark plugs can be a clue to internal oil consumption. If internal oil consumption still persists proceed as follows:
 - a. Remove engine from vehicle and place it on an engine work stand. Remove intake manifold(s), cylinder head(s), oil pan and oil pump. Refer to procedures in the appropriate engine section.
 - b. Check piston ring clearance, ring gap and ring orientation. Service as required.
 - c. Check for excessive bearing clearance. Service as required.

NOTE: After checking for worn parts, if it is determined parts should be replaced, make sure correct replacement parts are used.
 11. Perform Step 5 again to confirm oil consumption concern has been resolved.

DIAGNOSIS AND TESTING (Continued)**Static Engine Off Valve Train Analysis****Rocker Arm Cover Removed**

NOTE: Refer to the appropriate engine section for the Removal and Installation of the engine rocker arm cover.

Check for damaged and/or severely worn parts, correct assembly, and use of correct parts by proceeding with the static engine analysis.

Rocker Arm Assemblies

- Check for loose mounting bolts, studs and nuts.
- Check for plugged oil feed in the rocker arm or cylinder head.

Push Rods

- Check for bent push rods and restriction in oil passage.

Valve Springs

- Check for broken or damaged parts.

Retainer and Keys

- Check for proper seating of keys on valve stem and in retainer.

Positive Rotator and Keys

- Check for proper seating in the positive rotator, and on valve stem.

Valves and Cylinder Head

- Check the cylinder head gasket for proper installation.
- Check for plugged oil drain back holes.
- Check for worn or damaged valve tips.
- Check for missing or damaged guide-mounted valve stem oil seals.
- Check collapsed tappet gap.
- Check installed spring height.
- Check for missing or worn valve spring seats, if equipped.

Static checks (engine off) are to be made on the engine prior to the dynamic procedure.

Dynamic Valve Train Analysis

Start the engine and, while running at idle, check for proper operation of all parts. Check the following:

Rocker Arm Assemblies, Individually Mounted

- Check for plugged oil feed in rocker arm or cylinder head.
- Check for proper overhead valve train lubrication.

Rocker Arm Assemblies

- Check for plugged oil feeds.
- Check for proper overhead valve train lubrication.

WARNING: AVOID GETTING OIL ON HOT EXHAUST MANIFOLDS.

If a condition of insufficient oiling is suspected, accelerate the engine to 1200 rpm \pm 100 rpm with the transmission in NEUTRAL, wheels blocked, parking brake set and the engine at normal operating temperature. Oil should spurt from the rocker arm oil holes such that valve tips and rocker arm are well oiled. With the rocker arm cover off, oil splash may overshoot rocker arm. If oiling is insufficient for this condition to occur, check oil passages for blockage.

Push Rods

- Check for bent push rods and restriction in oil passage.
- Check for proper rotation of push rod (non-roller tappets).

Positive Rotator and Keys

- Check for proper operation of positive rotator.

Valves and Cylinder Head

- Check for plugged oil drain-back holes.
- Check for missing or damaged valve stem oil seals or guide mounted oil seals.

WARNING: AVOID GETTING OIL ON HOT EXHAUST MANIFOLDS.

If a condition of insufficient oiling is suspected, check oil passages for blockage, then accelerate the engine to 1200 rpm with the transmission in NEUTRAL, wheels blocked, parking brake set and the engine at normal operating temperature. Oil should spurt from the rocker arm holes such that valve tips and rocker arms are well oiled. With the rocker arm cover off, some oil splash may overshoot rocker arm.

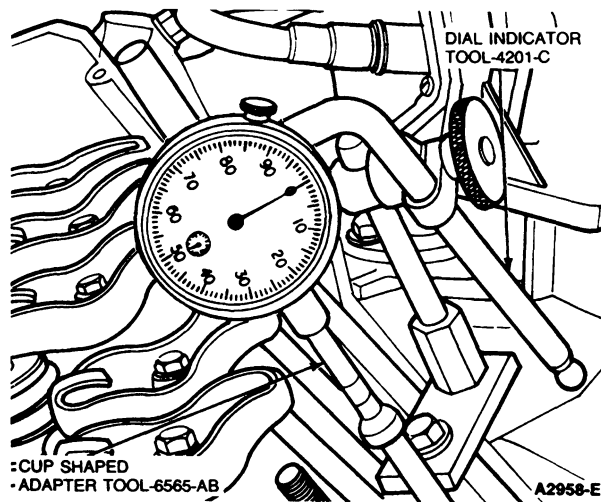
Camshaft Lobe Lift

Check the lift of each lobe in consecutive order and make a note of the readings.

1. Remove valve rocker arm cover(s).
2. Remove rocker arm fulcrum bolts, fulcrum and rocker arm.
3. Make sure tappet is seated against cam. Install Dial Indicator with bracketry TOOL-4201-C in such a manner as to have ball socket adapter of indicator on top of tappet, or push rod and in same plane as tappet or push rod movement.

DIAGNOSIS AND TESTING (Continued)

Typical Engine With Push Rods



4. Remove spark plugs.
5. Connect an auxiliary starter switch in starting circuit. Crank engine with ignition switch in OFF position. "Bump" crankshaft over until tappet is on base circle of camshaft lobe. At this point, tappet will be in its lowest position.
NOTE: If checking during engine assembly, turn crankshaft using a socket or ratchet.
6. Zero dial indicator. Continue to rotate crankshaft slowly until tappet is in fully raised position (highest indicator reading).
7. Compare total lift recorded on indicator with specifications. Refer to the Specifications portion of the appropriate engine section in this group for camshaft lobe lift specifications.
8. To check accuracy of original indicator reading, continue to rotate crankshaft until indicator reads zero.
NOTE: If lift on any lobe is below specified service limits, camshaft and tappet operating on worn lobe(s) must be replaced, as well as any tappet showing pitting or having contact face worn flat or concave. Refer to Camshaft Inspection in this section.
9. Remove dial indicator and auxiliary starter switch.
CAUTION: After installing rocker arms, do not rotate crankshaft until tappets have had sufficient time to bleed down. To do otherwise may cause serious valve damage. Manually bleeding down will reduce waiting time.
10. Install valve rocker arm cover.
11. Install spark plugs.

Hydraulic Tappet

Hydraulic tappet noise may be caused by any of the following:

1. Excessive collapsed tappet gap
2. Sticking tappet plunger
3. Tappet check valve not functioning properly
4. Air in lubrication system
5. Leakdown rate too rapid
6. Excessive valve guide wear

Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts/nuts, cam lobe wear, tappet face wear or roller wear, push rod rocker arm wear, rocker arm fulcrum or valve tip wear. With tappet collapsed, check gap between valve tip and rocker to determine if any other valve train parts are damaged, worn or out of adjustment.

A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. The sticking can be corrected by disassembling the tappet and removing the dirt, chips or varnish that are causing the condition.

A tappet check valve that is not functional may be caused by an obstruction such as dirt or chips preventing it from closing when the cam lobe is lifting the tappet, or it may be caused by a broken check valve spring.

Air bubbles in the lubrication system will prevent the tappet from supporting the valve spring load and may be caused by too high or too low an oil level in the oil pan, or by air being drawn into the system through a hole, crack or leaking gasket on the oil pump pickup tube.

If the leakdown time is below the specified time for tappets (as listed in the Specifications portion of the individual engine sections), noisy operation may result. If no other cause for noisy tappets can be found, the leakdown rate should be checked and any outside the specification should be replaced.

Assembled tappets can be tested with Hydraulic Tappet Leakdown Tester TOOL-6500-E, to check the leakdown rate. The leakdown rate specification is the time in seconds for the plunger to move a specified distance of its travel while under a 22.7 kg (50 lb) load. Test the tappets as follows.

Leakdown Testing

1. Disassemble and clean tappet to remove all traces of engine oil.

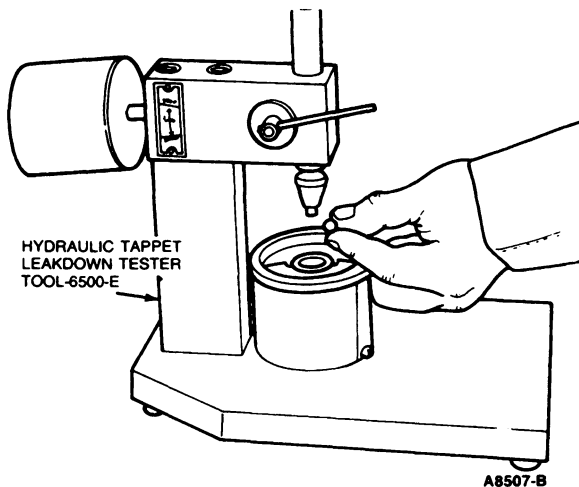
NOTE: Do not mix parts from different tappets. Parts are select-fitted and are not interchangeable.

NOTE: Tappets cannot be checked with engine oil in them. Only testing fluid can be used.

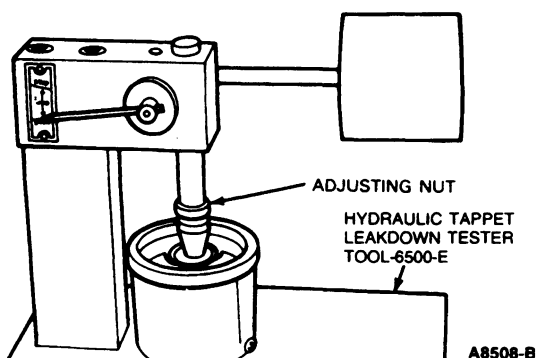
2. Place tappet in tester, with plunger facing upward. Pour hydraulic tester fluid into cup to a level that will cover tappet assembly. The fluid can be purchased from manufacturer of tester. Using kerosene or any other fluid will not provide an accurate test.

DIAGNOSIS AND TESTING (Continued)

- Place a 7.94mm (5 / 16-inch) steel ball provided with tester in plunger cap.



- Adjust length of ram so that pointer is 1.59mm (1 / 16-inch) below starting mark when ram contracts tappet plunger, to facilitate timing as pointer passes Start Timing mark.



Use center mark on pointer scale as Stop Timing point instead of original Stop Timing mark at top of scale.

- Work tappet plunger up and down until tappet fills with fluid and all traces of air bubbles have disappeared.
- Allow ram and weight to force tappet plunger downward. Measure exact time it takes for pointer to travel from Start Timing to Stop Timing marks of tester.

NOTE: Refer to the Specifications portion of the appropriate engine section in this group for hydraulic lifter leakdown rates.

- A tappet that is satisfactory must have a leakdown rate (time in seconds) within minimum and maximum limits specified.

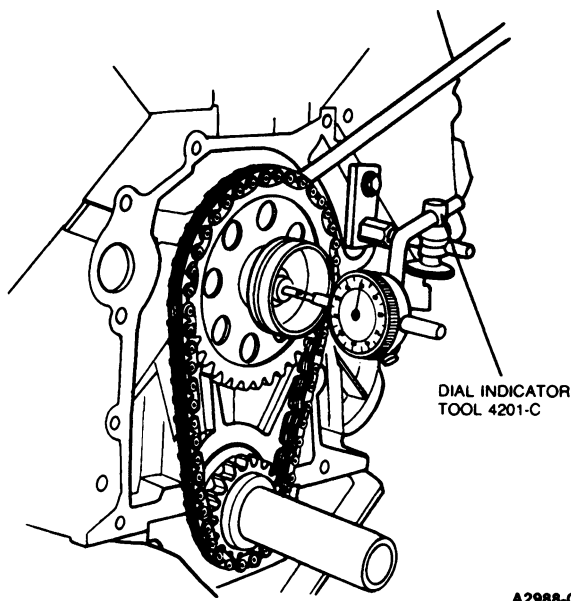
NOTE: Refer to the Specifications portion of the appropriate engine section in this group for camshaft endplay specifications.

- If tappet leakdown is not within specification, replace it with a new tappet. If a worn flat tappet is replaced with a new tappet it is recommended that a new camshaft be installed. It is not necessary to disassemble and clean new tappets before testing because oil contained in new tappets is test fluid.
- Remove fluid from cup and bleed fluid from tappet by working plunger up and down. This step will aid in depressing tappet plungers when checking valve clearance.

Camshaft End Play

CAUTION: Prying against the camshaft gear with the valve train load on the camshaft can break or damage the gear. Therefore, the rocker arm adjusting nuts must be backed off, or the rocker arm and shaft assembly must be loosened sufficiently to free the camshaft. After checking the camshaft end play, adjust the valve clearance.

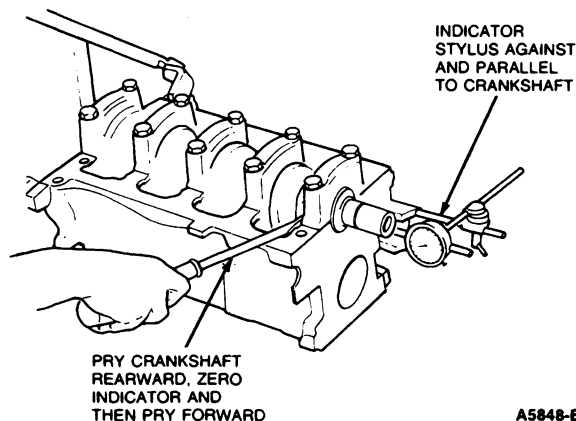
- Push camshaft toward rear of engine. Install Dial Indicator TOOL-4201-C so indicator point is on camshaft sprocket attaching screw.



- Zero dial indicator. Pull camshaft forward and release it. Compare dial indicator reading with specifications. If end play is excessive, replace camshaft thrust plate.
- Remove dial indicator.
- After replacing thrust plate, check end play again. If it is still out of specified range, inspect camshaft and cylinder head / cylinder block for excessive wear.

DIAGNOSIS AND TESTING (Continued)**Crankshaft End Play**

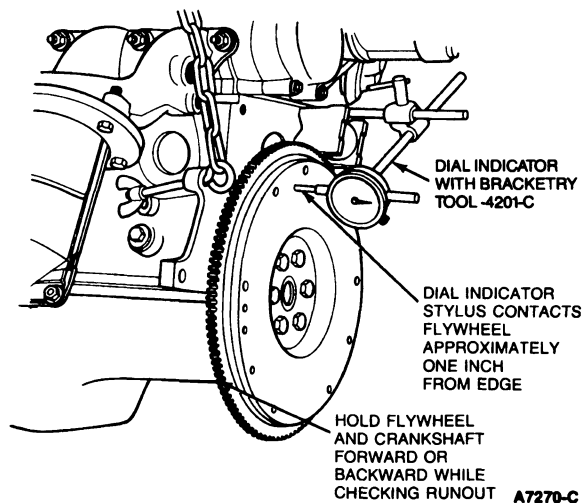
1. Force crankshaft toward rear of engine.
2. Install Dial Indicator with Bracketry TOOL-4201-C so contact point rests against crankshaft flange and indicator axis is parallel to crankshaft axis.



3. Zero dial indicator. Push crankshaft forward and note reading on dial.
4. If the end play exceeds the wear limit listed in the specific engine section, replace the thrust bearing. Inspect the crankshaft for damage to the thrust face before installing the new bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks, or dirt. If the thrust faces are not damaged or dirty, they may have been improperly aligned. Lubricate and install the thrust bearing and align the faces, following Main Bearing Replacement procedure in the appropriate engine section. Check the crankshaft end play.

Flywheel Runout (Manual Transmission)

1. Remove spark plugs.
2. Install Dial Indicator with Bracketry TOOL-4201-C so indicator points rest on face of the flywheel.



3. Hold flywheel and crankshaft forward or backward as far as possible to prevent crankshaft end play from being indicated as flywheel runout.
- NOTE: Refer to the Specifications portion of the appropriate engine section in this group for flywheel runout specifications.
4. Set indicator dial on zero mark. Turn flywheel one complete revolution while observing total indicator reading (TIR). If TIR exceeds specification, flywheel and ring gear assembly must be replaced.
 5. If clutch face runout exceeds specification, remove flywheel and check for burrs between flywheel and face of crankshaft mounting flange. If no burrs exist, check runout of crankshaft mounting flange. Replace flywheel or machine crankshaft flywheel mounting face sufficiently to true-up the surface.

REMOVAL AND INSTALLATION**Core Plugs**

To remove a large core plug, drill a 12.70mm (1/2-inch) hole in the center of the plug and remove with an impact Slide Hammer T59L-100-B or T50T-100-A or pry it out with a large drift punch. On a small core plug, drill a 6.35mm (1/4-inch) hole in the center of the plug and pry it out with a small pin punch. Clean and inspect the plug bore.

Prior to installing a core plug, the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged, it will be necessary to true the surface by boring for the next specified oversize plug.

Oversize (OS) plugs are identified by the OS stamped in the flat located on the cup side of the plug.

REMOVAL AND INSTALLATION (Continued)

Coat the plug and/or bore lightly with an oil-resistant (oil galley) Sealing Compound E0AZ-19554-B or EAZ-19544-B or equivalent and install it following the procedure for cup-type or expansion type below:

Cup-Type

Cup-type core plugs are installed with the flanged edge outward. The maximum diameter of this plug is located at the outer edge of the flange. The flange on cup-type plugs flares outward with the largest diameter of the outer (sealing) edge.

Expansion-Type

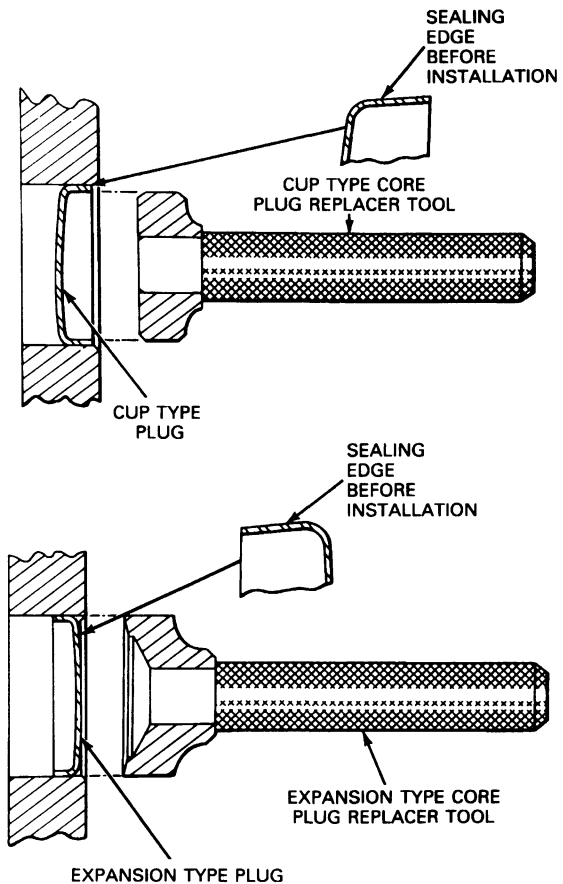
Expansion-type core plugs are installed with the flange edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

CAUTION: It is critical to push or drive the plug into the machined bore using a properly designed tool. Under no circumstances is the plug to be driven using a tool that contacts the crowned portion of the plug. This method will expand the plug prior to installation and may damage the plug and/or plug bore.

When installed, the trailing (maximum) diameter must be below the chamfered edge of the bore to effectively seal the plugged bore.

If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

CAUTION: It is critical to pull the plug into the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blowout.



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The flanged (trailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore.

If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

CLEANING AND INSPECTION**Cleaning the Engine**

A clean engine is more efficient because the engine is able to cool properly. A buildup of grease and dirt acts as an insulator, keeping the engine warmer than normal. A clean engine is also easier to work on.

Materials:

- Ford Extra Strength Engine Shampoo D8AZ-19A536-AA or equivalent
- Plastic bags or pieces of plastic
- Duct tape

Tools:

CLEANING AND INSPECTION (Continued)

- Putty knife
- Garden hose
- Nozzle
- Fender covers

CAUTION: In order to avoid possible cracking of the engine block, or fuel injection pump, do not spray a hot engine or injection pump with cold water.

CAUTION: The alternator, distributor and air intake must be covered. Covering these components will aid in the prevention of water damage.

CAUTION: Extreme care must be exercised if a power washer is used to clean the engine. The high pressure fluid could penetrate sealed parts and assemblies causing damage or malfunctions.

NOTE: This cleaning operation should be done away from lawn, garden or driveway. The degreaser could kill the grass or stain the driveway.

1. Park the vehicle on a level surface, turn the engine off and apply the parking brake. Open the hood and install fender covers.

CAUTION: Never wash or rinse the engine while it is running. Water getting into the engine may cause internal damage.

CAUTION: If your engine is hot, let it cool before wrapping the distributor, alternator and air intake. The plastic may melt.

2. Wrap the distributor, alternator and air intake duct with pieces of plastic. Tape the plastic so that no water will be able to damage these parts.
3. Follow the manufacturer's directions printed on the can for application of the engine degreaser.
4. Use a putty knife to scrape away the excessive amounts of grease buildup during the time the degreaser is soaking.
5. Reapply extra degreaser to areas which were scraped. This will help remove any grease that the cleaner and putty knife failed to remove.
CAUTION: Rinse the engine in such a manner as to avoid splashing the degreaser/water mixture on the vehicle's painted surfaces. The engine degreaser will damage the paint and finish.
6. Rinse the engine compartment thoroughly with water.
7. Remove the plastic from the alternator, distributor and air intake duct after the majority of the water has drained off or dried. Throw the plastic away.
8. Lubricate the shift linkages and inspect the ignition wires to make sure that they are properly seated.
9. Start the engine and allow it to reach normal operating temperature. This will help to dry the engine.

Cylinder Block

Cleaning

After any cylinder bore service operation, such as honing or deglazing, clean the bore(s) with soap or detergent and water. Then, thoroughly rinse the bore(s) with clean water to remove the soap or detergent, and wipe the bore(s) with a clean cloth dipped in engine oil. **If these procedures are not followed, rusting of the cylinder bore(s) may occur.**

If the engine is disassembled, thoroughly clean the block with solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages, clean out all the passages. Blow out all passages, then bolt holes, etc., with compressed air. Make sure threads in the cylinder head bolt holes are clean. Dirt in the threads may cause binding and result in a false torque reading. Use a tap to true-up threads and to remove all deposits. Thoroughly clean the grooves in the crankshaft bearings and bearing retainers.

Inspection

After the block has been thoroughly cleaned, check it for cracks. Tiny cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil. Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. Do not use rubbing alcohol as a substitute. If cracks are present, the coating will become discolored at the damaged area. Replace the block if it is cracked.

Check all machined surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone.

Check the cylinder block for flatness of the cylinder head gasket surface following the procedure and specifications recommended for the cylinder head. The cylinder block can be machined to bring the cylinder head gasket surface within the flatness specifications listed in the specific engine section, **but not to exceed 0.254mm (0.010 inch) stock removal from the original gasket surface.**

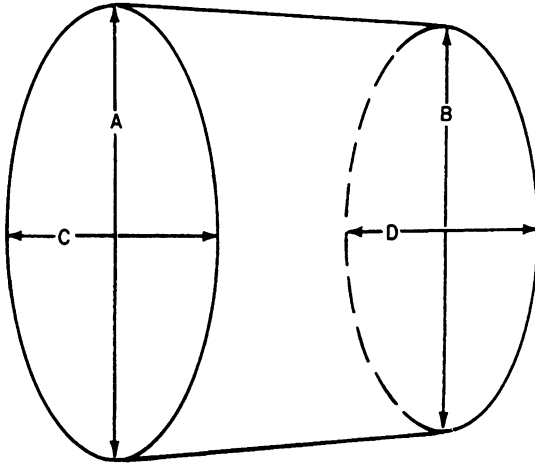
Replace all plugs that show evidence of leakage. Inspect the cylinder walls for scoring, roughness or other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate bore gauge following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle and bottom with the gauge placed at right angles and parallel to the centerline of the engine. **Use only the measurements obtained at 90 degrees to the engine centerline when calculating the piston-to-cylinder bore clearance.**

CLEANING AND INSPECTION (Continued)

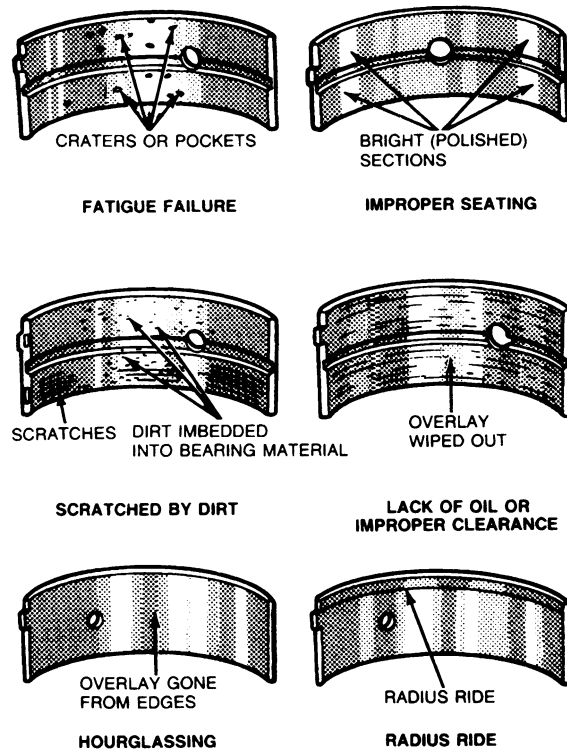
Inspect the main and connecting rod journals for cracks, scratches, grooves, scores or rough finish. Inspect the crankshaft oil seal surface for nicks, sharp edges, or burrs that might damage the oil seal during installation or cause premature seal wear.

A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A7267-B



A8509-B

Main and Connecting Rod Bearings

Cleaning

Bearings that are to be reused should be identified so they can be installed in their original locations.

Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air. **Do not scrape gum or varnish deposits from the bearing shells.**

Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped or worn surface should be replaced. Typical examples of unsatisfactory bearings and their causes are shown in the illustration. The copper lead bearing base may be visible through the bearing overlay. If the base showing is less than 20 percent of the total area, the bearing is not excessively worn. It is not necessary to replace the bearing if the bearing clearance is within recommended limits. Check the clearance of bearings that appear to be satisfactory with Plastigage as outlined under Overhaul in this section.

Crankshaft

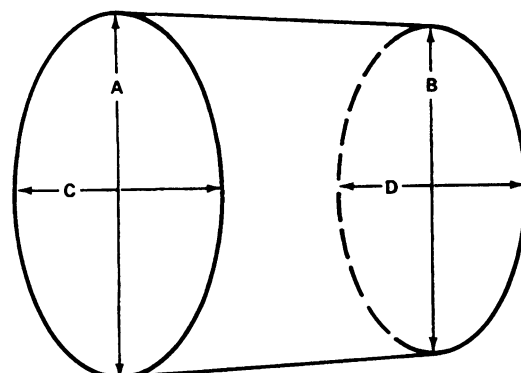
Cleaning

CAUTION: Handle the crankshaft with care to avoid possible damage to the finished surfaces.

Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

Measure the diameter of each journal in at least four places to determine an out-of-round, taper or undersize condition. For specifications, refer to the appropriate engine section.

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

A10094-1A

CLEANING AND INSPECTION (Continued)

On an engine used with a manual transmission, check the fit of the clutch pilot bearing in the bore of the crankshaft. A needle roller bearing and adapter assembly is used as a clutch pilot bearing. It is press fit directly into the engine crankshaft and should not be loose. Inspect the inner surface of the bearing for wear or a bell-mouth condition. Check the inside diameter of the bearing to see if it is worn or damaged. The bearing and adapter assembly cannot be serviced separately. The needle bearing clutch pilot can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pre-greased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.

Inspect the pilot bearing, when used, for roughness, evidence of overheating or loss of lubricant. Replace if any of these conditions are found.

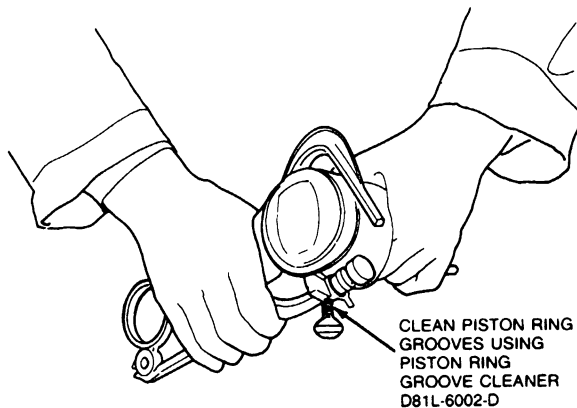
Pistons, Pins and Rings

Cleaning

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins, and rings with solvent.

CAUTION: Do not use a caustic cleaning solution or a wire brush to clean pistons.

Clean the ring grooves with Piston Ring Groove Cleaner D81L-6002-D or equivalent. Make sure oil ring slots (or holes) are clean.



A8102-B

Inspection

Carefully inspect the pistons for fractures at the ring lands, skirts, oil ring slot corners, and pin bosses, and for scuffed, rough or scored skirts. If the lower inner portion of the ring grooves have a high step, replace the piston. The step will interfere with ring operation and cause excessive ring side clearance.

Spongy, eroded areas near the edge of the top of the piston are usually caused by detonation or preignition. A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands or fractures or damage from detonation or preignition.

Check the piston-to-cylinder bore clearance by measuring the piston and bore diameters. Refer to Specifications in the appropriate engine section for the proper clearance. Refer to Cylinder Block Inspection for the bore measurements procedure. Measure the outside diameter of the piston and check the ring side clearance following the procedure under Fitting Pistons, Pins and Rings.

Replace piston pins showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod.

Check the outside diameter of the piston pin and the inside diameter of the pin bore in the piston. Replace any piston pin or piston that is not within specifications. Refer to the Specifications in appropriate engine section.

Replace all rings that are scored, broken, chipped or cracked. Check the end gap and side clearance.

Rings should not be transferred from one piston to another, regardless of mileage.

Connecting Rods

Cleaning

Remove the bearings from the rod and cap. Identify each bearing location if they are to be used again. Clean the connecting rod in solvent, including the rod bore and the back of the inserts. **Do not use a caustic solution.** Blow out all passages with compressed air.

Inspection

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. Refer to the appropriate engine section.

Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on either pin boss inside of the piston usually indicates that a connecting rod is bent.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, worn or damaged crankpin, or a tapered connecting rod bore.

Twisted connecting rods can create an identifiable piston skirt wear pattern, but badly twisted rods will disturb the action of the entire piston, rings, and connecting rod assembly and may be the cause of excessive oil consumption.

Check the connecting rods for bend or twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and / or twist exceeds specification, the connecting rod must be replaced.

CLEANING AND INSPECTION (Continued)

Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the recommended limits and / or it the connecting rod is fractured, it should be replaced. Check the inside diameter of the connecting rod piston pin bore. If the pin bore in the connecting rod is larger than specification, install a 0.025mm (0.001 inch) oversize piston pin. First, prefit the oversize piston pin to the piston pin bore by reaming or honing the piston to provide 0.007-0.13mm (0.0003-0.0005 inch) clearance (light slip fit). Assemble the piston, piston pin and connecting rod following the procedure in this section. **It is not necessary to ream or hone the pin bore in the connecting rod. Replace damaged connecting rod nuts and bolts.**

Camshaft

Cleaning

Clean the camshaft in solvent and wipe it dry.

Remove light scuffs, scores or nicks from the camshaft machined surfaces with a smooth oil stone.

NOTE: If camshaft journals are excessively worn or scored, the camshaft must be replaced. Camshaft journals can be refinished to accommodate 0.38mm (0.015 inch) undersize bearing. If the journals do not "clean up," the camshaft must be replaced.

Inspection

Check camshaft bores for size, taper, roundness, alignment and finish.

NOTE: Refer to Specifications in the appropriate engine section in this group for camshaft specifications.

If any of these exceed the limits given in specifications, install new camshaft bearings.

Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe pitting except in the general area of the lobe toe is not detrimental to the operation of the camshaft; therefore, the camshaft should not be replaced unless the lobe lift loss has exceeded specification or pitting has occurred in the lobe lift area.

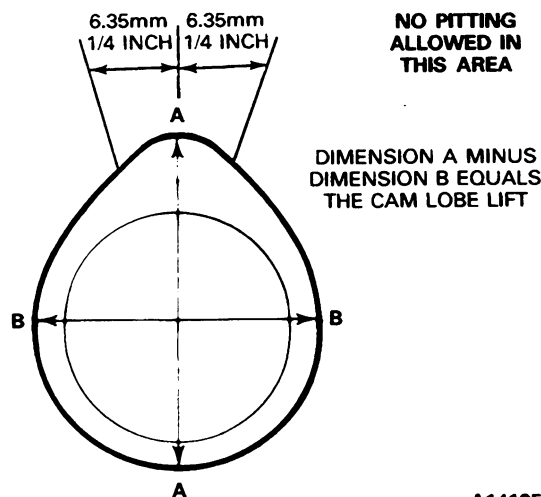
The lift of the camshaft lobes can be checked with the camshaft installed in the engine or on centers. Refer to Camshaft Lobe Lift.

To measure the camshaft lobe lift, proceed as follows:

1. Measure distance between major (A-A) and minor (B-B) diameters of each cam lobe with a Vernier caliper and record readings. The difference in readings on each cam diameter is lobe lift.

2. If readings do not meet specification, replace camshaft.

NOTE: Refer to Specifications in the appropriate engine section.



Hydraulic Tappets

The tappet assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each tappet separately so as not to intermix. **If any part of the tappet assembly needs replacing, replace the entire assembly.** If a tappet is worn, it is recommended that all tappets and camshaft be replaced.

Cleaning

Thoroughly clean all the parts in clean solvent and wipe them with a clean, lint-free cloth.

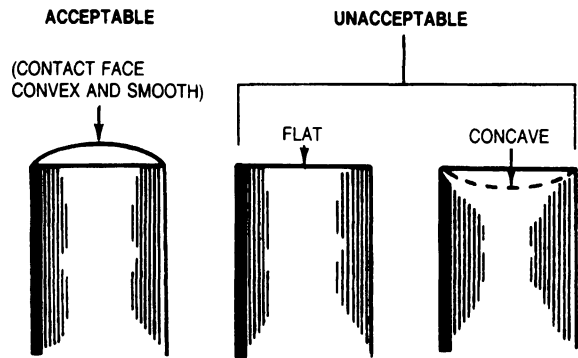
Inspection

Inspect the parts and discard the entire tappet assembly if any part shows pitting, scoring or excessive wear. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry.

Assemble the tappet assembly and check for freeness of operation by pressing down on the plunger. The tappets can also be checked with a hydraulic tester to test the leakdown rate. Follow the instructions of the test unit manufacturer or the Hydraulic Tappet procedure under Diagnosis and Testing.

CLEANING AND INSPECTION (Continued)

Flat Tappet Wear



A4290-B

Oil Pump

Cleaning

Wash all parts in a solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Make sure all dirt and metal particles are removed.

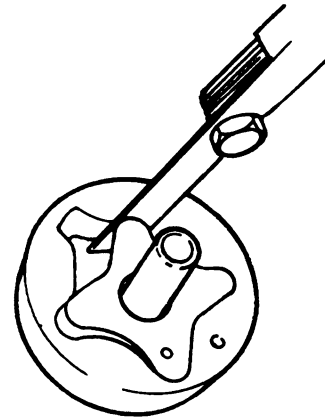
Inspection

NOTE: Refer to Specifications in the appropriate engine section for clearances and service limits.

Check the inside of the pump housing and the inner and outer gears for damage or excessive wear.

Check the mating surface of the pump cover for wear. Minor scuff marks are normal, but if the cover, gears or housing surfaces are excessively worn, scored or grooved, replace the pump. Inspect the rotor for nicks, burrs or score marks. Remove minor imperfections with an oil stone.

Measure the inner to outer rotor tip clearance.

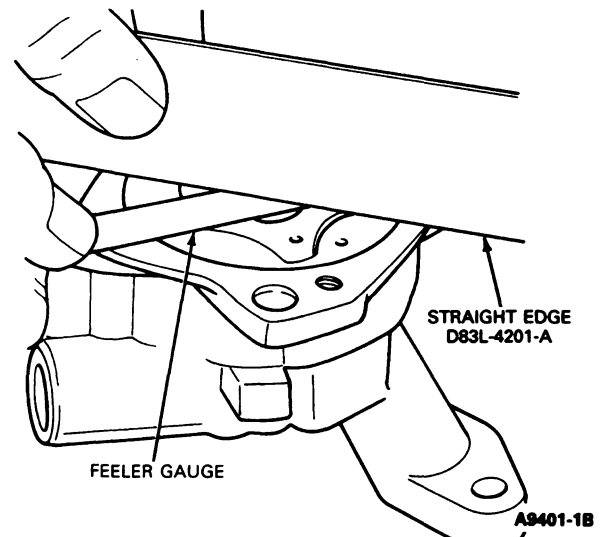


NOTE:
WITH ROTOR ASSEMBLY REMOVED FROM THE PUMP AND RESTING ON A FLAT SURFACE, THE INNER AND OUTER ROTOR TIP CLEARANCE MUST NOT EXCEED 0.30mm (0.012 IN) WITH FEELER GAUGE INSERTED 13mm (0.5 IN) MINIMUM.

A7541-1A

With the rotor assembly installed in the housing, place a straightedge over the rotor assembly and the housing.

Measure the vertical clearance (rotor end play) between the straightedge and both the inner rotor and the outer race. Maximum clearance must not exceed 0.13mm (0.005 inch).



Inspect the relief valve spring to see if it is collapsed or worn. Check the relief valve spring tension. If the spring tension is not within specification and / or the spring is worn or damaged, replace the pump. Check the relief valve piston for free operation in the bore.

NOTE: Internal components are not serviced. If any component is out of specification, the pump assembly must be replaced.

Refer to the Specifications portion of the appropriate engine section in this group for oil pump specifications.

CLEANING AND INSPECTION (Continued)**Oil Pan****Cleaning**

Scrape any dirt or metal particles from the inside of the pan. Scrape all old gasket material from the gasket surface. Wash the pan in a solvent and dry it thoroughly. Make sure all foreign particles are removed.

CAUTION: Do not damage the oil level sensor (if equipped) when cleaning the oil pan.

Inspection

Check the pan for cracks, holes or damaged drain plug threads. Check the gasket surface for damage caused by over-tightened bolts. Replace with a new oil pan if repairs cannot be made.

Cylinder Heads**Cleaning**

With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. After the valves are removed, clean the valve guide bores. Use cleaning solvent to remove dirt, grease and other deposits from the valves with a fine wire brush or buffing wheel.

Inspection

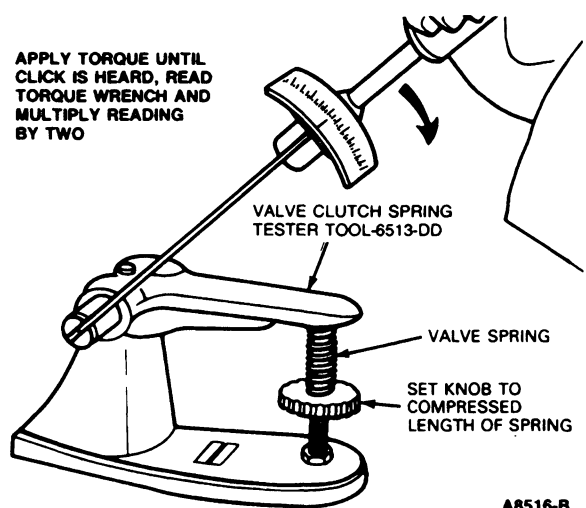
Inspect the cylinder heads for cracks or excessively burned areas in the exhaust outlet ports.

Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Small imperfections of this type can be dressed down using an oil stone. Replace the head if it is cracked.

Valve Spring Tension

Inspect the valve spring, valve spring retainers, and keys for wear or damage. Discard any damaged parts.

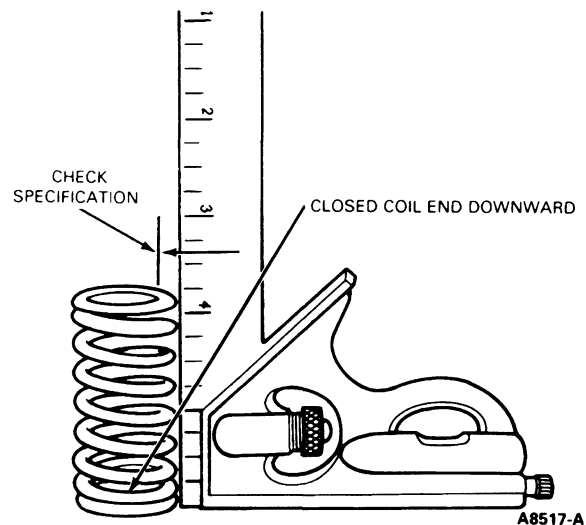
Check the springs for proper pressure at the specified spring lengths using Valve Clutch Spring Tester TOOL-6513-DD. Weak valve springs cause poor engine performance. Replace any spring not within specification. For Specifications, refer to the appropriate engine section. Manually rotating the valve spring assemblies while installed in the engine, will not determine condition of valve springs.



A8516-B

Valve Spring Squareness

Check each spring for squareness using a steel square and a flat surface. Stand the spring and square on end of the flat surface. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square. Refer to the illustration below.



Refer to Specifications in the appropriate engine section for out-of-square limits.

Follow the same procedure to new valve springs before installation.

Make sure the proper spring (color-coded) is installed.

Valve Rocker Arm**Cleaning**

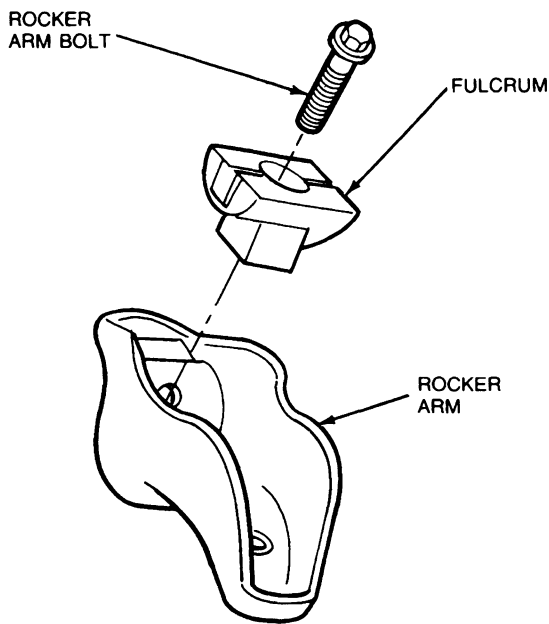
Clean all parts thoroughly. Make sure all oil passages are open.

CLEANING AND INSPECTION (Continued)

Make sure oil passage in the push rod end of the rocker arm is open.

Inspection

Inspect the shaft and the rocker arm bore for nicks, scratches, scores or scuffs. Replace any damaged parts.



A5859-E

Inspect the pad at the valve end of the rocker arm for indications of scuffing or abnormal wear. If the pad is grooved, replace the rocker arm. **Do not attempt to true this surface by grinding.** On pedestal mounted rocker arms, check the rocker arm pad, side rails and fulcrum seat for excessive wear, cracks, nicks, or burrs. Check the rocker arm bolt for stripped or broken threads.

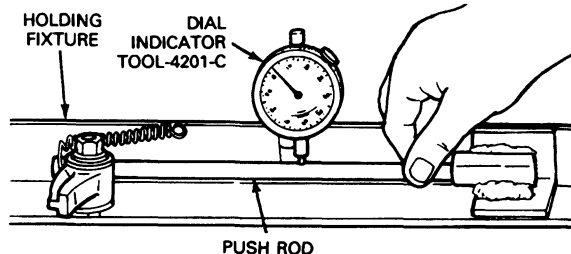
Push Rods**Cleaning**

Clean the push rods in a suitable solvent. Blow out the oil passage in the push rods with compressed air.

Inspection

Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Replace damaged push rods.

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with a dial indicator.



A10196-1B

If the push rod is bent beyond specifications, it should be replaced. **Do not attempt to straighten push rods.**

Intake Manifold**Cleaning**

Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.

Inspection

Inspect the manifold for cracks, damaged gasket surfaces, or other problems that would make it unfit for further service. Replace all studs that are stripped or otherwise damaged. Clean the EGR exhaust passages. **Remove all fillings and foreign matter that may have entered the manifold as a result of service.**

Check the baffle plate(s) on the underside of the manifold if so equipped. The baffle(s) should be securely fastened.

Exhaust Manifold**Cleaning**

Remove all gasket or foreign material from all inlet and outlet sealing surfaces of the manifold.

Inspection

Inspect the cylinder head joining flanges of the exhaust manifold for evidence of exhaust gas leaks.

Inspect the manifold for cracks, damaged gasket surfaces, or other damage that would make them unfit for further service. Warped or cracked exhaust manifolds must be replaced.

CLEANING AND INSPECTION (Continued)

Flywheel, Automatic Transmission

Inspection

Inspect the flywheel for cracks or other damage that would make it unfit for further service. Inspect the flywheel ring gear for worn, chipped or cracked teeth. If the teeth are damaged, replace the ring gear and flywheel assembly.

With the flywheel installed on the crankshaft, check the gear face runout.

OVERHAUL

Service Limit Specifications

Service limit specifications are intended to be a guide only, to be used when overhauling or reconditioning an engine or engine component. A determination can be made whether a component is suitable for continued service or should be replaced for extended service while the engine is disassembled.

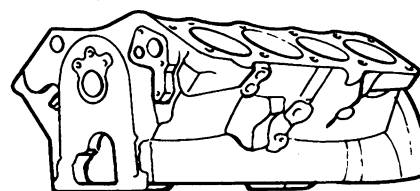
Cylinder Block

Servicing Sand Holes or Porous Engine Castings

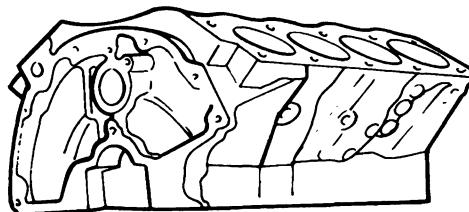
Porosity or sand hole(s), which will cause oil seepage or leakage, can occur with modern casting processes. A complete inspection of engine and transmission should be made. If the leak is attributed to the porous condition of the cylinder block or sand hole(s), service can be made with Ford Metallic Plastic C6AZ-19554-A (M3D35-A(E)) or equivalent. **Do not service cracks with this material.** Service with this metallic plastic must be confined to those cast iron engine component surfaces where the inner wall surface is not exposed to engine coolant pressure or oil pressure. For example:

- Cylinder block surfaces extending along the length of the block, upward from the oil pan rail to the cylinder water jacket, but not including machined areas.
- Lower rear face of the cylinder block.
- Intake manifold casting. **Service is not recommended to the intake manifold exhaust crossover section, since temperatures can exceed the recommended temperature limit of 260°C (500°F).**
- Cylinder front cover on engines using cast iron material.
- Cylinder head, along the valve rocker arm cover gasket surface.

TYPICAL FOR V-8 ENGINE



FRONT AND LH SIDE



REAR AND RH SIDE

A14134-1A

- Clean surface to be serviced by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut hole or porosity to a greater depth than rest of cleaned surface. Solid metal must surround hole. Openings larger than 6.35mm (1/4-inch) should not be serviced using metallic plastic. Openings in excess of 6.35mm (1/4-inch) can be drilled, tapped and plugged using common tools. Clean service area thoroughly. Metallic plastic will not stick to a dirty or oily surface.
- Mix metallic plastic base and hardener as directed on container. Stir thoroughly until uniform.
- Apply service mixture with a suitable clean tool (putty knife, wood spoon, etc.) forcing epoxy into hole or porosity.
- Allow service mixture to harden. This can be accomplished by two methods. Heat cure with a 250-watt lamp placed 254mm (10 inches) from serviced surface, or air-dry for 10-12 hours at temperatures above 10°C (50°F).
- Sand or grind serviced area to blend with general contour of surrounding surface.
- Paint the surface to match the rest of the block.

Cylinder Walls, Refinishing

Honing is recommended for refinishing cylinder walls only when no cross-hatch pattern is visible on cylinder walls, or for fitting pistons to the specified clearance. The grade of hone to be used is determined by the amount of metal to be removed. Follow the instructions of the hone manufacturer. If coarse stones are used to start the honing operation, leave enough material so that all hone marks can be removed with the finishing hone which is used to obtain the proper piston clearance. After honing, thoroughly clean cylinder bores with a detergent and water solution. Then wipe the bore(s) with a clean cloth dipped in new engine oil.

OVERHAUL (Continued)

Cylinder walls that are severely marred and /or worn beyond the specified limits should be refinished. Refer to the Specifications portion of the appropriate engine section in this group for cylinder bore diameter specifications.

CAUTION: Before any cylinder is refinished, all main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation.

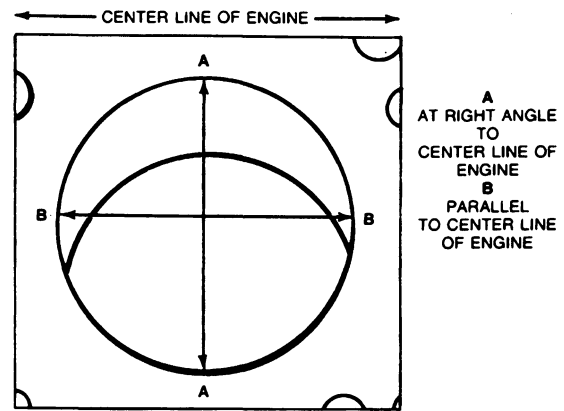
Hone only the cylinder or cylinders that require refinishing. All pistons are the same weight, both standard and oversize; therefore, various sizes of pistons can be used without upsetting engine balance. Refinish the cylinder with the most wear first to determine the maximum oversize. If the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

Refinish the cylinder to within approximately 0.038mm (0.0015 inch) of the required oversize diameter. This will allow enough stock for the final step of honing so that the correct surface finish and pattern are obtained. For the proper use of the refinishing equipment, follow the instructions of the manufacturer. **Only experienced personnel should be allowed to perform this work.**

Use a motor-driven, spring pressure-type Cylinder Hone Set T73L-6011-A, hone at a speed of 300-500 rpm. Hones of grit sizes 180-220 will normally provide the desired bore surface finish of 18-38 AA.

When honing the cylinder bores, use a lubricant mixture of equal parts of kerosene and SAE No. 20 motor oil. Operate the hone in such a way as to produce a cross-hatch finish on the cylinder bore. The cross-hatch pattern should be at an angle of approximately 30 degrees to the cylinder bore. **After the final operation in either refinishing method and prior to checking the piston fit, thoroughly clean with a detergent and water solution, and then oil the cylinder walls.** Mark the pistons to correspond to the cylinders in which they are to be installed. When the refinishing has been completed and all pistons are fitted, thoroughly clean the entire block and oil the cylinder walls.

Refinish cylinders that are deeply scored, out-of-round, and /or where taper exceeds specification. If the cylinder walls have minor surface imperfections, but the out-of-round and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new service piston rings, providing the piston clearance is within specification. For specifications, refer to the appropriate engine section.



1. OUT-OF-ROUND = DIFFERENCE BETWEEN A AND B
2. TAPER = DIFFERENCE BETWEEN THE A MEASUREMENT AT TOP OF CYLINDER BORE AND THE A MEASUREMENT AT BOTTOM OF CYLINDER BORE.

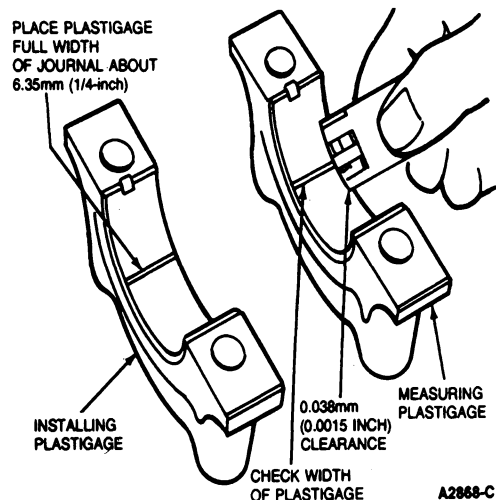
A2905-B

Fitting Main or Connecting Rod Bearings with Plastigage

1. Clean crankshaft journals. Inspect journals and thrust faces for nicks, burrs or roughness that would cause premature bearing wear. **When replacing standard bearings with new bearings, it is good practice to fit bearing to minimum specified clearance.** If desired clearance cannot be obtained with a standard bearing, try a 0.050mm (0.002 inch) undersize bearing set to obtain proper clearance.
2. If fitting main bearing in vehicle, position a jack under counterweight adjoining bearing which is being checked. Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.
CAUTION: Do not position jack under crankshaft pulley. Crankshaft post damage will result.
3. Place a piece of Plastigage D81L-6002-B or equivalent on bearing surface across full width of bearing cup and about 6.35mm (1/4 inch) off center.
4. Install cap and tighten bolts to specification. Refer to the torque specifications chart in the appropriate engine section in this group for bearing cap bolt or nut torque specifications. Do not turn crankshaft while Plastigage is in place.

OVERHAUL (Continued)

5. Remove cap. Using Plastigage scale, check width of Plastigage at widest point to get minimum clearance. check at narrowest point to get maximum clearance. Difference between reading is taper of journals.



6. If bearing clearance exceeds the specified limits, try using one of the various combinations of undersize bearings as directed by the accompanying table. Use of any other bearing combination is not recommended. Bearing clearance must be within specified limits. Refer to appropriate section under Specifications for main and connecting rod bearing clearance limits.
7. If use of these bearing combinations does not bring clearance to the desired limits, refinish the crank journal to .254mm (.010 inch) undersize, and use the appropriate undersize bearing.
8. After bearing has been fitted and cleaned, apply a light coat of engine oil to journal and bearings. Install bearing cap. Tighten cap bolts to specification.
9. Repeat procedure for remaining bearings that require replacement.

Undersize Bearing Chart

FOR THIS AMOUNT OF BEARING CLEARANCE EXCESS		USE THIS BEARING SIZE			
		UPPER BEARING		LOWER BEARING	
mm	Inch	mm	Inch	mm	Inch
0.0-0.013	0.0-0.0005	0.025	0.001 U.S.	STANDARD	STANDARD
0.013-0.026	0.0005-0.0010	0.025	0.001 U.S.	0.025	0.001 U.S.
0.026-0.039	0.0010-0.0015	0.050	0.002 U.S.	0.025	0.001 U.S.
0.039-0.052	0.0015-0.0020	0.050	0.002 U.S.	0.050	0.002 U.S.

CA9330-A

Journals, Refinishing

Dress minor imperfections such as scores, nicks or burrs with an oil stone. If the journals are severely marred or exceed the service limit, they should be refinished to size for the next undersize bearing.

If required, machine the journals to give the proper clearance with the next undersize bearing. If the journals will not clean up to maximum undersize bearing available, replace the crankshaft.

Always reproduce the same journal shoulder radius that existed originally. Too small a radius will result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

After refinishing the journals, chamfer the oil holes. Polish the journal with a No. 320 grit polishing cloth and engine oil (crocus cloth may also be used as a polishing agent) to obtain a smooth finish.

Pistons, Pins and Rings**Fitting Pistons**

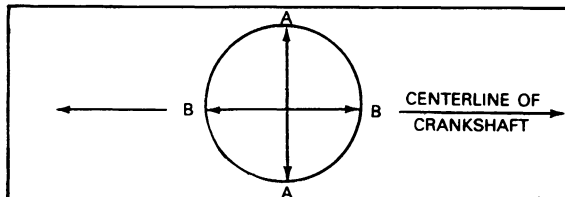
Pistons are available for service in standard size and the oversize shown in the appropriate engine section under Specifications.

The standard size pistons are color-coded red, blue or yellow on the dome.

OVERHAUL (Continued)

Measure the cylinder bore and select the piston to make sure the proper clearance is achieved. When the bore diameter is in the lower one-third of the specified range, a red piston should be used. When the bore diameter is in the middle one-third, a blue piston should be used. When the bore diameter is in the upper one-third, a yellow piston should be used.

NOTE: Cylinder bore must be clean and dry, and engine block must remain at room temperature (21°C/70°F) for eight hours before taking cylinder measurements.



A - At Right angle to center line of engine
B - Parallel to center line of engine

Top Measurement: Make 12.70mm (1/2 inch) below top of block deck

Bottom Measurement: Make within 12.70mm (1/2 inch) above top of piston - when piston is at its lowest travel (B.D.C)

Bore Service Limit: Equals the average of "A" and "B" when measured at the center of the piston travel.

Taper: Equals difference between "A" top and "A" bottom.

Out-of-Round: Equals difference between "A" and "B" when measured at the center of piston travel.

Refer to Specification tables at end of each engine section.

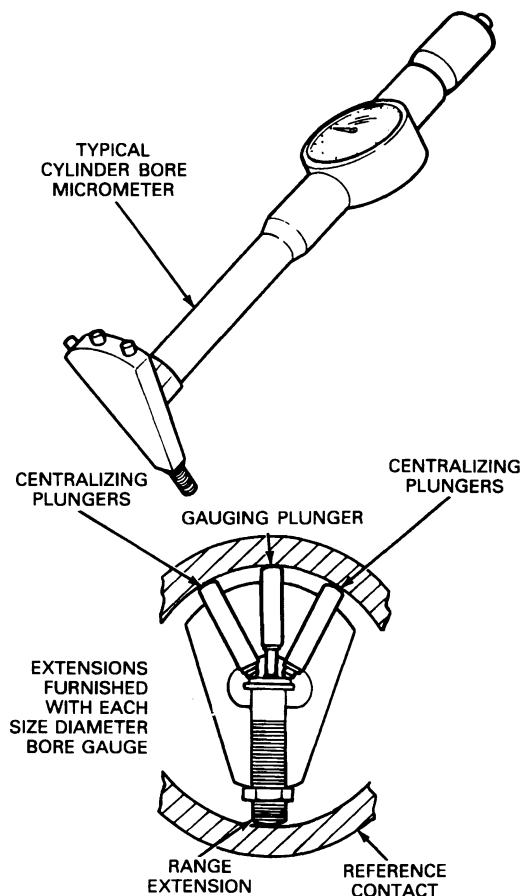
A4165-1G

Measure the piston diameter to make sure the specified clearance is obtained. It may be necessary periodically to use another piston (within the same grade size) that is either slightly larger or smaller to achieve the specified clearance.

If none can be fitted, refinish the cylinder to provide the proper clearance for the piston.

When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted.

If the taper, out-of-round and piston-to-cylinder bore clearance conditions of the cylinder bore are within specified limits, new piston rings will give satisfactory service.



POSITIVE CENTRALIZATION

CENTRALIZING PLUNGERS AUTOMATICALLY LOCATE THE GAUGING CONTACTS CENTRALLY ON THE BORE DIAMETER EVEN WHEN THE GAUGE IS INSERTED AT AN ANGLE.

A8793-E

If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze using only spring-loaded Engine Cylinder Hone Set T73L-6011-A, and only if there is no visible sign of cross-hatch markings on the cylinder walls. (Refer to Cylinder Block, Cylinder Walls, Refinishing). Always clean the cylinder bore thoroughly with detergent and water solution.

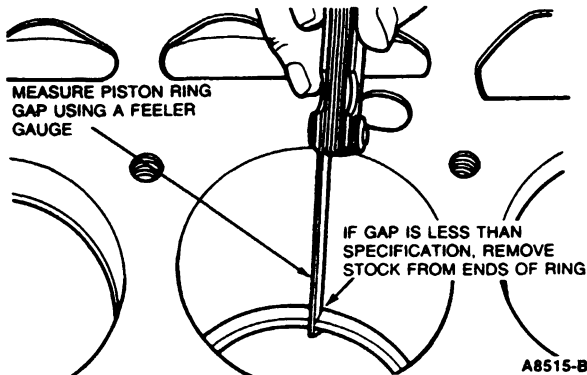
1. Calculate size piston to be used by taking a cylinder bore check. Follow procedures outlined previously.
2. Select proper size piston to provide desired clearance. Measure piston diameter in-line with centerline of piston pin and at 90 degrees to piston pin axis.
3. Make sure piston and cylinder block are at room temperature, 21°C (70°F). **After any refinishing operation, allow cylinder bore to cool, and make sure piston and bore are clean and dry before piston fit is checked.**

Fitting Piston Rings

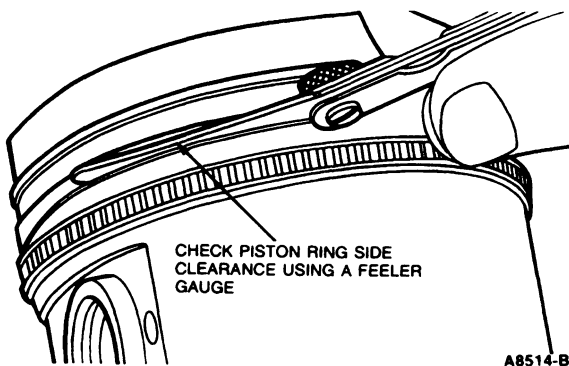
NOTE: Always use a piston ring expanding tool to install rings on a piston.

OVERHAUL (Continued)

1. Select proper ring set for size of cylinder bore.
2. Position ring in cylinder bore in which it is going to be used.
3. Push ring down into bore area where normal ring wear is not encountered.
4. Position ring in bore so ring is square with cylinder wall. **Use caution to avoid damage to ring or cylinder bore.**
5. Measure gap between ends of ring with a feeler gauge. If ring gap is less than or greater than specified limits, try another ring set. For specifications, refer to the appropriate engine section.



6. Check ring side clearance of compression rings with a feeler gauge inserted between ring and its lower land. Gauge should slide freely around entire ring circumference without binding. Any wear that occurs will form a step at inner portion of lower land. **If lower lands have high steps, piston should be replaced.**
7. Piston rings should be staggered on the piston to make sure the piston ring end gaps are **not** aligned.



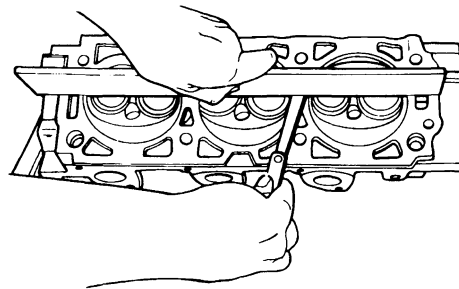
Cylinder Heads

Replace the head if it is cracked. **Do not plane or grind more than 0.254mm (0.010 inch) from original cylinder head gasket surface.** Remove all burrs or scratches with an oil stone.

Cylinder Head Flatness

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface for conformance to specification. For specifications, refer to the appropriate engine section.

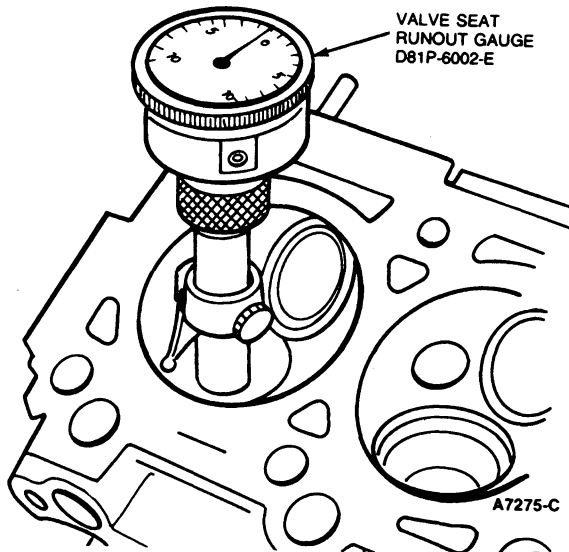
If necessary to refinish the cylinder head gasket surface, **do not plane or grind off more than 0.254mm (0.010 inch).**



OVERHAUL (Continued)

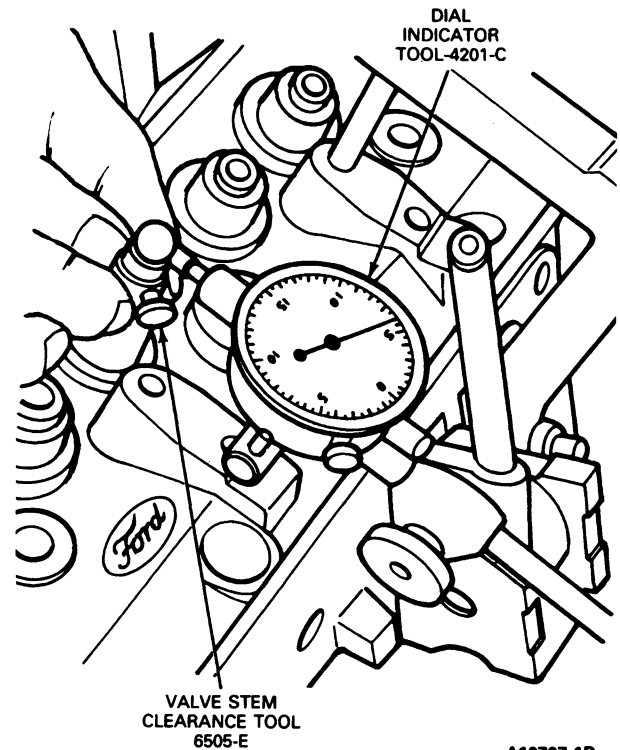
Valve Seat Runout

Check the valve seat runout with Valve Seat Runout Gauge D81P-6002-E or equivalent as illustrated below. Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat. For specifications, refer to the appropriate engine section.

**Valve Stem-to-Guide Clearance**

Check the valve stem-to-valve guide clearance of each valve in its respective valve guide with Valve Stem Clearance TOOL-6505-E. Use a flat-end indicator point.

Install the tool on the valve stem until it is fully seated, and tighten the knurled setscrew firmly. Permit the valve to drop away from its seat until the tool contacts the upper surface of the valve guide.



Position the dial indicator with its flat tip against the center portion of the tool's spherical section at approximately 90 degrees to the valve stem axis. Move the tool back and forth in line with the indicator stem. Take a reading on the dial indicator without removing the tool from the valve guide upper surface. Divide the reading by two, the division factor for the tool. If valve stem-to-valve guide clearance exceeds the wear limit, ream the valve guide for the next oversize valve stem as outlined under Valves.

Valves, Select Fitting

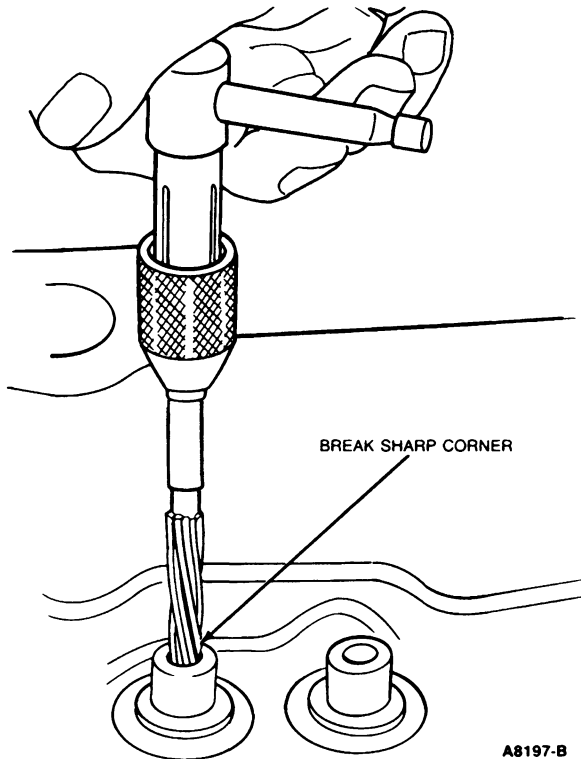
If the valve stem-to-valve guide clearance exceeds the service clearance, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.38mm and 0.76mm (0.015 inch and 0.030 inch) are available for service in diameters of 0.41mm and 0.81mm (0.016 inch and 0.032 inch) oversize. **Always reface the valve seat after the valve guide has been reamed.** Refer to Valve Guides, Reaming.

In the case of valve stem-to-valve guide clearance, the service clearance is intended as an aid to diagnosing engine noise only, and does not constitute a failure or indicate need for service. However, when overhauling or reconditioning a cylinder head, the service clearance should be regarded as a practical working value, and used as a determinant for installing the next oversize valve to make sure service life is extended.

OVERHAUL (Continued)

Valve Guides, Reaming

If it becomes necessary to ream a valve guide to install a valve with an oversize stem, a hand reaming kit is available which contains the following reamer and pilot combinations: a 0.38mm (0.015 inch) OS reamer with a 0.76mm (0.03 inch) OS pilot, and a 0.76mm (0.03 inch) reamer with a 0.38mm (0.015 inch) OS pilot.



A8197-B

When replacing a standard size valve with an oversize valve, always use the reamer in sequence (smallest oversize first, and then next smallest, etc.) so as not to overload the reamers. **Always reface the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (inside diameter) at the top of the valve guide.**

NOTE: If oversize valve stems and oversize stem seals are not available, bore out original guide and install service bushing. Ream inside diameter for specified clearance for standard size valve. Reface valve seat, as required. Install standard size valve stem oil seal.

If the valve face runout is excessive and/or to remove pits and grooves, reface the valves to a true 45 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less than 0.794mm (1/32 inch) thick after grinding, replace the valve as the valve will run too hot in the engine. **The interference angle of the valve and seat should not be lapped out. Remove all grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.254mm (0.010 inch) from the end of the valve stem.**

If the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rocker arm pad and the valve stem with the valve train assembly installed in the engine.

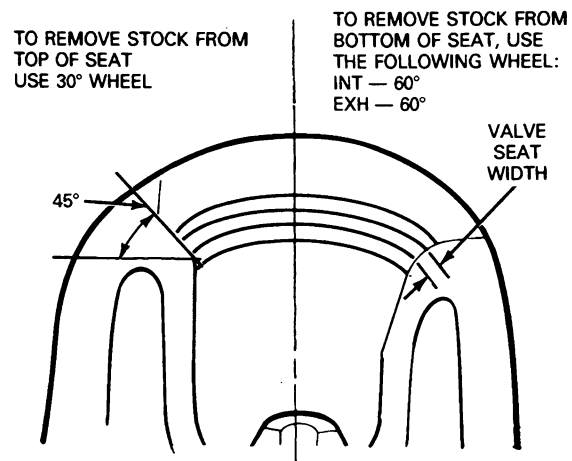
Valve Seats, Refacing

Measure the valve seat width. Reface the valve seat(s) if the width is not within specifications. Refer to the appropriate engine section.

Refer to Engine Service in the Rotunda Tool catalog for a description of the various types of valve seat grinders and cutters available.

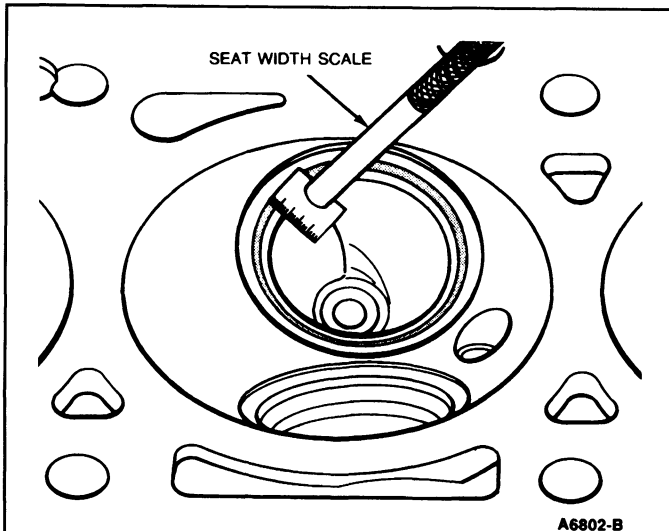
Refacing the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference angle will be maintained. This is important so that the valve and seat will have a compression-tight fit. Make sure refacer grinding wheels are properly dressed.

Grind the valve seats of all engines to a true 45 degree angle. Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width. Narrow the seat, if necessary, to bring it within specification. Refer to the appropriate engine section for specifications.



A14138-1A

OVERHAUL (Continued)



If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and / or bottom edge of the seat to reduce the width to specification.

On the intake and exhaust seats, use a 60 degree angle grinding wheel to remove stock from the bottom of the seat (raise the seats). A 30 degree angle wheel is used to remove stock from the top of the seats (lower the seats).

The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face.

To do this, coat the seat with Prussian Blue and set the valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

Valves

The critical inspection points and tolerances of the valve are illustrated. Refer to Specifications for service limits. Refer to appropriate engine section.

Inspect the valve stem for bends, and the end of the stem for grooves or scoring.

Inspect the valve face and the edge of the valve head for pits, grooves or scores. Inspect the stem for a bend condition and the end of the stem for grooves or scores. Check the valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

Inspect the valve spring assembly, valve spring retainers, locks and sleeves and discard any visually damaged parts.

Valves, Refacing

Minor pits or grooves may be removed. Discard valves that are severely damaged, if the face runout cannot be corrected by refinishing, or stem clearance exceeds specification.

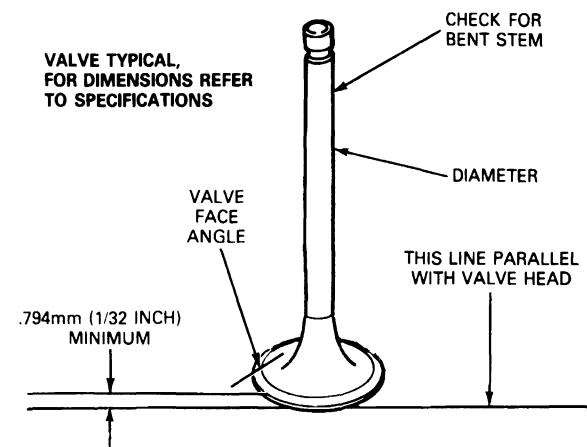
Refer to the appropriate engine for specifications.

Discard any excessively worn or damaged valve train parts.

Refer to Engine Service in the Rotunda Tool catalog for a description of the various types of valve resurfacing equipment.

The valve refacing operation should be closely coordinated with the valve seat refacing operations so that the finished angles of the valve face and valve seat will be to specifications and provide a compression-tight fit.

Make sure refacer grinding wheels are properly dressed. Refer to the following illustration for critical valve dimensions.



A14139-B

Flywheel Service Repair: Re-Machine Clutch Surface

Inspect the flywheel for cracks, heat check or other damage that would make it unfit for further use. Acceptable flywheels may be repaired by polishing with fine grade (400 grit) sandpaper. Flywheels may be resurfaced to remove scratches or grooves. After resurfacing, the flywheel thicknesses must not be less than the dimensions noted in the chart.

Flywheel Resurfacing Machining Requirements:

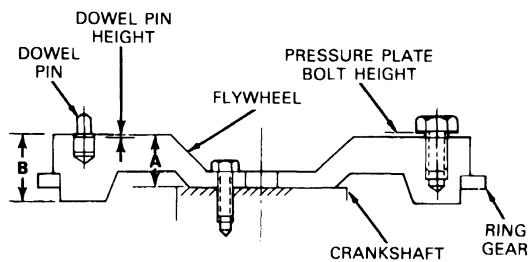
- a. Mount flywheel rigidly on crankshaft mounting flange.

OVERHAUL (Continued)**b. After machining:**

- Surface runout must not exceed 0.13mm (0.005 inch) TIR, surface finish must be in the range of 4.0 / 1.3 micrometer (160 / 52 microinch).
- Major diameter of dowel pin (press fit diameter) must not extend above the new surface.
- The clutch pressure plate retaining bolts must screw into the flywheel under hand torque to within 1.50mm (0.06) of new surface.
- Flywheels with dimensions less than the charted dimensions must not be used; install new service flywheel.

Charts

Dimension A is the minimum acceptable dimension from the crankshaft mounting surface to the new resurfaced clutch face surface. Dimension B is a referenced minimum acceptable dimension for the overall width of the outer flange.



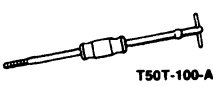
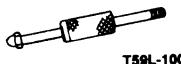




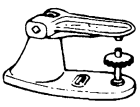
A15182-A

Flywheel Part Number	Dimension A mm (Inch)	Dimension B mm (Inch)
E7TZ-6375-A	25.40 (1.00)	28.45 (1.12)
E8TZ-6375-D	22.60 (0.89)	23.40 (0.92)
E8TZ-6375-C	22.60 (0.89)	23.40 (0.92)

NOTE: The above chart shows only a selected few flywheels that are used in production. Specifications may vary depending on the actual flywheel being serviced.

Inspect the ring gear for worn, chipped or cracked teeth. If the teeth are damaged, replace the ring gear.

SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T59L-100-B Impact Slide Hammer	 T59L-100-B
TOOL-4201-C Dial Indicator with Bracketry	 TOOL-4201-C
T73L-6011-A Cylinder Hone Set	 T73L-6011-A
TOOL-6500-E Hydraulic Tappet Leakdown Tester	 TOOL-6500-E
TOOL-6505-E Valve Stem Clearance Tool	 TOOL-6505-E
TOOL-6513-DD Valve / Clutch Spring Tester	 TOOL-6513-DD

Tool Number	Description
D81L-6002-B	Plastigage
D81L-6002-D	Piston Ring Groove Cleaner
D81P-6002-E	Valve Seat Runout Gauge

ROTUNDA EQUIPMENT

Tool Number	Description
112-R0030	Oil Leak Detector
059-R0009	Compression Tester
014-00705	Engine Cylinder Leak Detection Kit

SECTION 03-01A Engine, 4.9L Six-Cylinder

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION (Cont'd.)	
Valve Clearance	03-01A-40	Cylinder Front Cover	03-01A-17
CLEANING AND INSPECTION	03-01A-40	Cylinder Head	03-01A-13
DESCRIPTION AND OPERATION		E-150-250-350	03-01A-31
Cooling System	03-01A-3	Engine Assembly	03-01A-29
Crankcase Ventilation System	03-01A-2	F-150-250-350 and Bronco	03-01A-29
Emission Calibration Label	03-01A-2	Engine Components	03-01A-6
Engine	03-01A-1	Engine Front Supports	03-01A-3
Exhaust Emission Control System	03-01A-2	E-150-250-350	03-01A-3
Lubrication System	03-01A-2	Engine Rear Supports	03-01A-6
DIAGNOSIS AND TESTING	03-01A-3	Flywheel	03-01A-24
DISASSEMBLY AND ASSEMBLY		Main Bearing	03-01A-26
Cylinder Assembly	03-01A-40	Manifolds	03-01A-15
Cylinder Block	03-01A-40	Oil Filter	03-01A-29
Cylinder Head	03-01A-36	Oil Pan	03-01A-19
Piston and Connecting Rod	03-01A-38	Oil Pump	03-01A-21
Valve Tappet	03-01A-38	Pistons and Connecting Rods	03-01A-28
REMOVAL AND INSTALLATION		Timing Gears	03-01A-23
Camshaft	03-01A-21	Valve Rocker Arm Cover and Rocker	
Camshaft Bearings	03-01A-35	Arm	03-01A-11
Camshaft Rear Bearing Bore Plug	03-01A-25	Valve Spring, Retainer and Stem Seal	03-01A-11
Clutch Pilot Bearings	03-01A-25	Valve Tappet	03-01A-13
Connecting Rod Bearing	03-01A-27	Water Pump	03-01A-17
Crankcase Ventilation System	03-01A-10	SPECIAL SERVICE TOOLS/EQUIPMENT	03-01A-45
Crankshaft	03-01A-32	SPECIFICATIONS	03-01A-42
		VEHICLE APPLICATION	03-01A-1

VEHICLE APPLICATION

E-150-250-350, F-150-250-350 and Bronco Vehicles

DESCRIPTION AND OPERATION

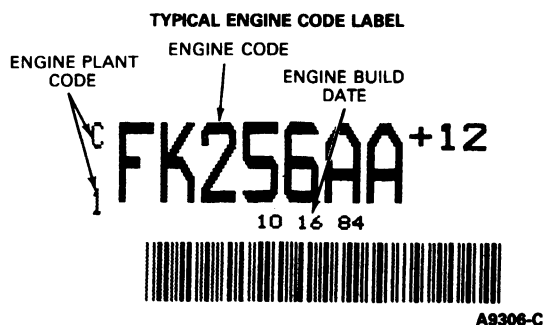
Engine

The 4.9L (300 CID) I-6 engine block is made of a special high-grade cast iron. The crankshaft has seven main bearings and is made of precision cast nodular iron. Pistons are aluminum alloy with integral steel struts. The valve rocker arms are stamped steel with powdered metal cylindrical fulcrums. Tappets are hydraulic and self-adjusting. The 4.9L (300 CID) I-6 engine has exhaust valve rotators. Timing gears are helical gear type. The cam gear is made of phenolic material.

The 4.9L (300 CID) I-6 is the standard engine for E-150-250-350, Bronco, F-150-250-350 (4x2) and F-150-250 (4x4).

Engine Code Information Label

Located on the timing gear front cover is the engine code information label containing, among other pertinent data, an engine build date, an engine plant code, and an engine code.



DESCRIPTION AND OPERATION (Continued)**Emission Calibration Label**

The emission calibration number label is located on the left side door or left door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.

NOTE: It is imperative that the engine codes and the calibration number be used when ordering parts or making inquiries about the engine.

**CALIBRATION
ÉTALONNAGE
CALIBRACIÓN**



2-54E-R00 E8AE-6E061-ABY

A10693-B

Exhaust Emission Control System

The exhaust emission control devices used on these engines are covered in the Powertrain Control / Emissions Diagnosis Manual.¹

Crankcase Ventilation System

These engines are equipped with a positive, closed-type ventilation system which directs the crankcase vapors to the intake manifold for combustion.

Lubrication System

Oil from the oil pan sump is forced through the pressure-type lubrication system by a rotor-type oil pump. A spring-loaded relief valve in the pump limits the maximum pressure of the system. Oil relieved by the valve is directed back to the intake side of the pump.

From the filter, the oil flows into the main oil gallery. The oil gallery supplies oil to all the camshaft and main bearings.

The crankshaft is drilled from the main bearings to the connecting rod journals to lubricate the rod bearings.

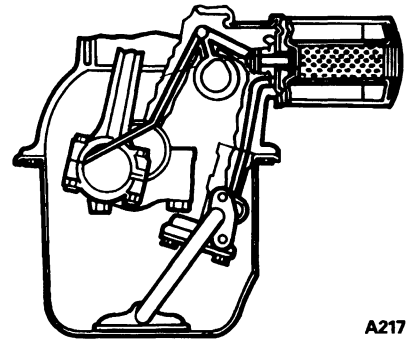
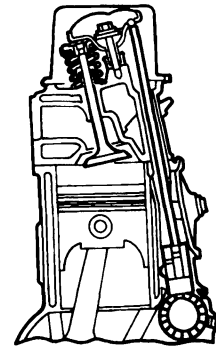
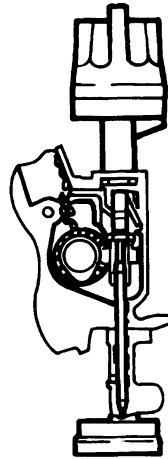
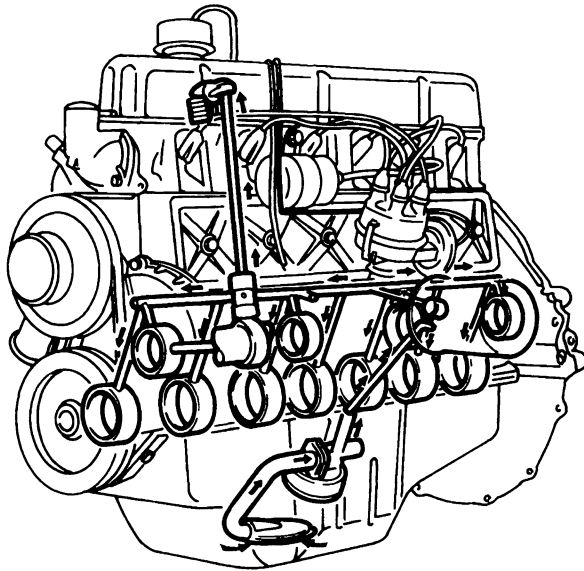
Oil from the floor of the valve tappet chamber is fed through a drilled passage in the cylinder block into the distributor pilot to lubricate the distributor shaft, bushings, and the distributor-to-oil pump intermediate shaft engagement.

The main oil gallery intersects all of the valve tappet bores supplying pressurized oil to the hydraulic valve tappets. A reservoir at each valve tappet bore boss traps oil so that oil is available for valve tappet lubrication as soon as the engine starts.

When the hydraulic tappet is on the base circle of the camshaft lobe (valve closed), the oil hole in the hydraulic tappet is indexed with the oil gallery, and oil flows into the plunger. Oil is also metered through the metering valve (disc) through the oil passages in the push rod cup and it flows up the hollow push rod. In this position, the drilled hole in the ball end of the push rod is indexed with a drilled hole in the rocker arm, and the oil lubricates the upper valve train bearing areas. Excess oil is returned to the oil pan through drain holes along the side of the cylinder head and block.

Excess oil in the push rod chamber drains back into the oil pan through openings along the cylinder block.

¹ Can be purchased as a separate item.

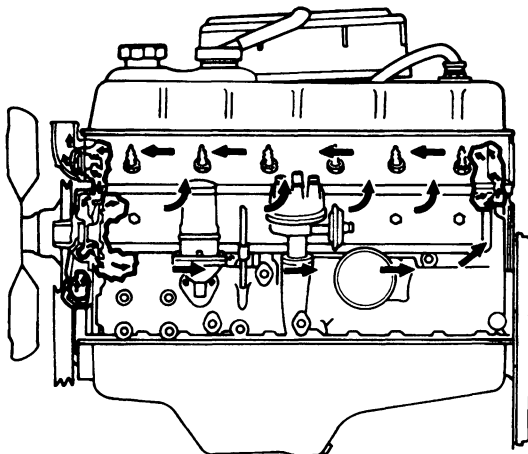
DESCRIPTION AND OPERATION (Continued)**Engine Lubrication, 4.9L Six Cylinder**

A2176-D

Cooling System

As the coolant flows through the block, it travels through cored passages to cool the entire length of each cylinder wall. The coolant is then directed upward into the cylinder head where it cools the combustion chambers, valves and valve seats.

The coolant from the cylinder head flows into the coolant outlet housing. If the thermostat is open, the coolant flows through the thermostat and into the top of the radiator. If the thermostat is closed, the coolant is returned to the water pump for recirculation.



A2274-1B

DIAGNOSIS AND TESTING

Refer to Diagnosis and Testing in Section 03-00.

REMOVAL AND INSTALLATION

The following procedures can be performed with the engine in the vehicle.

NOTE: Lightly oil attaching bolt and stud threads before installing, except those specifying special sealant.

Refer to Section 03-00 for cleaning, inspecting and repair procedures. Refer to the end of this section for all engine component bolt torque specifications. Refer to Section 03-05 for all belt tension specifications.

Engine Front Supports

The 4.9L (300 CID) I-6 engine for F-150-250-350, Bronco, E-150-250-350 is mounted on three engine mounts. These models have two front mounts located on each side of the engine and one rear mount located on the transmission extension housing.

E-150-250-350**Removal and Installation**

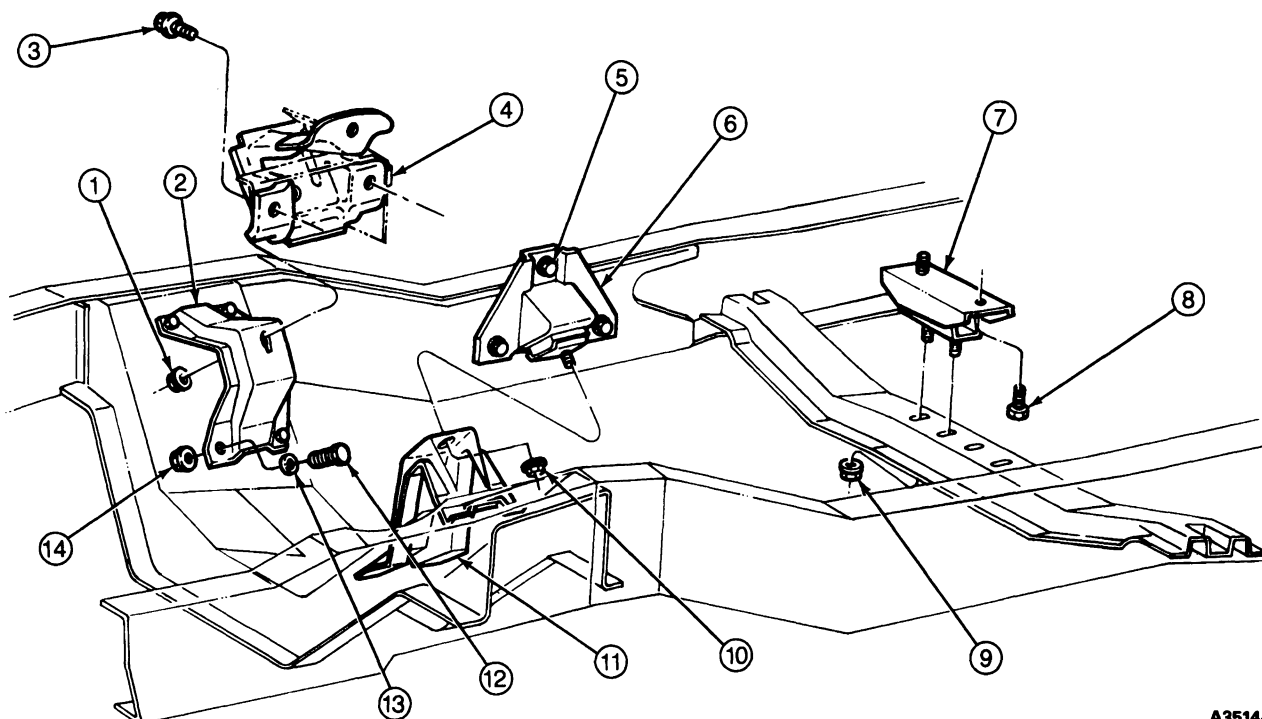
1. Raise the vehicle on a hoist.

REMOVAL AND INSTALLATION (Continued)

2. Remove the front support insulator-to-support bracket nuts and washers from both insulators.
3. Place a Rotunda Transmission Jack 066-00017 or equivalent under the engine oil pan and position a wood block between the jack and oil pan. Raise the engine just enough to take the weight off the support brackets.
4. The support brackets are mounted to the front frame crossmember with four bolts and locknuts. If these are to be removed, loosen the four locknuts on each support bracket and remove from the crossmember.

5. Remove the insulator assembly-to-cylinder block bolts and remove the front support insulators.

For installation, follow removal procedures in reverse order. Tighten crossmember support bracket bolts to 82-108 N-m (60-80 ft-lb). Tighten insulator-to-support bracket nuts to 67-100 N-m (50-74 ft-lb).

Engine Front Supports, E-150-250-350 Vehicles

A3514-P

Item	Part Number	Description
1	388049-S2	Nut and Washer Assembly 82-108 N-m (60-80 Ft-Lb)
2	6028	Bracket
3	390979-S100	Screw and Washer Assembly 82-108 N-m (60-80 Ft-Lb)
4	6038	Front Support Insulator Assembly
5	387811-S100	Screw and Washer Assembly 82-108 N-m (60-80 Ft-Lb)
6	6B032	Insulator Assembly

(Continued)

Item	Part Number	Description
7	6D091	Insulator and Retainer Assembly
8	388824-S2	Screw and Washer Assembly 82-108 N-m (60-80 Ft-Lb)
9	N621945-S2	Nut 82-108 N-m (60-80 Ft-Lb)
10	390128-S2	Nut and Washer Assembly 67-100 N-m (50-74 Ft-Lb)
11	6061	Bracket
12	58654-S2	Bolt
13	44878-S2	Washer
14	382400-S2	Nut 68-94 N-m (50-70 Ft-Lb)

TA3514A

REMOVAL AND INSTALLATION (Continued)

Double Front Mount, F-150-250 and Bronco

The following procedures apply to either a right or left installation.

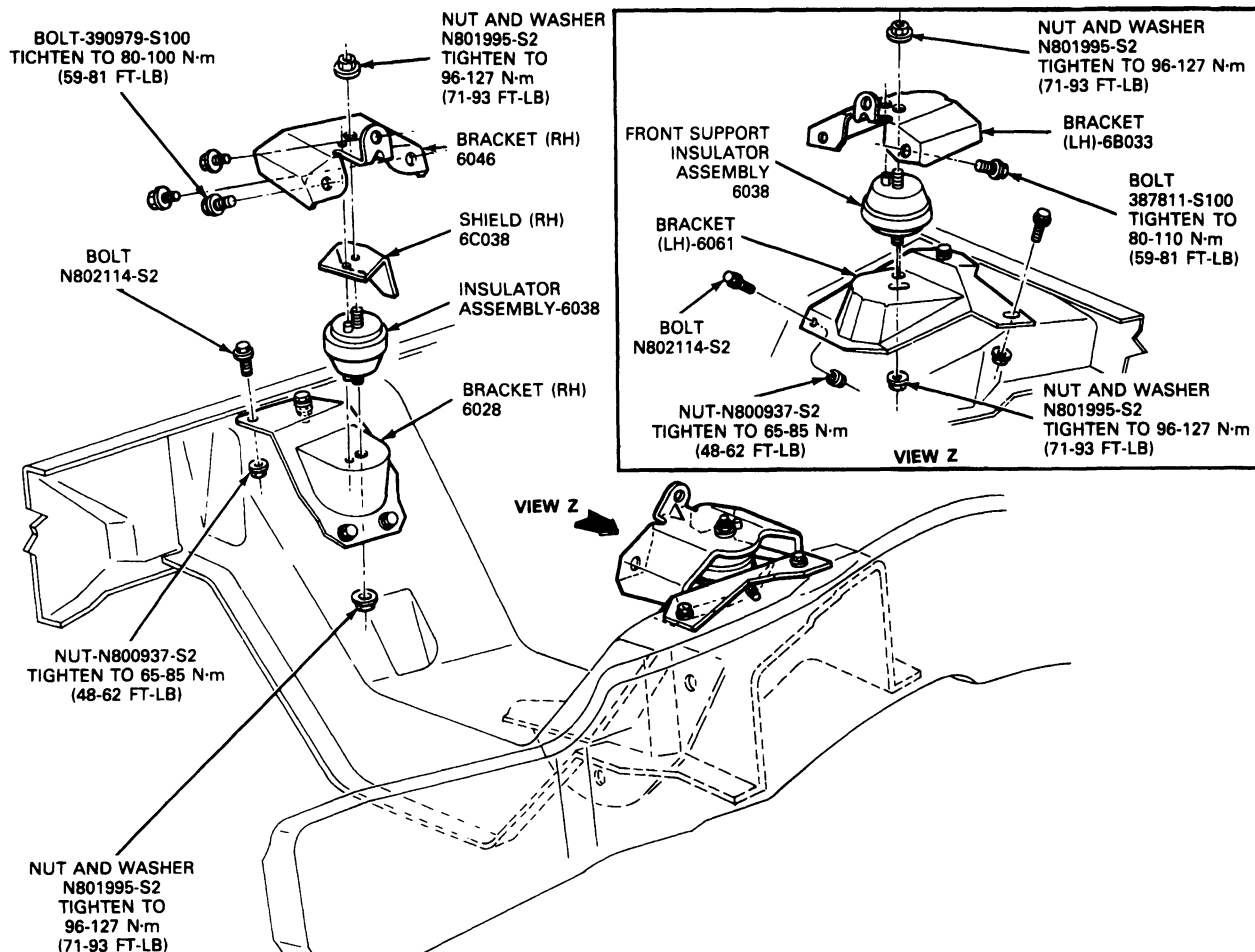
Removal

1. Remove the upper and lower nut and washer assemblies from the insulator assembly. If only one insulator is being removed, loosen nut and washer assemblies on opposite insulator.
2. Raise the engine to allow just enough clearance for removal of the mount using a jack and a wood block placed under the oil pan.
3. Remove the right or left mount, and shield (right mount only).
4. Remove three bolts securing upper bracket.
5. Remove nuts and bolts securing lower bracket.

Installation

1. Position the lower bracket and install new bolts and nuts. Tighten to 65-85 N·m (48-62 ft·lb).
2. Position upper bracket and install bolts. Tighten to 80-110 N·m (59-81 ft·lb).
3. Align locator pin with hole and position insulator on lower bracket.
4. Install lower nut and washer assembly finger tight.
5. On right insulator, position shield.
6. Lower the engine carefully to make sure the insulator stud and pin engage the upper bracket mounting hole.
7. Install the nut and washer on the upper insulator stud. Tighten the upper and lower stud nuts to 96-127 N·m (71-93 ft·lb).
8. Tighten the other insulator at the support brackets if only one insulator was removed.

Engine Front Supports, Double Front Mounts, F-150-250-350 and Bronco Vehicles



A10185-C

REMOVAL AND INSTALLATION (Continued)

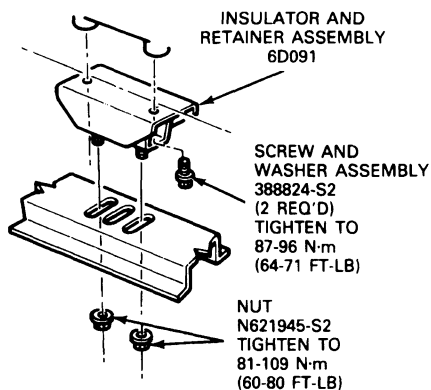
Engine Rear Supports

F-150-250-350 and Bronco

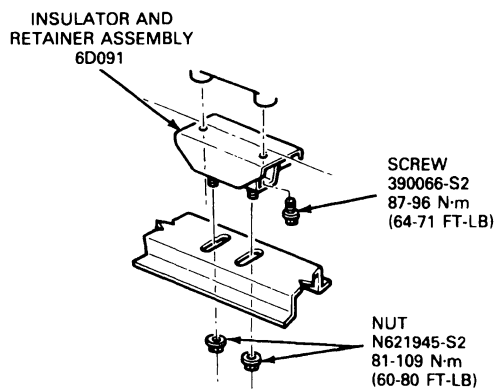
Removal and Installation

1. Remove the attaching bolts, nut and washers.
2. Raise the transmission slightly to provide clearance and remove the insulator and insulator retainer.

For installation, follow removal steps in reverse order. Tighten the nuts and bolts to specifications.



INSTALLATION FOR
F-150 - F-350, BRONCO (4x4)



INSTALLATION FOR F-150 - F-350 (4x2)

A5522-1G

E-150-250-350

Removal

1. Raise the vehicle on a hoist. Place a transmission jack, such as Rotunda 066-00017 or equivalent, under the transmission and raise it slightly so the transmission weight is not supported by the rear support insulator.

CAUTION: On 138-inch wheelbase vehicles, remove fuel reservoir to eliminate any part damage due to removing the rear transmission support crossmember. Refer to Section 10-01A.

2. Remove the insulator-to-crossmember and transmission extension housing locknuts and bolts.
3. Remove the rear support insulator.

Installation

1. Position the rear support insulator between the transmission extension housing and vehicle crossmember. Refer to the previous E-150-250-350 illustration for the proper position of the support insulator.
2. Install the support insulator attaching bolts and locknuts. Tighten the locknuts to 68-94 N·m (50-70 ft-lb).
3. Lower the transmission and remove the transmission jack. Lower the vehicle.

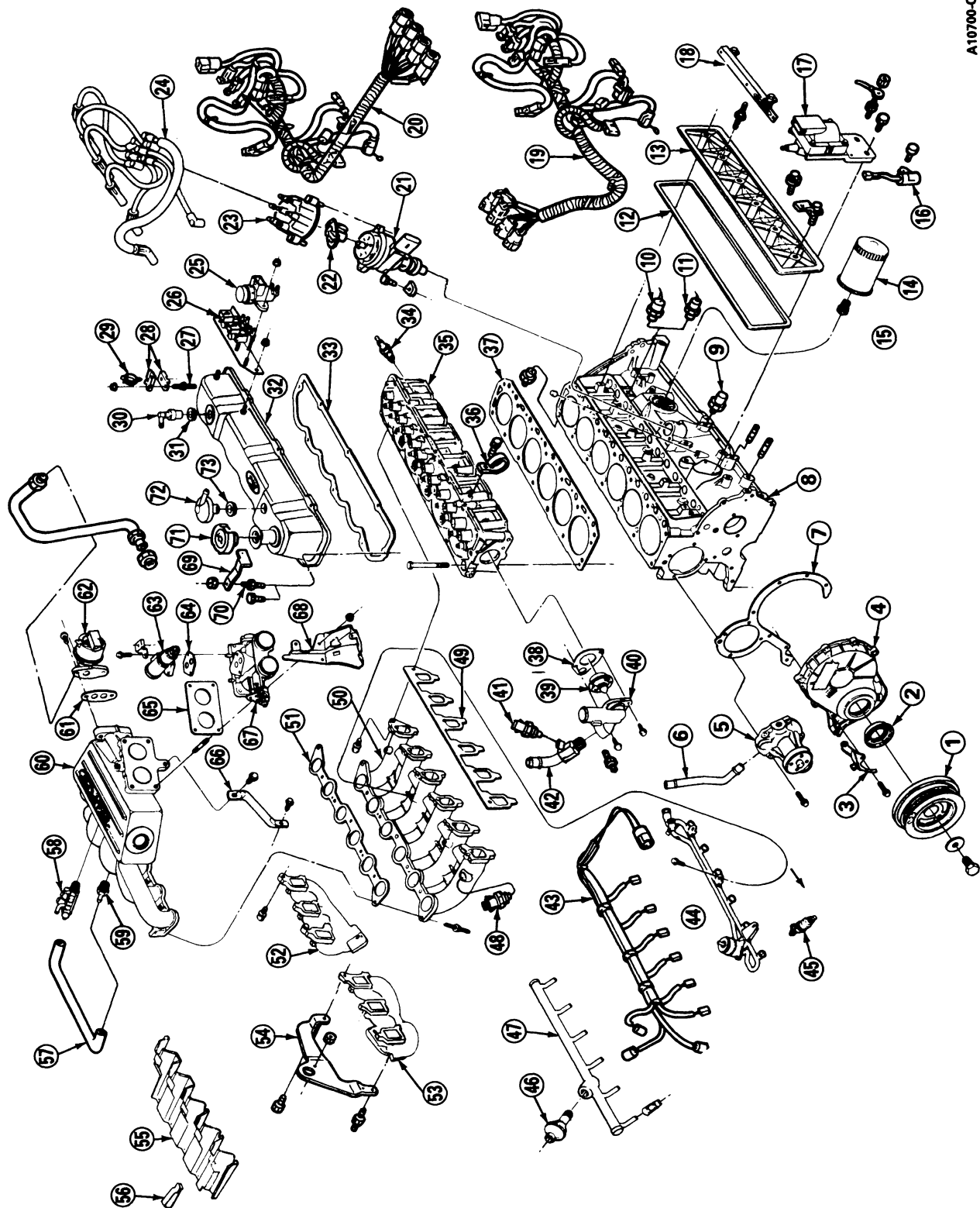
Engine Components

The following exploded views of the engine are typical and will serve as a reference for the procedures. The numbers and part descriptions shown are basic part numbers corresponding with the Ford Master Parts Catalog.

Refer to the end of this section for all specifications and torque values.

REMOVAL AND INSTALLATION (Continued)

Engine Components



REMOVAL AND INSTALLATION (Continued)

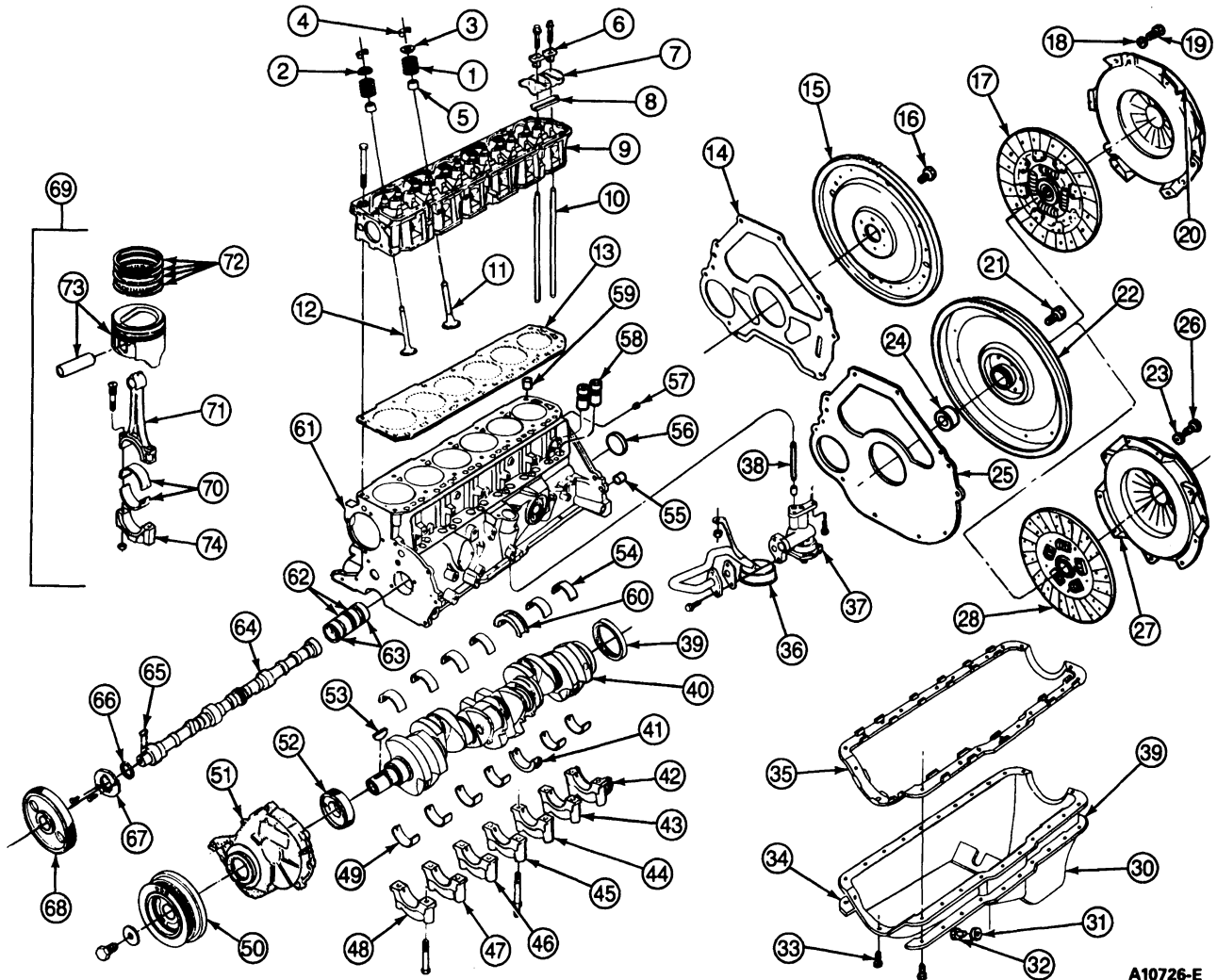
Item	Part Number	Description
1	6316	Damper Assy.
2	6700	Front Seal
3	6M025	Timing Pointer
4	6059	Front Cover
5	8501	Water Pump
6	8555	Connector Tube
7	6020	Gasket
8	6010	Block Assy.
9	12A699	Sensor
10	9D290	Oil Pressure Sending Unit (E-Series)
11	9278	Oil Pressure Sending Unit (F-Series)
12	6521	Gasket
13	6519	Cover
14	6714	Oil Filter
15	6890	Insert
16	18801	RFI Capacitor
17	12A310	Ignition Coil and Bracket Assy.
18	14A282	Retainer
19	14289	Wiring (E-Series)
20	14289	Wiring (F-Series)
21	12A332	Distributor
22	12200	Rotor
23	12106	Cap
24	12286	Wire Assy.
25	9J459	EVR Solenoid
26	9D474	Solenoid and Bracket Assy.
27	390056-S	Bolt (Studded Head)
28	14A163	Retainer
29	14A163	Clip
30	6B890	PCV Valve Assy.
31	6K780	Grommet
32	6582	Valve Rocker Arm Cover
33	6584	Gasket
34	12405	Spark Plug
35	6049	Cylinder Head

(Continued)

Item	Part Number	Description
36	45334	Strap (E-Series)
37	6051	Gasket
38	8255	Gasket
39	8575	Thermostat — Water
40	8594	Water Outlet Connection
41	12A648	Coolant Sensor
42	185899	Elbow
43	9D930	Wiring Harness Assy.
44	9S441	Fuel Rail Assy.
45	9F593	Fuel Injector
46	9A487	Check Valve
47	9B445	Exhaust Air Supply Manifold
48	12A697	ACT Sensor
49	9439	Gasket
50	9K461	Lower Intake Manifold
51	9H486	Gasket
52	9431	Exhaust Manifold
53	9430	Exhaust Manifold
54	17A084	Lifting Eye
55	9F460	Heat Shield
56	390717	Spring Clip
57	6K817	Vacuum Hose (Molded)
58	9D446	Vacuum Fitting
59	390659	PCV Connector
60	9424	Upper Intake Manifold
61	9D476	Gasket
62	9F483	EGR Valve
63	9F715	Air Bypass Valve Assy.
64	9F670	Gasket
65	9E936	Gasket
66	9J444	Bracket
67	9E926	Throttle Body Assy.
68	9278	Bracket
69	14A163	Bracket (E-Series)
70	390056-S	Bolt (Studded Head E-Series)
71	6766	Oil Fill Cap
72	6A768	Filter Assy.
73	6K780	Grommet

REMOVAL AND INSTALLATION (Continued)

Engine Components



A10726-E

Item	Part Number	Description
1	6513	Valve Spring
2	6A516	Exhaust Valve Spring Retainer
3	6514	Intake Valve Spring Retainer
4	6518	Key
5	6A517	Valve Stem Seal
6	6A528	Fulcrum
7	6564	Rocker Arm
8	6A588	Guide
9	6049	Cylinder Head
10	6565	Pushrod
11	6507	Intake Valve
12	6505	Exhaust Valve
13	6051	Gasket
14	6A372	Rear Cover
15	6375	Flywheel Assembly Auto Trans (C6/E4OD)
16	390453-S	Bolt (6 Req'd)

(Continued)

Item	Part Number	Description
17	7550	Clutch Disc
18	34792-S36	Washer (6 Req'd)
19	387299-S2	Bolt (6 Req'd)
20	7563	Clutch Pressure Plate and Cover
21	390453-S	Bolt (6 Req'd)
22	6375	Flywheel Assembly
23	34791-S36	Washer (6 Req'd)
24	7120	Pilot Bearing
25	6A372	Rear Cover
26	382067-S2	Bolt (6 Req'd)
27	7563	Clutch Pressure Plate and Cover
28	7550	Clutch Disc
29	6694	Reinforcement Plate
30	6675	Oil Pan
31	6734	Gasket
32	6730	Drain Plug 20-34 N-m (15-25 Ft-Lb)

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
33	390674-S2	Bolt 16-24 N·m (12-18 Ft-Lb) 3 Places X, 4, 2
34	6A674	Reinforcement Plate
35	6710	Oil Pan Gasket
36	6622	Screen and Cover Assembly
37	6600	Oil Pump Assembly
38	6A605	Shaft Assembly
39	6701	Rear Oil Seal
40	6303	Crankshaft
41	6A339	Lower Thrust Bearing
42	6325	Rear Cap
43	6327	Rear Intermediate Cap
44	6B308	Rear Center Cap
45	6330	Center Cap
46	6B307	Front Center Cap
47	6334	Front Intermediate Cap
48	6329	Front Cap
49	6A338	Lower Main Bearing (6)
50	6316	Damper Assembly
51	6059	Front Cover
52	6306	Crankshaft Gear

(Continued)

Item	Part Number	Description
53	379153-S	Key
54	6333	Upper Main Bearing (6)
55	6397	Dowel (2 Req'd)
56	376809-S	Cylinder Block Plug
57	87838-S101	Set Screw
58	6500	Tappet Assembly (12 Req'd)
59	6A008	Dowel Assembly (2 Req'd)
60	6337	Upper Thrust Bearing
61	6010	Cylinder Block Assembly
62	6262	Bearing
63	6261	Bearing
64	6250	Camshaft
65	74148-S	Key
66	6265	Spacer
67	6269	Thrust Plate
68	6256	Camshaft Gear
69	6100	Piston and Rod Assembly
70	6211	Rod Bearing
71	6205	Piston Rod
72	6148	Piston Ring Set
73	6108	Piston Assembly

TA10726A

Crankcase Ventilation System

Removal and Installation

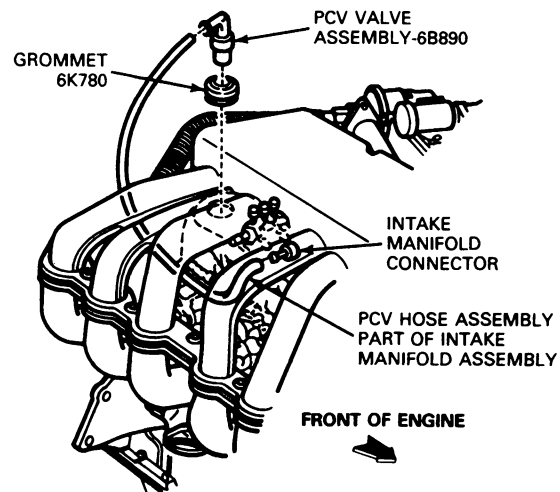
1. Grasp the positive crankcase ventilation (PCV) regulator valve and pull upward to remove it from the rocker arm cover.
2. Remove the PCV valve from the vent hose.
3. Remove the air inlet hose from the crankcase filter cap and air cleaner.

For installation, follow removal steps in reverse order.

WARNING: DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS BEEN FIRST EXAMINED FOR POSSIBLE CRACKS AND BLADE SEPARATION.

Operate the engine and check for leaks.

Typical Closed-Type Crankcase Ventilation System



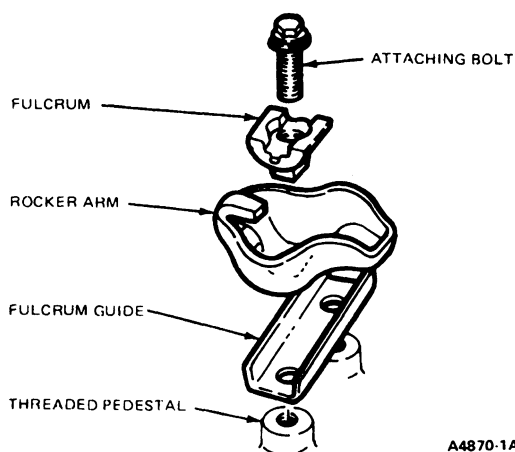
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REMOVAL AND INSTALLATION (Continued)

Valve Rocker Arm Cover and Rocker Arm

Removal

1. Disconnect the inlet air hose at the crankcase filter cap. Remove the throttle body (9E926) inlet tubes.
CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the ball stud to pry off. Removing by hand may damage the cable.
2. Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring. Remove the accelerator cable bracket from the upper intake manifold and position the cable and bracket assembly out of the way.
3. Remove the fuel line from the fuel rail. Do not bend the fuel line.
4. Remove the upper intake and throttle body.
5. Remove the PCV valve from the valve rocker arm cover. Remove the crankcase filter. Remove the cover bolts and remove the valve rocker arm cover. Inspect the rocker arm cover bolts for worn or damaged seals under the bolt heads and replace as necessary.
6. Remove the valve rocker arm bolt, fulcrums seat and rocker arm.



A4870-1A

Installation

1. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the top of the valve stem.
2. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the rocker arm fulcrum seat and the fulcrum seat socket in the rocker arm. Install the valve rocker arm, fulcrum seat and rocker arm bolt. Adjust the valve clearance following the procedure under Valve Clearance Adjustment.

3. Clean the valve rocker arm cover and the cylinder head gasket surface. Place the new gasket on cylinder head making sure that the tabs of the gasket face down toward the head. No sealer or adhesive is necessary.
4. Install the cover on the cylinder head. Make sure the gasket seats evenly all around the head. Partially tighten the cover bolts in an opposing pattern, starting at the middle bolts. Then tighten the bolts to 8-14 N·m (70-120 in·lb) in the same sequence.
5. Install the PCV valve in the rocker arm cover. Install the accelerator cable bracket on the upper intake manifold and connect the cable to the throttle body.
6. Install the upper intake and throttle body.
7. Install the fuel line at the fuel rail.
8. Connect the inlet air hose to the crankcase filter cap.
9. Install throttle body inlet tubes.

Valve Spring, Retainer and Stem Seal

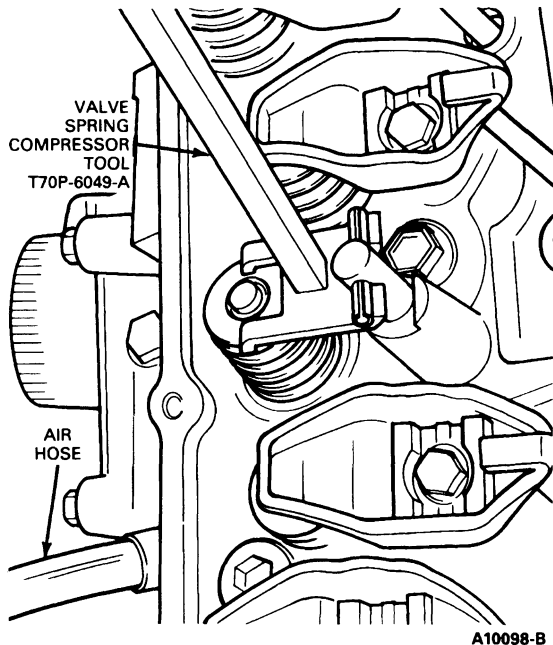
Broken valve springs or worn or damaged valve stem seals and retainers may be replaced without removing the cylinder head providing damage to the valve or valve seat has not occurred.

Removal

1. Disconnect the inlet air hose at the crankcase filter cap. Remove the throttle body inlet tubes.
2. Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring. Remove the accelerator cable bracket from the upper intake manifold and position the cable and bracket assembly out of the way.
3. Remove the fuel line from the fuel rail. Do not bend the fuel line.
4. Remove the upper intake and throttle body.
5. Remove the PCV valve from the valve rocker arm cover and remove the valve rocker arm cover. Remove the applicable spark plug.
6. Crank the engine until the applicable piston is on TDC at the end of the compression stroke.

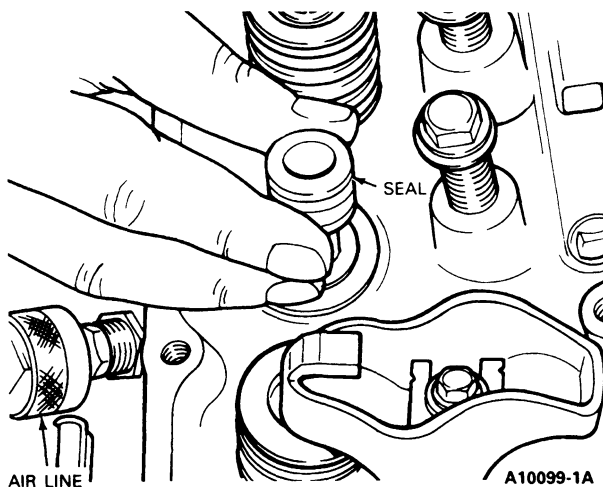
REMOVAL AND INSTALLATION (Continued)

7. Install a Valve Holdup Air Adapter TOOL-6513-ABA in the spark plug hole and connect the air line.



8. Remove the applicable valve rocker arm bolt, fulcrum, valve rocker arm and push rod. Place a block of wood on top edge of valve spring cap and tap moderately with a hammer to unlock valve keys. Install the bolt and position the Valve Spring Compressor T70P-6049-A as shown in the previous illustration. Compress the valve spring and remove the retainer locks, spring retainer and valve spring. Remove and discard the valve stem seal.

If air pressure fails to hold the valve in the closed position during this operation, it can be presumed that the valve is not seating or is damaged. If this condition occurs, remove the cylinder head for further inspection.



9. If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.
10. Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head for repairs. Refer to Section 03-00.
11. If the condition of the valve proved satisfactory, hold the valve in the closed position and apply air pressure within the cylinder.

Installation

1. Install new valve stem seals. Use a 5/8-inch deep well socket and a light hammer or mallet to seat the seal on the valve guide or use Valve Stem Seal Replacer T87L-657-1BH. Place the spring in position over the valve and install the valve spring retainer and sleeve, if so equipped. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and fulcrum bolt.
2. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to both ends of the push rod. Install the push rod. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the top of the valve stem.
3. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the fulcrum seat and socket. Install the valve rocker arm, fulcrum seat, fulcrum guide and bolt. Check the valve clearance following the procedure under Valve Clearance.
4. Turn off the air and remove the air line and adapter. Install the spark plug and connect the spark plug wire.
5. Clean the valve rocker arm cover and cylinder head gasket surface. Install the new gasket on the cover and position the cover on the cylinder head, making sure that the gasket seats evenly around the cylinder head. Install the cover bolts and tighten them in opposing pattern (starting in the center) to 8-14 N-m (70-120 in-lb).
6. Install the PCV valve in the rocker arm cover. Install the accelerator cable bracket on the upper intake manifold and connect the cable to the throttle body.
7. Install the upper intake and throttle body.
8. Install the fuel line at the fuel rail.
9. Connect the inlet air hose to the crankcase filter cap.
10. Install throttle body inlet tubes.

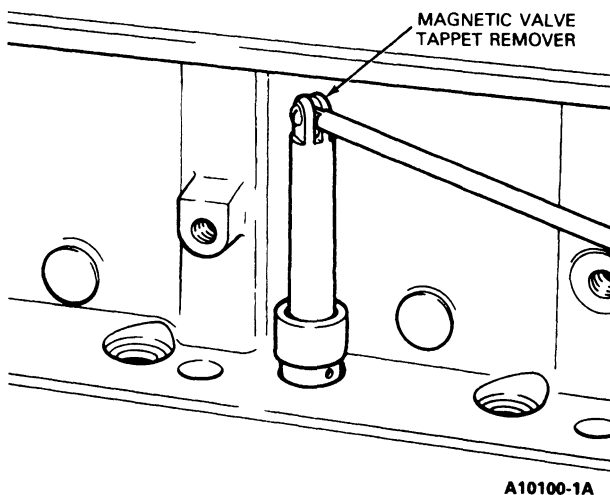
REMOVAL AND INSTALLATION (Continued)

Valve Tappet

Removal

1. Disconnect the inlet air hose at the crankcase filter cap. Remove the throttle body inlet tubes.
2. Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring. Remove the accelerator cable bracket from the upper intake manifold and position the cable and bracket assembly out of the way.
3. Remove the fuel line from the fuel rail. Do not bend the fuel line.
4. Remove the upper intake and throttle body.
5. Remove the coil bracket attaching bolt or "E" core assembly attaching nuts and position the coil out of the way.
6. Remove the valve rocker arm cover.
7. Disconnect the spark plug wires at the spark plugs using Spark Plug Wire Remover T74P-6666-A. Remove secondary high tension wire from the coil. Remove the distributor cap and spark plug wire assembly.
8. Remove the valve push rod cover.
9. Loosen the rocker arm bolts until the rocker arm(s) can be disengaged from the push rod(s). Remove the push rod(s). Remove the valve tappet(s) with the tool shown. If more than one push rod and valve tappet is removed, do so in sequence and place the parts in a rack so they can be installed in their original locations.

Refer to Section 03-00 for the cleaning, inspection and testing procedures.



Installation

1. Clean the external surfaces of the valve tappets, rocker arm cover, push rod cover, cylinder head and block gasket surfaces.

2. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the cam lobe contact surface of the valve tappet(s). Coat the rest of the valve tappet(s) with engine oil. Install the valve tappets with the tool shown under Removal.
3. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to both ends of the push rod(s). Install the push rod(s) in sequence. Engage the rocker arm(s) with push rod(s) and tighten the rocker arm bolts sufficiently to hold the push rod(s) in place. **Make sure each push rod is properly seated in the valve tappet socket.**
4. Adjust the valve clearance. Refer to Adjustments in this section.
5. Coat one side of a new push rod cover gasket with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent oil resistant sealer, and position to the push rod cover. Install the push rod cover. Tighten the cover screws in sequence to 2.8-4.0 N·m (25-35 in-lb). Clean the rocker arm cover. Place the new gasket in the rocker arm cover. Install the rocker arm cover and tighten the bolts to 7.9-11.9 N·m (70-105 in-lb). Install the PCV valve in the rocker arm cover.
6. Position the coil assembly on the cylinder head and install the attaching bolt or nuts.
7. Install the distributor cap and spark plug wire assembly. Connect the spark plug wires and coil secondary high tension wire.
8. Install the accelerator cable bracket on the upper intake manifold and connect the cable to the throttle body.
9. Install the fuel line at the fuel rail.
10. Install the throttle body inlet tubes.

Cylinder Head

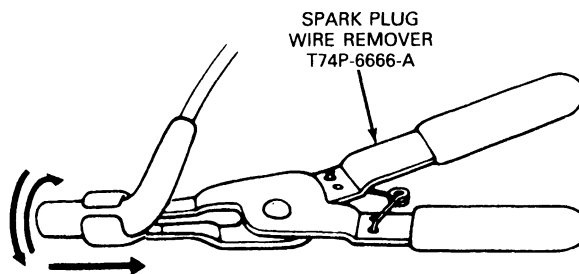
Removal

If the cylinder head is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly. Transfer all valves, springs, spark plugs, etc., to the new cylinder head. If these are bad, the complete head assembly may have to be replaced. Clean and inspect all parts, reface the valves and check valve guide clearances before assembling the used parts to the new cylinder head. Refer to Section 03-00.

1. Drain the cooling system and the crankcase. Remove the hood. Remove the throttle body inlet tubes. Remove air conditioner compressor and condenser. Refer to Section 03-05 and to the applicable section in Group 12 in the Body Electrical Manual.

REMOVAL AND INSTALLATION (Continued)

2. Disconnect the battery ground cable. Disconnect the heater hose from the water pump and coolant outlet housing. Disconnect the flexible fuel line from the fuel pump (9350).
3. Remove the radiator. Refer to Section 03-03.
4. Remove the cooling fan, viscous fan drive, water pump pulley and fan drive belt as outlined in Section 03-05.
5. Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring.
On a vehicle with power brakes, disconnect the vacuum line at the intake manifold.
On a vehicle with an automatic transmission, disconnect the transmission kickdown cable at the throttle body.
6. Disconnect the exhaust manifold from the muffler inlet pipe. Disconnect the body ground strap and the battery ground cable at the engine.
7. Disconnect the powertrain control module (PCM)(12A650) harness from all sensors.
8. Disconnect the engine wiring harness at the ignition coil, coolant temperature sending unit and oil pressure sending unit. Position the harness out of the way.
9. Remove the alternator mounting bolts and position the alternator out of the way, leaving the wires attached. Remove the air pump from bracket. Remove the alternator / air pump bracket from engine.
10. Remove power steering pump from the mounting brackets and position it right side up and to one side, leaving the lines attached. If equipped with an air compressor, bleed the air system and disconnect the two air pressure lines at the compressor. Remove air conditioner compressor from bracket. Remove the power steering / air conditioner bracket from engine.
11. Remove the coil bracket attaching bolts and position the coil out of the way.
12. Remove the valve rocker arm cover. Loosen the rocker arm bolts so that the rocker arms can be rotated to one side.
13. Remove the valve push rods in sequence and identify them so that they can be installed in their original position.
14. Disconnect the spark plug wires at the spark plugs using Spark Plug Wire Remover T74P-6666-A.

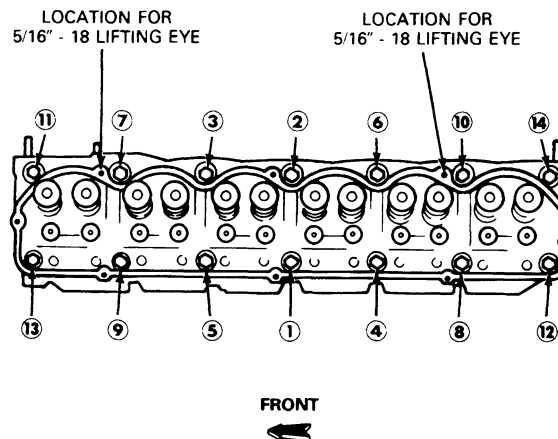


TWIST AND PULL

B3496-E

15. Remove the cylinder head bolts. Install the cylinder head lifting eyes using Engine Lifting Bracket T70P-6000, in the locations shown. Position a floor crane and attach the hoist and lifting sling to the lifting eyes using Rotunda Engine Sling 014-00036 Sling and Rotunda Floor Crane 014-00133 or equivalents. Lift the cylinder head and intake and exhaust manifold assemblies off the engine. **Do not pry between the head and block as the gasket surfaces may become damaged.** Gently tapping the cylinder head using a heavy plastic or rawhide hammer will help free up the head and ease removal.

Cylinder Head Bolts Tightening Sequence



A10351-1A

Installation

1. Clean the cylinder head and cylinder block gasket surfaces. Clean the exhaust manifold and muffler inlet pipe gasket surfaces.
2. Check the flatness of the head and block gasket surfaces if the cylinder head was removed for a cylinder head gasket replacement. Refer to Section 03-00.
3. Position the gasket over the dowel pins on the cylinder block.

REMOVAL AND INSTALLATION (Continued)

4. Install lifting eyes on the cylinder head in the location shown and use a floor crane and lifting sling to lift the cylinder head over the cylinder block. Lower it carefully until it is properly positioned on the block and dowel pins. Remove the hoist and lifting eyes.
5. Coat the threads of the cylinder head bolts with engine oil. Install the bolts.
6. Tighten the bolts in numerical sequence shown. Bolts are tightened in three steps.
 - Step 1: Tighten all bolts to 67-75 N-m (50-55 ft-lb).
 - Step 2: Tighten all bolts to 82-88 N-m (60-65 ft-lb).
 - Step 3: Tighten all bolts to 94-115 N-m (70-85 ft-lb).

NOTE: When cylinder head bolts have been tightened it is not necessary to re-tighten the bolts after extended operation.
7. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to both ends of the push rods. Install the push rods in their original bores, positioning the lower end of the rods in the valve tappet sockets.
8. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the rocker arm fulcrum seat and the fulcrum seat socket in the rocker arm. Position the rocker arms and tighten the rocker arm bolt just enough to hold the push rods in position. Check the valve clearance as outlined.
9. Clean the valve rocker arm cover. Place the new gasket and position the cover, making sure that the gasket seats evenly around the cylinder head. Install the cover bolts and tighten in sequence (starting in the center) to 8-14 N-m (70-120 in-lb).
10. Connect the spark plug wires to the correct spark plugs.
11. Connect the crankcase vent hose to the inlet tube in the intake manifold. Install the PCV valve in the valve rocker arm cover.
12. Install the exhaust manifold-to-muffler inlet pipe lockwashers and nuts. Tighten the nuts 34-49 N-m (25-36 ft-lb).
13. Connect the engine ground strap and the battery ground cable.
14. Connect powertrain control module harness to all sensors.
15. On a vehicle with an automatic transmission, connect the kickdown cable to the throttle body. Connect the accelerator linkage to the throttle body and install the retracting spring.
On a vehicle with power brakes, connect the brake vacuum line to the intake manifold.

16. Connect the coil primary wire, oil pressure and coolant temperature sending unit wires, flexible fuel line, heater hoses and the battery positive cable.
17. Install the alternator / air pump bracket on engine. Install the alternator and air pump on the mounting bracket.
Install the power steering / air conditioner bracket on engine. Install the air conditioner compressor and power steering pump on the mounting brackets.
Tighten the alternator, power steering pump and air pump and air compressor mounting bolts to specification. Refer to Section 03-05.
18. Install the water pump pulley, viscous fan drive (right-hand threads on fan clutch), cooling fan and drive belt. Tighten the fan bolts to 16-24 N-m (12-18 ft-lb).
19. Install the radiator. Connect the radiator lower hose to the water pump and the radiator upper hose to the coolant outlet housing. Connect the air compressor lines. If removed, install air conditioner compressor and condenser.
On a vehicle with an automatic transmission, connect the oil cooler lines.
20. Install and adjust the hood if applicable.
21. Fill and bleed the cooling system. Refer to Section 03-03. Fill the crankcase. Operate the engine at fast idle and check all hose connections and gaskets for leaks.
22. Perform EEC Quick Test to check the function of the EEC system. Refer to Powertrain Control / Emissions Diagnosis Manual.²
23. On a vehicle with standard transmission, check for correct clutch operation.
On a vehicle with an automatic transmission, adjust the transmission control linkage. Refer to Section 07-05. Check the fluid level and add as required to bring it to the proper level on the oil indicator.
24. Install the throttle body intake tubes.

Manifolds**Removal**

1. Disconnect the inlet air hose at the crankcase filter cap. Remove the throttle body inlet hoses.
2. Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring. Remove the accelerator cable bracket from the upper intake manifold and position the cable and bracket assembly out of the way.
3. Remove the fuel line from the fuel rail. Do not bend the fuel line.
4. Remove the upper intake and throttle body.

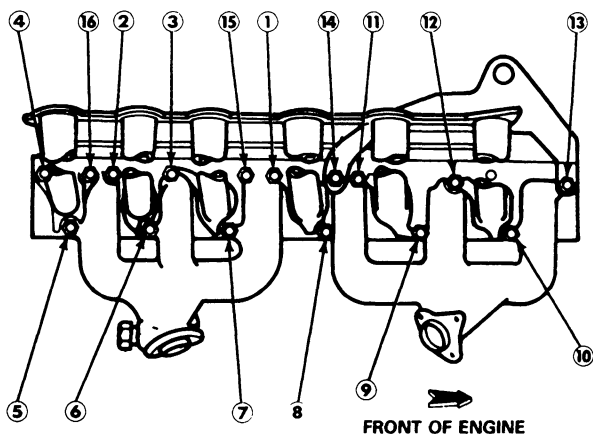
² Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

5. Disconnect all the vacuum lines. Label the lines so they are re-installed properly.
6. Disconnect the inlet pipe from the exhaust manifolds.
7. Disconnect the power brake vacuum line (if so equipped).
8. Remove the bolts attaching the manifolds to the cylinder head. Lift the manifolds from the engine. Remove and discard the gaskets.

Installation

1. Clean the mating surfaces of the cylinder head and manifolds.
2. If one of the manifolds is to be replaced, remove the tube fittings from the discarded manifolds and install them in the new manifold as required. Also install new studs in the new manifold.
3. Install a new intake manifold gasket.
NOTE: Combination intake / exhaust gasket is not to be used on a new exhaust manifold. Gasketing of the exhaust manifold is only recommended when the original exhaust manifold is reinstalled, in order to prevent leakage.
4. Coat the mating surfaces lightly with Steering Gear Grease C3AZ-19578-A (ESW-M1C87-A) or equivalent graphite grease. Place the manifold assemblies in position against the cylinder head. Make sure that the gasket has not become dislodged. Install the attaching washers, bolts and nuts. Tighten the bolts and nuts on intake and exhaust manifolds to 30-43 N·m (22-32 ft·lb) in the sequence shown.



A10704-1A

5. Connect the inlet pipe to the exhaust manifold. Tighten the lockwashers and nuts to 34-49 N·m (25-36 ft·lb).
6. Connect the crankcase vent hose to the intake manifold and position the hose clamp.

7. Install the upper intake and throttle body using new gaskets.
8. Connect the engine ground strap and the battery ground cable.
9. Connect powertrain control module harness to all sensors.
10. On a vehicle with an automatic transmission, connect the kickdown cable to the throttle body.
11. Connect the accelerator linkage to the throttle body and install the retracting spring.
12. Connect the brake vacuum line to the intake manifold.
13. Connect the coil primary wire, RFI capacitor (on coil bracket), oil pressure and coolant temperature sending unit wires, flexible fuel line, heater hoses and the battery positive cable.
14. Install the alternator on the mounting bracket. Install the power steering pump on the mounting brackets.
15. Install the water pump pulley, viscous fan drive (right-hand threads on fan clutch), cooling fan and drive belt. Tighten the fan bolts to 16.2-24.4 N·m (12-18 ft·lb).
Tighten the alternator, power steering pump and air pump and air compressor mounting bolts to specification. Refer to Section 03-05.
16. Install the radiator. Connect the radiator lower hose to the water pump and the radiator upper hose to the coolant outlet housing. Connect the air compressor lines. If removed, install air conditioner compressor and condenser.
On a vehicle with an automatic transmission, connect the oil cooler lines.
17. Install and adjust the hood.
18. Fill and bleed the cooling system. Refer to Section 03-03. Fill the crankcase. Operate the engine at fast idle and check all hose connections and gaskets for leaks.
19. Perform EEC Quick Test to check the function of the EEC system. Refer to Powertrain Control/Emissions Diagnosis Manual.³
20. On a vehicle with manual transmission, check for correct clutch operation.
On a vehicle with an automatic transmission, adjust the transmission control linkage. Refer to Section 07-05. Check the fluid level and add as required to bring it to the proper level on the oil indicator.
21. Install the throttle body intake tubes.

³ Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)**Water Pump****Removal**

1. Drain the cooling system. To prevent loss of coolant when draining the radiator, attach a hose on the radiator draincock and drain the coolant from the radiator into a clean container.

To drain the radiator, open the draincock located at the bottom of the radiator and remove the radiator cap or supply tank cap. The engine has one drain plug located at the left rear of the cylinder block.

2. Install a 16mm or 5/8-inch box end wrench on the tensioner pulley bolt and lift the tensioner arm away from the belt. Remove belt. Release tensioner arm slowly.

CAUTION: Release tensioner arm slowly or damage to the tensioner may occur.

3. Remove the fan, viscous fan drive (right-hand thread on clutch), and pulley as outlined in Section 03-05.
4. Disconnect the heater hose, radiator lower hose and radiator supply line at the water pump.
5. Remove the bolts attaching the water pump to the block. Remove the pump and gasket.

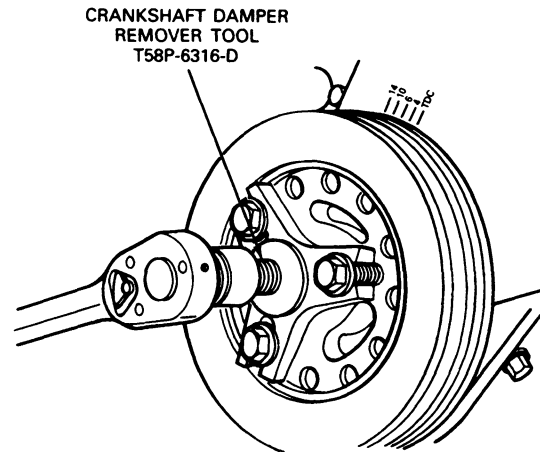
Installation

1. If required, remove the fittings from the old pump and install them on the new pump. Clean all gasket material from the mounting surfaces of the water pump and cylinder block.
2. Position a new gasket, coated on both sides with sealer, on the water pump.
3. Install the pump body on the block. Install the pump attaching bolts, coated with sealer, and tighten the bolts to 17-24 N·m (12-18 ft·lb).
4. Connect the radiator lower hose, radiator supply line and heater hose. Install the pulley and fan. Install the alternator belt and adjust the belt tension. On a vehicle with an air compressor, install the air compressor belt and adjust the belt tension to specifications. Refer to Section 03-05. Fill and bleed the cooling system as outlined in Section 03-03. Operate the engine and check for leaks.

Cylinder Front Cover**Removal**

1. Drain the cooling system as outlined in Section 03-03.

2. Remove the shroud and radiator.
3. Remove the drive belt, power steering pump, air conditioning compressor and power steering / air conditioning bracket.
4. Remove the screw and washer from the end of the crankshaft and remove the damper using Crankshaft Damper Remover T58P-6316-D.



A9793-1A

5. Remove the front oil pan and front cover attaching screws. Loosen the first six bolts on each side of the pan. Lightly push pan down so it does not exert any upward force on the front cover, which may affect front seal alignment.
6. Remove the cylinder front cover and discard the gasket. Replace crankshaft oil seal whenever the cylinder front cover is removed.

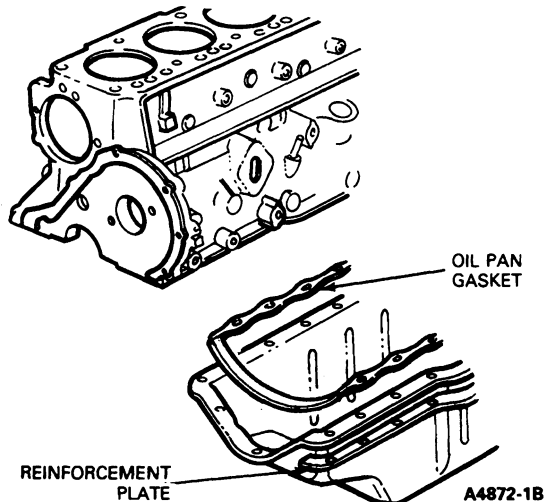
Installation

1. Clean front cover and block gasket surfaces. Also, clean any oil on oil pan gasket as it will be re-installed.
2. Coat front cover gasket surfaces of the block and cover with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent oil resistant sealer. Position a new front cover gasket on the block.

REMOVAL AND INSTALLATION (Continued)

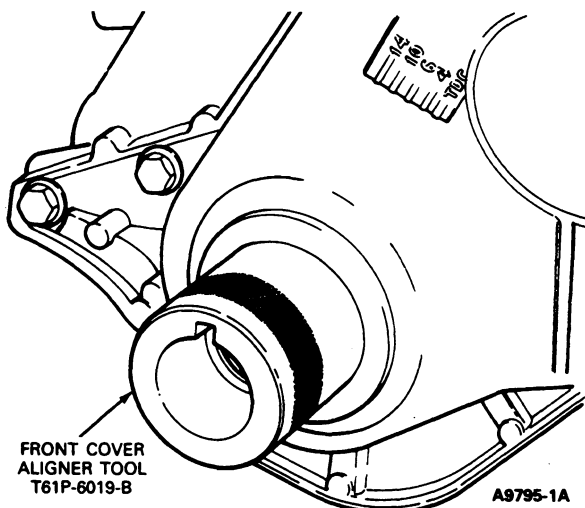
3. Apply Silicone Rubber D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent to the block / pan junction and a small bead on oil pan gasket sealing surface of front cover. This provides an additional seal between front cover and the used oil pan gasket.

NOTE: When applying RTV sealant, always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to set up and its sealing effectiveness may be reduced.

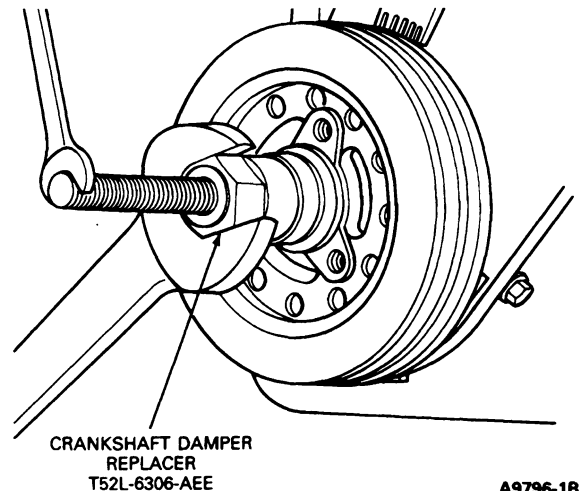


4. Position the front cover assembly over the end of the crankshaft and against the cylinder block. Start the cover and pan attaching screws. Slide the Front Cover Aligner T61P-6019-B or equivalent over the crank stub and into the seal bore of the cover. Tighten attaching oil pan screws to 14-20 N·m (10-15 ft-lb) and front cover screws to 17-24 N·m (12-18 ft-lb).

NOTE: Tighten front cover screws first to obtain proper cover alignment.



5. Lubricate the crank stub, damper hub inside diameter and the seal rubbing surface with clean engine oil or 50 weight oil only. DO NOT use grease on seal. Apply a 6mm (1/4-inch) bead of silicone rubber to inside of keyway of damper hub. Align the damper keyway with the key on the crankshaft and install the damper using Crankshaft Sprocket and Damper Replacer T52L-6306-AEE.



6. Install the washer and capscrew. Tighten to 177-203 N·m (130-150 ft-lb).
 7. Install the power steering pump, air conditioning compressor, power steering / air conditioning bracket and drive belt as outlined. Refer to Section 03-05.
 8. Install the shroud, radiator, and hoses.
 9. Fill and bleed the cooling system. Use the specified antifreeze mix. Refer to Section 03-03. If foreign material has not entered the crankcase during the service work, it is not necessary to change the engine oil.
 10. Change the engine oil with proper quantity and quality oil.
- CAUTION: To avoid damage to the engine due to entrance of foreign material during repairs, engine oil must be changed when repairs are completed.**
11. Operate the engine at fast idle and check for coolant and oil leaks.

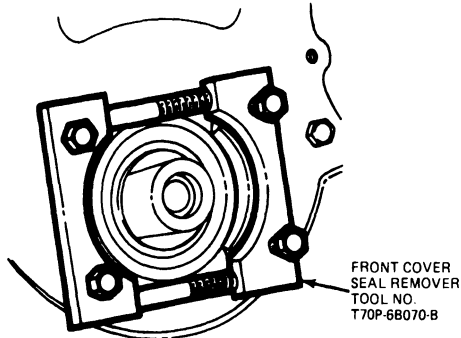
Front Oil Seal

Removal

1. Remove the drive belt from the engine.
2. Remove the bolts attaching the fan shroud to the radiator.
3. Remove the fan shroud. Remove the fan and fan clutch from the water pump shaft.
4. Remove the crankshaft pulley from the vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper and remove the vibration damper.

REMOVAL AND INSTALLATION (Continued)

5. Place the Front Cover Seal Remover T70P-6B070-B onto the front cover plate over the front seal. Tighten the two through-bolts to force the seal puller under the seal flange.

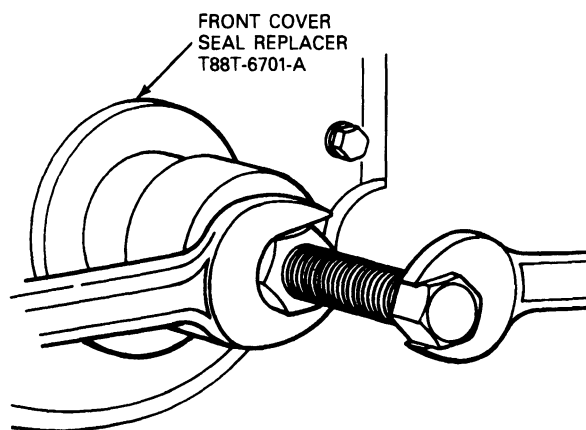


A5765-18

6. Alternately tighten the four puller bolts one half turn at a time. Pull the oil seal from the front cover.

Installation

1. Coat a new front cover plate oil seal with CLEAN engine oil or 50 weight oil only. Place the sleeve and seal onto the end of the crankshaft and push it toward the engine until the seal starts into the front cover.
2. Place the installation screw, washer, nut and Tool T88T-6701-A onto the end of the crankshaft. Thread the screw into the crankshaft. Tighten the nut against the washer and installation sleeve to force the seal into the front cover plate. Remove the installation tool from the crankshaft.



A10352-B

3. Apply CLEAN engine oil or 50 weight oil only. DO NOT use grease on the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply CLEAN engine oil or 50 weight oil only. DO NOT use grease on the front of the crankshaft for damper installation.
Apply a 6mm (1/4-inch) bead of silicone rubber to inside of keyway of damper hub. Install in five minutes.

4. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on crankshaft. Install the capscrew and washer. Tighten the screw to 95-122 N·m (70-90 ft·lb). Install the crankshaft pulley.
5. Install the drive belt.
6. Position the fan shroud over the water pump pulley. Install the fan and fan clutch. Install the fan shroud attaching screws.

Oil Pan**F-150-250-350 and Bronco****Removal**

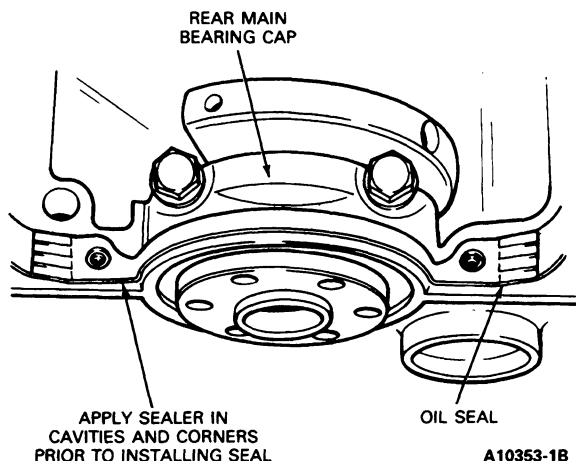
1. Drain the crankcase and the cooling system.
2. Remove the upper intake and throttle body assembly.
3. Raise the vehicle on a hoist. Disconnect the starter cable at the starter and remove the attaching bolts and starter.
4. Remove the engine front support insulator-to-support bracket nuts and washers on both supports. Raise the front of the engine with a transmission jack and wood block and place 25.4mm (1-inch) thick wood blocks between the front support insulators and support brackets. Lower the engine and remove the transmission jack.
5. Remove the oil pan attaching bolts and lower the pan to the crossmember. Remove the two oil pump bolts and the one oil pump inlet tube nut, and drop the assembly in the oil pan. Remove the oil pan. Remove the oil pan gasket. Remove the inlet tube and screen from the oil pan.

Installation

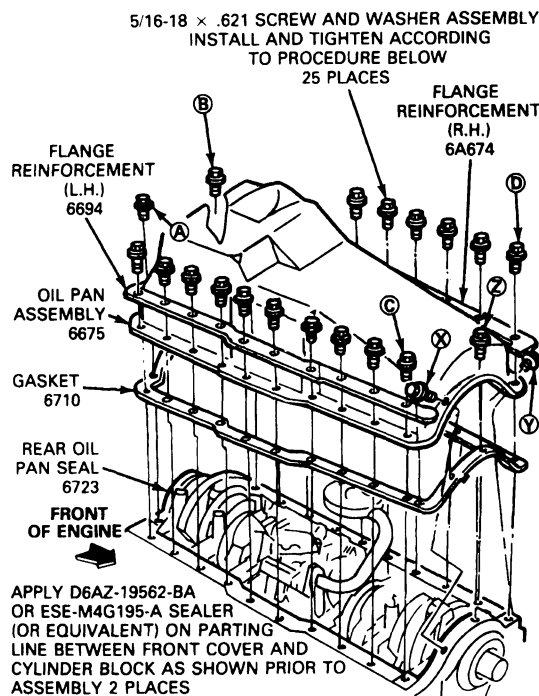
1. Clean the gasket surfaces of the oil pump, oil pan and cylinder block. Clean the seal grooves.
2. Apply a pressure-sensitive silicone-based adhesive (such as G.E., Dow, Loctite or equivalent) to block rails and front cover oil pan.

REMOVAL AND INSTALLATION (Continued)

3. Apply a bead of RTV Silicone Rubber D6AZ-19562-AA or -BA (ESE-M4G195-A) or equivalent to parting line between front cover and block (two places) and to tapered ends of rear seal portion of gasket (two places). Immediately install gasket to block to facilitate pan installation.



4. Clean the inlet tube and screen assembly and place it in the oil pan.
5. Position the oil pan under the engine. Install the inlet tube and screen assembly on the oil pump with a new gasket. Tighten the two screws to 14-20 N·m (10-15 ft·lb) and one nut to 30-43 N·m (22-32 ft·lb). Position the oil pan against the cylinder block and install reinforcement plates and the attaching bolts. Tighten the bolts in opposing pattern to 16-24 N·m (12-18 ft·lb).



SCREW TIGHTENING PROCEDURE:
 INSTALL FOUR BOLTS IN POSITIONS A B C AND D
 INSTALL THE REMAINING BOLTS EXCEPT X Y AND Z AND
 TIGHTEN SIMULTANEOUSLY TO 20-24 N·m (15-18 FT·LB)
 INSTALL BOLTS X Y AND Z LAST AND TIGHTEN
 TO 20-24 N·m (15-18 FT·LB).

6. Raise the engine with a transmission jack and remove the wood blocks from the engine front supports. Lower the engine until the front support insulators are positioned on the support brackets. Install the washers and nuts on the insulator studs and tighten the nuts to 73-100 N·m (54-74 ft·lb).
7. Install the starter and connect the starter cable.
8. Lower the vehicle. Install the radiator. Refer to Section 03-03.
9. Install the upper intake and throttle body.
10. Install the oil pan drain plug, fill the crankcase and cooling system. Refer to Section 03-03.
11. Start the engine and check for coolant and oil leaks.

E-150-250-350

Removal

1. Remove engine cover and open the hood.
2. Remove air cleaner. Disconnect the air inlet tubes from the throttle body.
3. Remove the retainer bolts for the idle air bypass valve and position the valve out of the way. Cover the manifold opening with a clean shop rag.
4. Unbolt the fan shroud and let it rest on the fan.
5. Remove the oil filler bracket and position it out of the way.

REMOVAL AND INSTALLATION (Continued)

6. Drain the cooling system and remove the upper radiator hose from the radiator.
7. Remove the auxiliary heater hoses from the cowl, if equipped.
8. Raise the vehicle on a hoist and position suitable safety stands under the vehicle.
9. Drain the engine oil and remove the oil filter.
10. Disconnect the lower radiator hose from the engine.
11. Remove the retainer nuts for the wiring harness for the starter and the heated oxygen sensor (H02S)(9F472) sensor.
12. Remove the front engine support retainer nuts and jack the engine up approximately 2-1/2 inches. Block the support with a 3-inch block of wood.
13. Remove the oil pan retainer bolts and remove the oil pan.

Installation

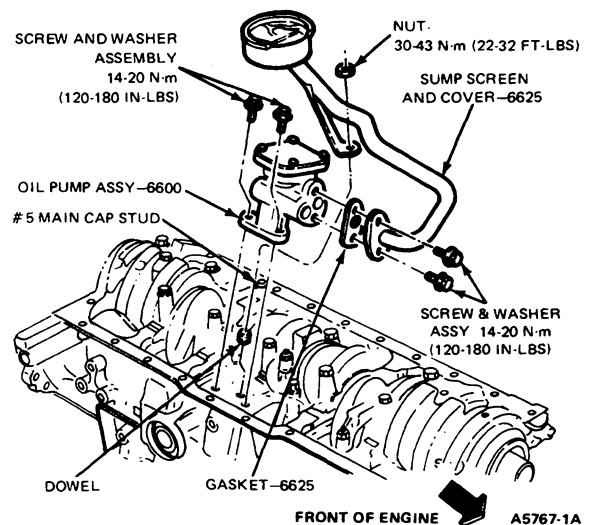
1. Clean the gasket surfaces of the oil pan and engine mating surface. Clean the seal grooves.
2. Apply a pressure-sensitive silicone-based adhesive, (such as G.E., DOW, Loctite or equivalent) to the block rails and front cover.
3. Apply a bead of RTV Silicone Rubber D6AZ-19562-AA or -BA (ESA-M4G195-A) or equivalent to the parting line between front cover and block (two places) and to tapered ends of the rear seal portion of the gasket (two places). Immediately install the gasket to the block to facilitate pan installation.
4. Position the oil pan against the engine block and install the reinforcement plates and retainer bolts as shown in the F-150-F-350 and Bronco Installation. Tighten the bolts in the sequence shown to 16-24 N·m (12-18 ft-lb).
5. Remove the block of wood and lower the engine back down into place. Install the retainer nuts and tighten to specifications.
6. Position the wiring harness and install the retainer nuts.
7. Connect the lower radiator hose to the engine.
8. Install a new oil filter.
9. Remove the safety stands and lower the vehicle.
10. Install the auxiliary heater hoses, if equipped.
11. Position the fan shroud in place and install the retainer bolts. Connect the upper radiator hose to the radiator.
12. Install the idle air bypass valve and retainer bolts.
13. Fill the radiator with coolant. Fill the engine with the specified engine oil.
14. Start the engine and check for leaks.
15. Install the air cleaner assembly and hoses. Close the hood and install the engine cover.

Oil Pump**Removal**

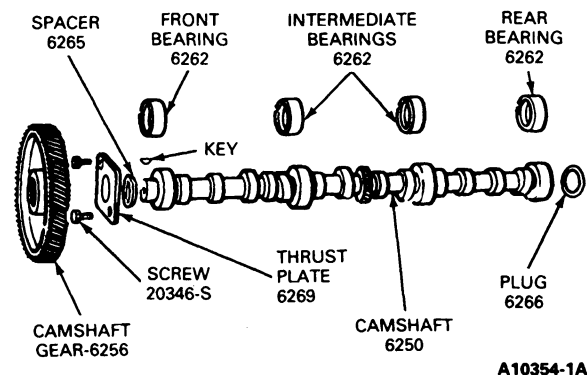
1. Remove the oil pan following the procedures under Oil Pan, Removal.
2. Remove the oil pump attaching bolts and oil pump inlet tube nut. Then, remove the pump assembly.

Installation

1. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening.
2. Install the oil pump on the cylinder block. Tighten the attaching bolts and nuts to specifications.
3. Install the oil pan following the procedures under Oil Pan, Installation.

**Camshaft**

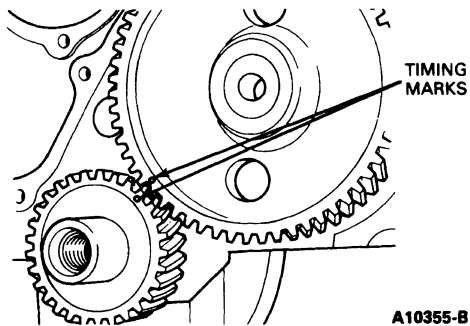
The camshaft and related parts are shown in the following illustration.

**Removal**

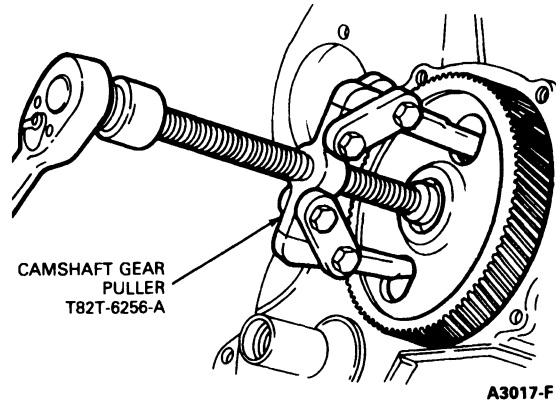
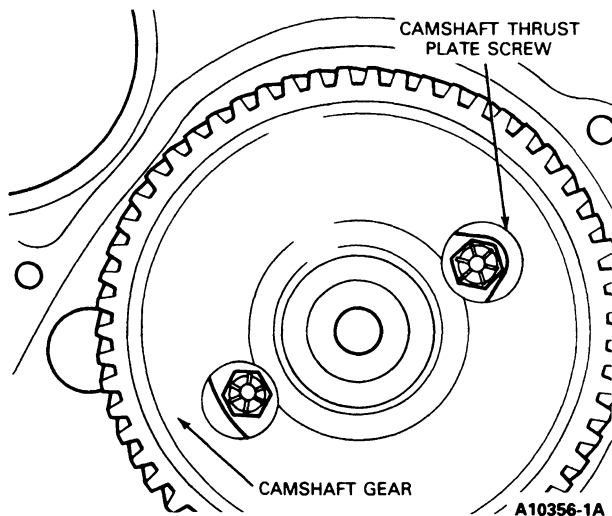
1. Drain the cooling system and the crankcase.

REMOVAL AND INSTALLATION (Continued)

2. Remove the shroud and radiator, valve tappets and cylinder front cover, following the procedures given in this section and Section 03-03.
3. Disconnect primary wire at the coil. Remove the distributor (12127) following the procedure in Section 03-07.
4. Check the camshaft end play, the timing gear backlash and the timing gear runout. Refer to Section 03-00.
5. Turn the crankshaft to align the timing marks as shown.



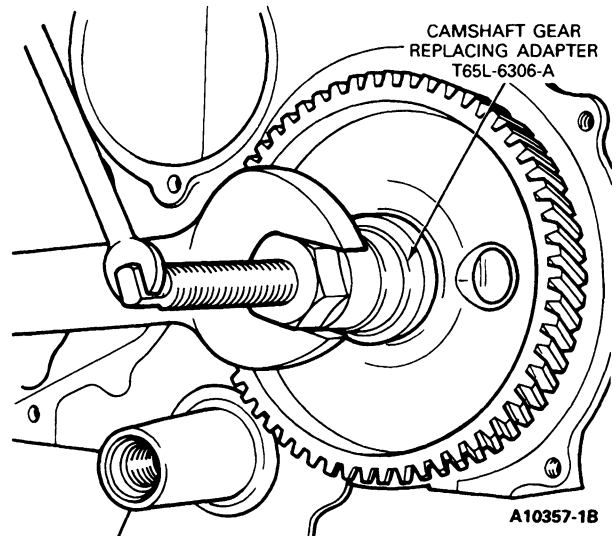
6. Remove the camshaft thrust plate screws. Remove the camshaft gear using Camshaft Gear Puller T82T-6256-A, as shown. Remove the key, thrust plate and spacer. Remove the camshaft. **Avoid damaging the camshaft bearings or lobes during removal.**



Installation

If the camshaft end play, timing gear backlash and / or timing gear runout were excessive, make the necessary corrections before installing the camshaft.

1. Oil the camshaft bearing journals and apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to all the lobes.
2. Assemble key, spacer and thrust plate to camshaft. Align the gear keyway with the key and install the gear on the camshaft using Camshaft Gear Replacing Adapter T65L-6306-A.



3. Install the camshaft, gear and thrust plate as an assembly, making sure that the timing marks are in alignment. Use care to avoid bearing damage.
4. Tighten the thrust plate attaching screws to 16-24 N·m (12-18 ft-lb).
5. Crank the engine until the timing marks are aligned. **Do not turn the crankshaft again until the distributor is installed.**

REMOVAL AND INSTALLATION (Continued)

6. Clean the cylinder front cover and cylinder block gasket surfaces. Install a new oil seal in the cylinder front cover if necessary. Clean the crankshaft damper and inspect it. Refer to Section 03-00. Install the cylinder front cover and damper, valve tappets and radiator, following the installation procedures given in this section and Section 03-03.

Install the distributor. Refer to Section 03-07. With the rotor at No. 1 firing position, align the stator armature tooth exactly with the armature tooth prior to tightening the hold-down clamp.

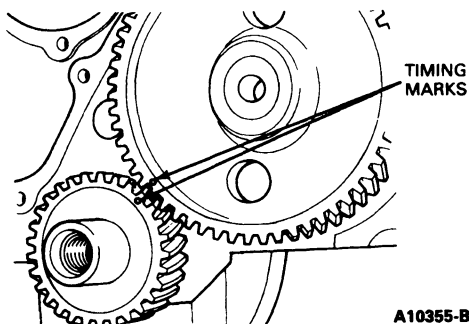
7. Fill the crankcase and cooling system. Refer to Section 03-03.
8. Start the engine and check for oil, coolant and fuel leaks. Adjust the ignition timing.

Timing Gears

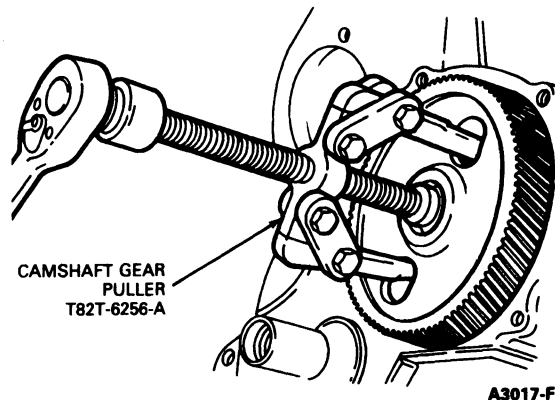
WARNING: TO PREVENT POSSIBLE DAMAGE TO THE CAMSHAFT LOBES, DO NOT ROTATE THE CAMSHAFT OR CRANKSHAFT IN THE ENGINE WITHOUT THE TIMING GEARS INSTALLED.

Camshaft Gear**Removal**

1. Drain the cooling system and crankcase.
2. Remove the cylinder front cover following the procedures under Cylinder Front Cover Removal.
3. Check the camshaft end play, the timing gear backlash and the timing gear runout. Refer to Section 03-00.
4. Crank the engine until the timing marks are aligned as shown.

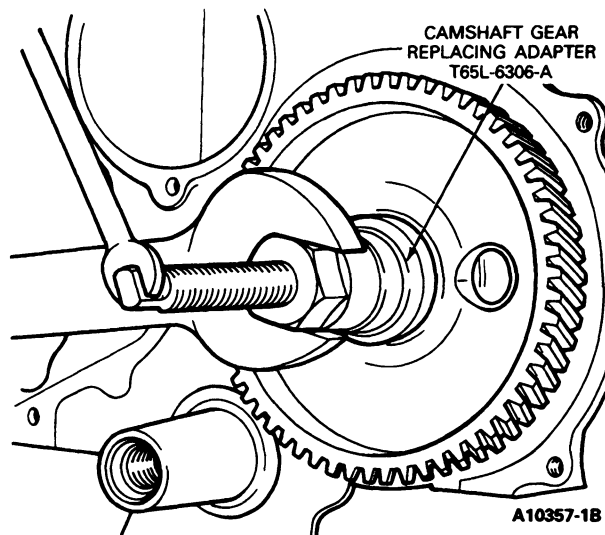


5. Install the Camshaft Gear Puller T82T-6256-A as shown and remove the camshaft gear.

**Installation**

If the camshaft end play, timing gear backlash and / or timing gear runout were excessive, make the necessary corrections before installing the gear.

1. Make sure the key spacer and thrust plate are properly installed. Align the gear keyway with the key and install the gear on the camshaft using Camshaft Gear Replacing Adapter T65L-6306-A. Make sure that the timing marks line up on the camshaft and crankshaft gears.



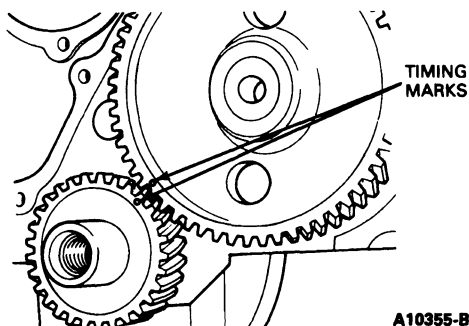
2. Install the cylinder front cover and related parts following the procedures under Cylinder Front Cover, Installation.
3. Fill the crankcase and cooling system. Refer to Section 03-03. Start the engine and adjust the ignition timing. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

Crankshaft Gear**Removal**

1. Drain the cooling system and crankcase. Remove the radiator. Refer to Section 03-03.
2. Remove the cylinder front cover.

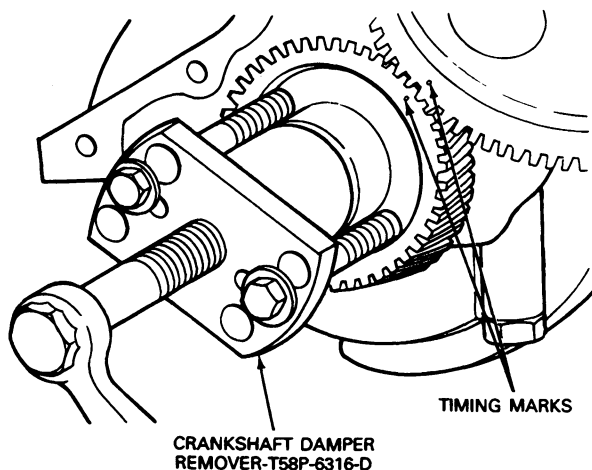
REMOVAL AND INSTALLATION (Continued)

3. Crank the engine until the timing marks are aligned.



A10355-B

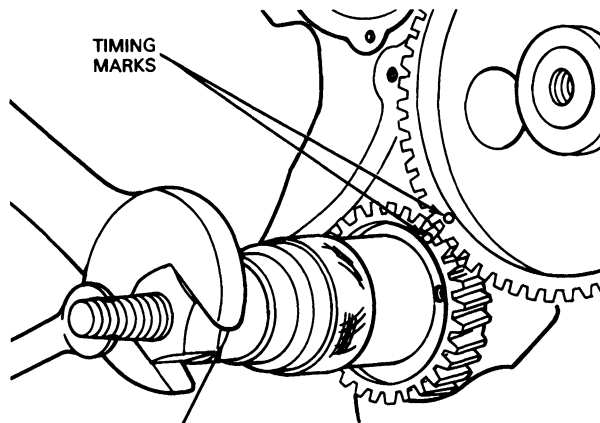
4. Use Crankshaft Damper Remover T58P-6316-D and remove the crankshaft gear. Remove the key from the crankshaft.



A10358-1B

Installation

1. Install the key in the crankshaft keyway. Install the crankshaft gear using the Crankshaft Damper Replacer T52L-6306-AEE. Make sure timing marks are aligned properly on the camshaft and crankshaft gears. Install the oil slinger.

CRANKSHAFT DAMPER
REPLACER-T52L-6306-AEE

A10359-1B

2. Replace the crankshaft front oil seal. Install the cylinder front cover following the procedures under Cylinder Front Cover.
3. Install the radiator. Refer to Section 03-03.
4. Fill the crankcase and the cooling systems. Refer to Section 03-03. Start the engine and check all gaskets and hose connections for leaks. Adjust the ignition timing and curb idle to the specifications on the engine decal.

Flywheel**Removal**

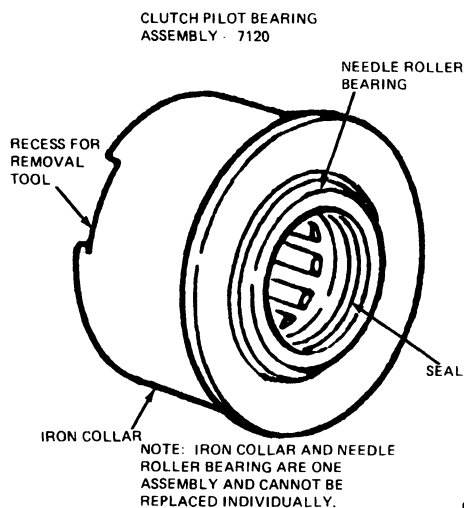
1. Remove the transmission following the procedure in the appropriate transmission section in Group 07.
2. On a manual transmission, remove the clutch pressure plate and cover assembly and clutch disc following the procedure in Section 07-00.
3. Remove the flywheel attaching bolts and remove the flywheel.

To check flywheel face runout or replace the flywheel ring gear, refer to Section 03-00.

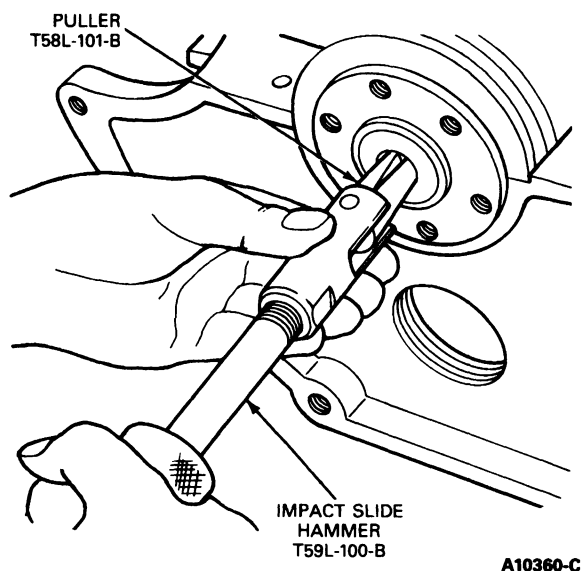
For installation, follow removal steps in reverse order. Coat the threads of the flywheel attaching bolts with oil-resistant sealer and install the bolts. Tighten in an opposing pattern to 102-115 N·m (75-85 ft·lb).

REMOVAL AND INSTALLATION (Continued)**Clutch Pilot Bearings**

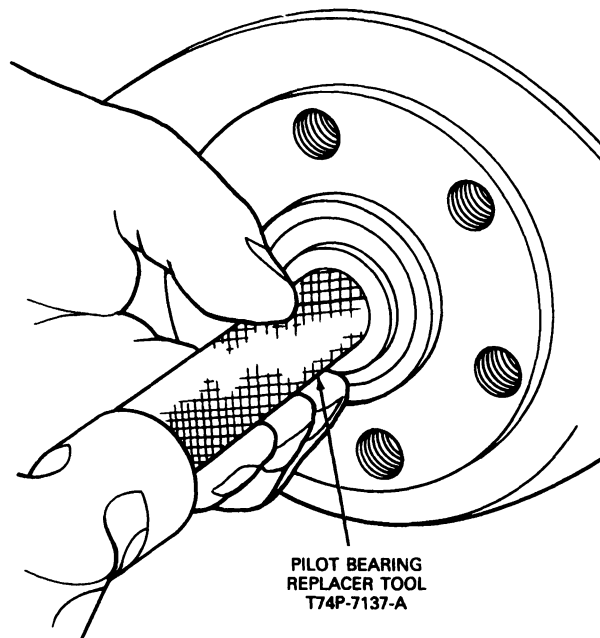
A needle roller bearing and adaptor assembly is used as a clutch pilot bearing on E-150-250-350, F-150-250-350, and Bronco vehicles. It is inserted directly into the engine crankshaft. The bearing and adaptor assembly cannot be serviced separately. The needle bearing clutch pilot can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pregreased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed. For additional information refer to Section 08-01.

**Removal**

1. Remove the transmission, clutch pressure plate, and disc. Refer to Section 08-01.
2. Using Puller T58L-101-B, remove the pilot bearing.

**Installation**

1. Using Pilot Bearing Replacer T74P-7137-A, install the pilot bearing with the seal facing the transmission so that the adaptor is not cocked.



NOTE: Care must be taken not to damage the bearing while the transmission input shaft is being inserted into the bearing during transmission installation.

2. Install the clutch pressure plate, disc, and transmission. Refer to Section 07-00.

Camshaft Rear Bearing Bore Plug**Removal**

1. Remove the transmission and flywheel housing. Refer to the appropriate transmission section in Group 07. On a manual transmission, remove the clutch pressure plate and disc. Refer to Section 08-01.
 2. Remove the flywheel attaching bolts. Remove the flywheel and the engine rear cover plate.
 3. Refer to Section 03-00 to remove the core plug.
- For installation, follow removal steps in reverse order. Coat the flywheel bolts with pipe sealant Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent and tighten in an opposing pattern to 102-115 N-m (78-85 ft-lb).

REMOVAL AND INSTALLATION (Continued)

Main Bearing

NOTE: If main bearings need to be replaced, crankshaft should be removed to check connecting rod bearings and crankshaft journals for damage. Refer to Section 03-00 for inspection procedures.

Do not file or lap bearing caps or use shims to obtain the proper bearing clearance.

Bearings are available for service in standard sizes or .010 and .020 inch undersize. Refer to the Parts Catalog for the available sizes. Undersize bearings are available for use on journals that have been refinished.

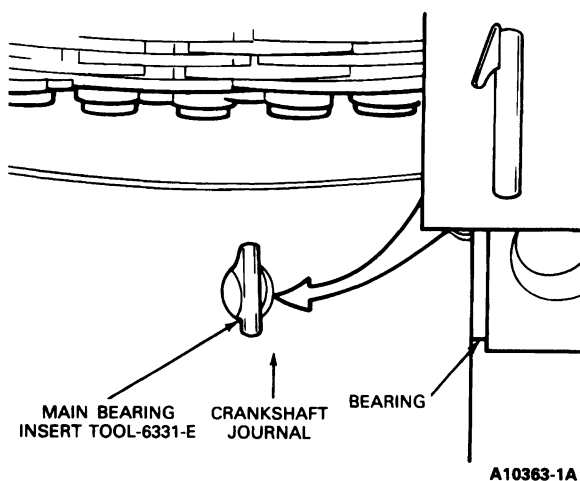
If the rear main bearing is to be replaced, it will be necessary to remove the engine, install it on a work stand, replace the main bearing and replace the crankshaft rear oil seal.

Removal

1. Drain the crankcase. Remove the oil pan and oil pump following the procedure under Oil Pan, Removal.

NOTE: Loosen all main bearing caps until finger-tight. This will lower the crankshaft and ease installation of new bearings.

2. **Replace one bearing at a time, leaving the other bearings securely fastened.** Remove the main bearing cap to which new bearings are to be installed.
3. Insert Main Bearing Insert Tool TOOL-6331-E in the oil hole in the crankshaft journal.



4. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
5. Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with standard bearings or a combination of a standard bearing and a .010- or .020-inch undersize bearing.

Installation

1. **The upper and lower bearing halves are not interchangeable. The upper half is drilled and grooved to provide entry of oil.** Be sure bearings and surfaces are clean. Foreign material under the inserts will distort the bearings and cause failure.

To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that Main Bearing Insert Tool TOOL-6331-E can be inserted in the oil hole in the crankshaft journal. With Main Bearing Insert Tool TOOL-6331-E positioned in the oil hole, rotate the crankshaft slowly in the opposite direction of engine rotation until the bearing is seated. Remove the tool.

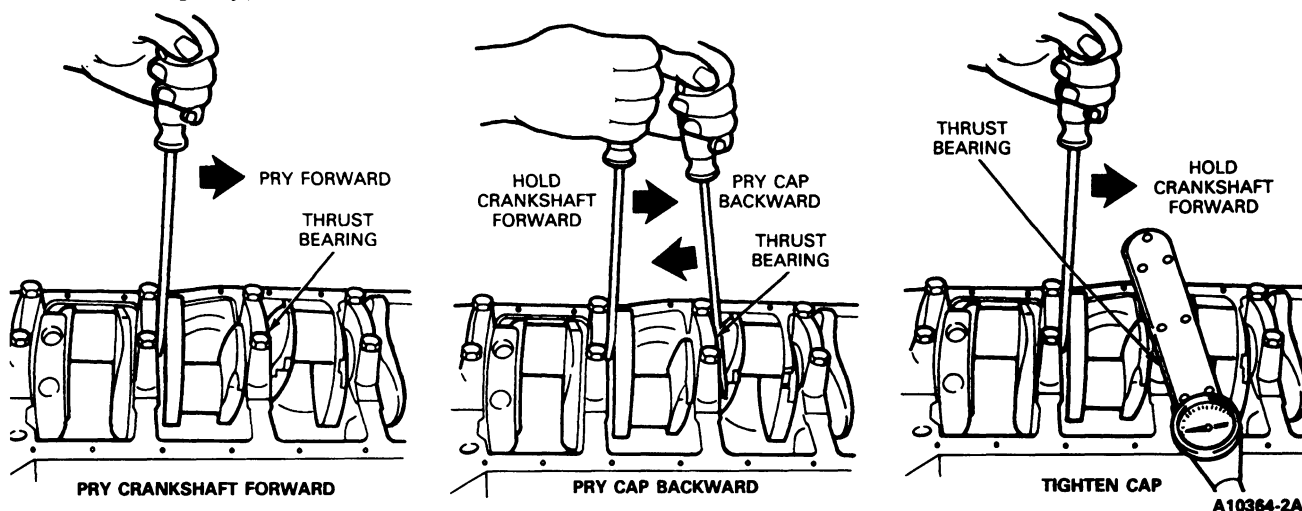
Select-fit the bearing for proper clearance. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00.

2. After the bearing has been fitted, apply a light coat of engine oil to the journal and bearings. Then, install the bearing cap. Tighten the cap bolts to 82-94 N-m (60-70 ft-lb).
3. Repeat the procedure for the remaining bearings that require replacement.
4. If the thrust bearing cap (No. 5 main bearing) has been removed, install it as follows:

Install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Tighten the cap bolts to 82-94 N-m (60-70 ft-lb).

REMOVAL AND INSTALLATION (Continued)

Thrust Bearing Cap, Installation



5. If the rear main bearing is replaced (on a work stand), clean the mating surfaces of the bearing cap and the block with Ford Extra-Strength Spot and Stain Remover B7A-1952 1-AA (ESR-M5B 197-A) or equivalent solvent.

NOTE: When applying RTV sealant, always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to "set-up" and its sealing effectiveness may be reduced.

Apply a 1.6mm (1/16-inch) bead of RTV sealer, Silicone Rubber D6AZ-19562-BA (ESE-M4G 195-A) or equivalent in each corner of the rear main bearing cap saddle the full length of the saddle. **Be sure the main bearing is fitted and the cap bolts tightened to 82-94 N·m (60-70 ft-lb) before installing the new crankshaft rear oil seal.**

6. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until the oil emerges from the outlet opening.
7. Install the oil pump and oil pan following the procedure under Oil Pan, Installation.
8. Fill the crankcase and cooling system. Refer to Section 00-03. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

Connecting Rod Bearing

Removal

1. Drain the crankcase. Remove the oil pan and oil pump following the procedure under Oil Pan, Removal.

2. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.
- NOTE: If bearings are to be reused, identify them according to location so that they can be installed in their original positions.
3. Make sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.
 4. Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to first try to obtain the proper clearance with standard bearings. Refer to Section 03-00 for the cleaning and inspection procedures.

Installation

1. Install the bearing inserts in the connecting rod and cap with the tangs fitted in the slots.
2. Pull the connecting rod assembly down firmly on the crankshaft journal.
Fit the bearing. Refer to Section 03-00.
3. After the bearing has been fitted, clean and apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap and tighten the nuts to 55-61 N·m (40-45 ft-lb).
4. Repeat the procedure for the remaining connecting rods that require new bearings.
5. Install the oil pan and oil pump following the procedures under Oil Pan Installation in this section.
6. Fill the crankcase. Fill the cooling system. Refer to Section 03-03. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

REMOVAL AND INSTALLATION (Continued)

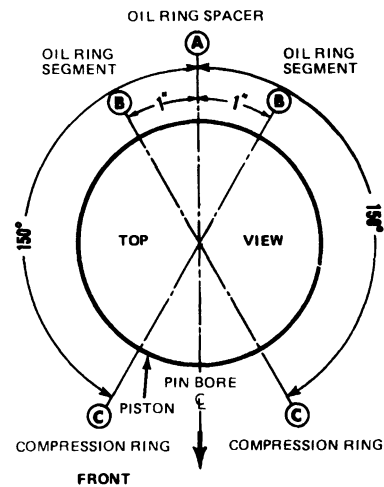
Pistons and Connecting Rods

Removal

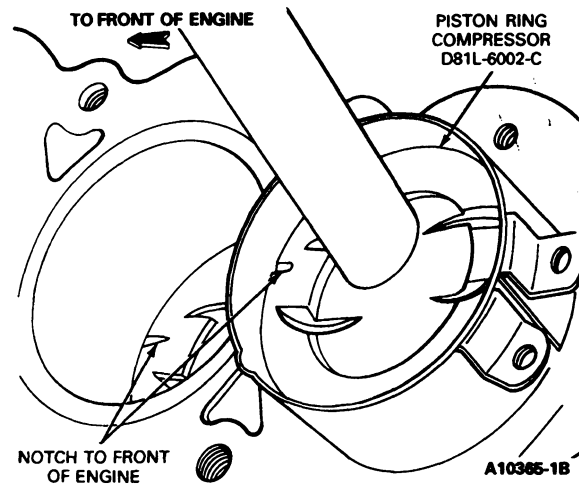
1. Drain the cooling system and the crankcase. Refer to Section 03-03.
2. Refer to Cylinder Head, Removal in this section and remove the cylinder head and related parts.
3. Remove the oil pan following the procedure under Oil Pan, Removal in this section. Remove the oil pump inlet tube and the oil pump.
4. Turn the crankshaft until the piston to be removed is at the bottom of the stroke and place a cloth on the piston dome to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bore with Cylinder Ridge Reamer T64L-6011-EA. Follow the instructions furnished by the tool manufacturer. **Never cut into the ring travel area in excess of 0.74mm (1/32 inch) when removing ridges.**
5. Make sure all the connecting rod caps are marked so that they can be installed in their original positions. Remove the connecting rod cap.
6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.

Installation

1. Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.
2. Oil the piston rings, pistons and cylinder walls with light engine oil.
3. **Make sure pistons are installed in the same cylinders from which they were removed or to which they were fitted.** The connecting rods and bearing caps are numbered from 1 to 6 beginning at the front of the engine. The number on the connecting rod and bearing cap must be on the same side of rod when installing in the cylinder bore. If a connecting rod is ever transferred from one cylinder block to another or from one cylinder to another, new bearings should be fitted and the connecting rod should be re-numbered to correspond with the new cylinder number.
4. Make sure the ring gaps (oil ring spacer A, oil ring segment B, and compression ring C) are properly spaced around the circumference of the piston. Oil the rings, then install Piston Ring Compressor D81L-6002-C or equivalent on the piston. Make sure that the indentation in the dome of piston is toward the front. Then, push the piston into its bore with the handle end of a hammer until it is slightly below the top of the cylinder. Be sure to guide the connecting rods to avoid damaging the crankshaft journals.



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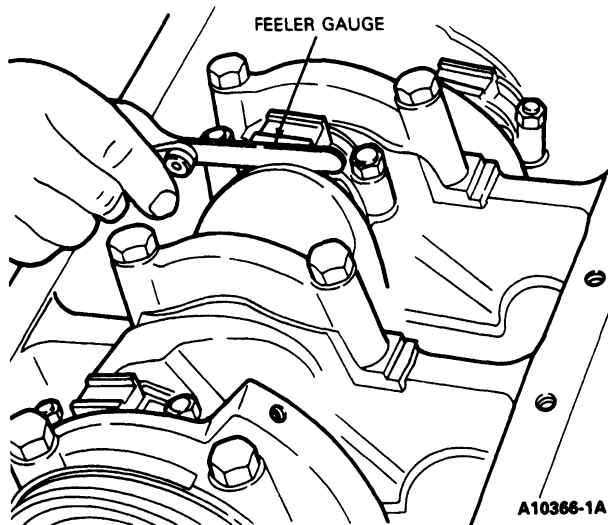


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5. Check the clearance of each bearing following the procedure under Fitting Main or Connecting Rod Bearing in Section 03-00.
6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.
7. Turn the crankshaft throw to the bottom of its stroke. Then, push the piston all the way down until the connecting rod bearing seats on the crankshaft journal. Install the connecting rod cap. Tighten the nuts to 55-61 N·m (40-45 ft·lb).

REMOVAL AND INSTALLATION (Continued)

8. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal.



9. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the oil pump inlet tube. Install the oil pan and related parts as outlined.
10. Refer to Cylinder Head Installation and install the cylinder head and related parts. Adjust the valve clearance as outlined.
11. Fill and bleed the cooling system. Refer to Section 03-03. Fill the crankcase.
12. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.
13. Operate the engine until engine temperatures have stabilized. Check and adjust the ignition timing.

On a vehicle with an automatic transmission, adjust the transmission control linkage. Refer to Section 07-05.

Oil Filter

Removal

1. Place a drip pan under the oil filter. Unscrew the filter from the cylinder block using Oil Filter wrench D79L-6731-A, -B or equivalent.

Installation

1. Coat the gasket on the filter with oil. Place the filter in position on the cylinder block. Hand-tighten the filter until the gasket contacts the adapter face, then advance it one-half turn.
2. Operate the engine at fast idle and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase if necessary.

Engine Assembly

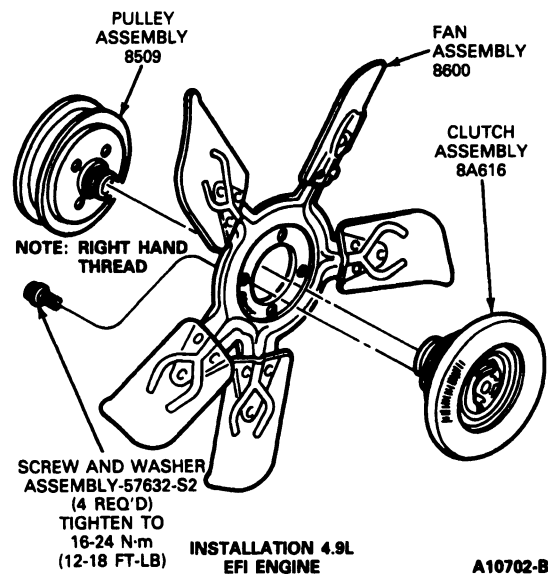
F-150-250-350 and Bronco

The following engine removal and installation procedures are for the engine only, without the transmission attached.

Removal

1. Drain the cooling system and the crankcase. Remove the hood. Remove the throttle body inlet tubes.
2. Disconnect the battery ground cable. Disconnect the heater hose from the water pump and coolant outlet housing. Disconnect the flexible fuel line from the fuel pump.
3. Remove the radiator and shroud. Refer to Section 03-03.
4. Remove the cooling fan, viscous fan drive, water pump pulley and fan drive belt.

NOTE: The fan clutch / water pump hub has a right-hand thread.



5. Disconnect the accelerator cable at the throttle body. Remove the cable retracting spring. Disconnect power brake vacuum line at the intake manifold.

On a vehicle with an automatic transmission, disconnect the transmission kickdown cable at the throttle body.

6. Disconnect the exhaust manifold from the muffler inlet pipe. Disconnect the body ground strap and the battery ground cable at the engine.
7. Disconnect the powertrain control module harness from all sensors.
8. Disconnect the engine wiring harness at the ignition coil, coolant temperature sending unit and oil pressure sending unit. Position the harness out of the way.

REMOVAL AND INSTALLATION (Continued)

9. Remove the alternator mounting bolts and position the alternator out of the way, leaving the wires attached.

Remove the power steering pump from the mounting brackets and position it right side up and to one side, leaving the lines attached. If equipped with an air compressor, bleed the air system and disconnect the two air pressure lines at the compressor.

10. Raise the vehicle. Remove the starter (and the automatic transmission fluid filler tube bracket). Remove the engine rear plate upper right bolt.

On a vehicle with a manual transmission, remove all the flywheel housing lower attaching bolts. Disconnect the clutch slave cylinder.

On a vehicle with an automatic transmission, remove the converter housing access cover assembly. Remove the flywheel-to-converter nuts and secure the converter assembly in the housing. Remove the transmission oil cooler lines from the retaining clip at the engine. Remove the converter housing-to-engine lower attaching bolts.

11. Remove the insulator-to-intermediate support bracket nut from each engine front support.
12. Lower the vehicle and position a transmission jack, such as Rotunda 066-00017 or equivalent, under the transmission to support it. Remove the remaining flywheel or converter housing-to-engine bolts.
13. Attach Engine Lifting Bracket T70P-6000 and Rotunda Engine Sling 014-00036 or equivalent. Raise the engine slightly and carefully pull it from the transmission. Lift the engine out of the chassis.

Installation

1. Lower the engine carefully into the chassis. Make sure the dowels in the block engage the holes in the flywheel or converter housing.

On a vehicle with an automatic transmission, start the converter pilot into the crankshaft. Remove the retainer securing the converter in the housing.

On a vehicle with a manual transmission, start the transmission input shaft into the clutch disc. It may be necessary to adjust the position of the transmission with relation to the engine if the transmission input shaft will not enter the clutch disc.

NOTE: If the engine hangs up after the shaft enters, turn the crankshaft slowly (with the transmission in gear) until the shaft splines mesh with the clutch disc splines.

2. Install the converter or flywheel housing upper attaching bolts. Remove the jack supporting the transmission.
3. Lower the engine until it rests on the engine support(s) and remove the lifting sling.

4. Install the engine left and right support insulator-to-intermediate support bracket attaching nuts and washers. Tighten the nuts to 73-100 N·m (54-74 ft-lb). Install the automatic transmission oil cooler lines bracket.
5. Install the remaining converter or flywheel housing attaching bolts. Connect the clutch return spring.
6. Install the starter and connect the starter cable. Attach the automatic transmission fluid filler tube bracket, if so equipped.
On a vehicle with an automatic transmission, install the transmission oil cooler lines in the bracket at the cylinder block.
7. Install the exhaust manifold-to-muffler inlet pipe lockwashers and nuts. Tighten the nuts to 34-49 N·m (25-36 ft-lb).
8. Connect the engine ground strap and the battery ground cable.
9. Connect powertrain control module harness to all sensors.
10. On a vehicle with an automatic transmission, connect the kickdown cable to the throttle body.
Connect the accelerator linkage to the throttle body and install the retracting spring.
Reconnect power brake vacuum line to the intake manifold.
11. Connect the coil primary wire, oil pressure and coolant temperature sending unit wires, flexible fuel line, heater hoses and the battery positive cable.
12. Install the alternator on the mounting bracket.
Install power steering pump on the mounting brackets. Tighten the alternator, power steering pump and air compressor mounting bolts to specification. Refer to Section 11-02D.
13. Install the water pump pulley, viscous fan drive, cooling fan and drive belt. Tighten the fan bolts to 16-24 N·m (12-18 ft-lb).
NOTE: The fan clutch / water pump hub has a right-hand thread.
14. Install the radiator and shroud. Connect the radiator lower hose to the water pump and the radiator upper hose to the coolant outlet housing. Connect the air compressor lines. If removed, install air conditioner compressor and condenser.
On a vehicle with an automatic transmission, connect the oil cooler lines.
15. Install and adjust the hood, if applicable.
16. Fill and bleed the cooling system. Refer to Section 03-03. Fill the crankcase. Operate the engine at fast idle and check all hose connections and gaskets for leaks.
17. Perform EEC Quick Test to check the function of the EEC system, if so equipped. Refer to Powertrain Control / Emissions Diagnosis Manual.⁴

⁴ Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

18. On a vehicle with a manual transmission, check for correct clutch operation.

On a vehicle with an automatic transmission, adjust the transmission control linkage. Refer to Section 07-05. Check the fluid level and add as required to bring it to the proper level on the oil indicator.

19. Install the throttle body intake tubes.

E-150-250-350**Removal**

1. Open the hood and door and install seat covers. Then, remove the engine cover, drain the coolant, remove the air cleaner and disconnect the battery.
2. Remove the front bumper. Then, remove the grille and lower gravel deflector as an assembly.
3. Disconnect the upper radiator hose at the radiator.
4. Remove the lower radiator hose at the radiator.
5. Disconnect the transmission oil cooler lines at the radiator, if so equipped.
6. Remove the radiator and the shroud.
7. Disconnect the heater hoses at the engine.
8. Disconnect the alternator and move aside.
9. Remove the drive belt. Then, remove the power steering pump and support from the engine and move aside.
10. Disconnect the fuel line at the fuel rail and plug it.
11. Disconnect the distributor and sender unit wires from the engine.
12. Disconnect the powertrain control module harness from all sensors.
13. Disconnect the brake booster hose at the engine.
14. Disconnect the accelerator cable and remove the bracket from the engine.
15. Disconnect the automatic transmission kickdown cable, if equipped, at the throttle body.
16. Remove the exhaust manifold heat deflector. Then, remove the inlet pipe-to-manifold nuts.
17. Disconnect both ends of the transmission vacuum line from the intake manifold and junction.
18. Remove the upper transmission-to-engine bolts.
19. Remove the automatic transmission dipstick tube support bolt at the intake manifold.
20. Raise the vehicle on a hoist and drain the crankcase.
21. Disconnect the wires from the starter and remove the starter.
22. Remove the flywheel inspection cover.
23. Remove the four converter nuts, then remove the front engine support nuts.
24. Remove the oil filter.
25. Complete the removal of the engine-to-transmission nuts.
26. Lower the vehicle.
27. Install the lift chain and remove the engine from the engine compartment.

Installation

1. Position the engine and lower into place. Then, start the mounting bolts.
2. Remove the lifting chain and connect the exhaust inlet to the manifold.
3. Connect the transmission dipstick tube, if so equipped, to the intake manifold.
4. Install the manifold heat shield.
5. Connect the automatic transmission kickdown cable, then install the upper transmission-to-engine bolts.
6. Connect the transmission vacuum line at the junction.
7. Install the accelerator cable and bracket assembly.
8. Connect the distributor and sender unit wires to the engine.
9. Connect the brake booster hose.
10. Unplug and connect the fuel line to the fuel rail.
11. Connect the transmission vacuum line to the manifold.
12. Install the alternator wires.
13. Connect the heater hoses to the engine.
14. Install the power steering pump and support bracket.
15. Install the drive belt. Refer to Section 03-05.
16. Install the radiator and shroud assembly.
17. Position the grille and lower gravel deflector.
18. Connect the upper radiator hose, then install the grille and deflector bolts and screws.
19. Install the bumper, then raise the vehicle on a hoist.
20. Install the converter nuts, then install the flywheel inspection cover bolts.
21. Connect the starter wires and install the starter assembly.
22. Install the oil filter.
23. Install the front support nuts, and the lower engine-to-transmission bolts. Tighten to 82-108 N·m (60-80 ft-lb).
24. Connect the lower radiator hose.
25. Connect the transmission cooler lines to the radiator.
26. Install the alternator splash shield.
27. Lower the vehicle.

REMOVAL AND INSTALLATION (Continued)

28. Fill and bleed the cooling system. Refer to Section 03-03. Connect the battery and fill the crankcase with the proper grade of oil.

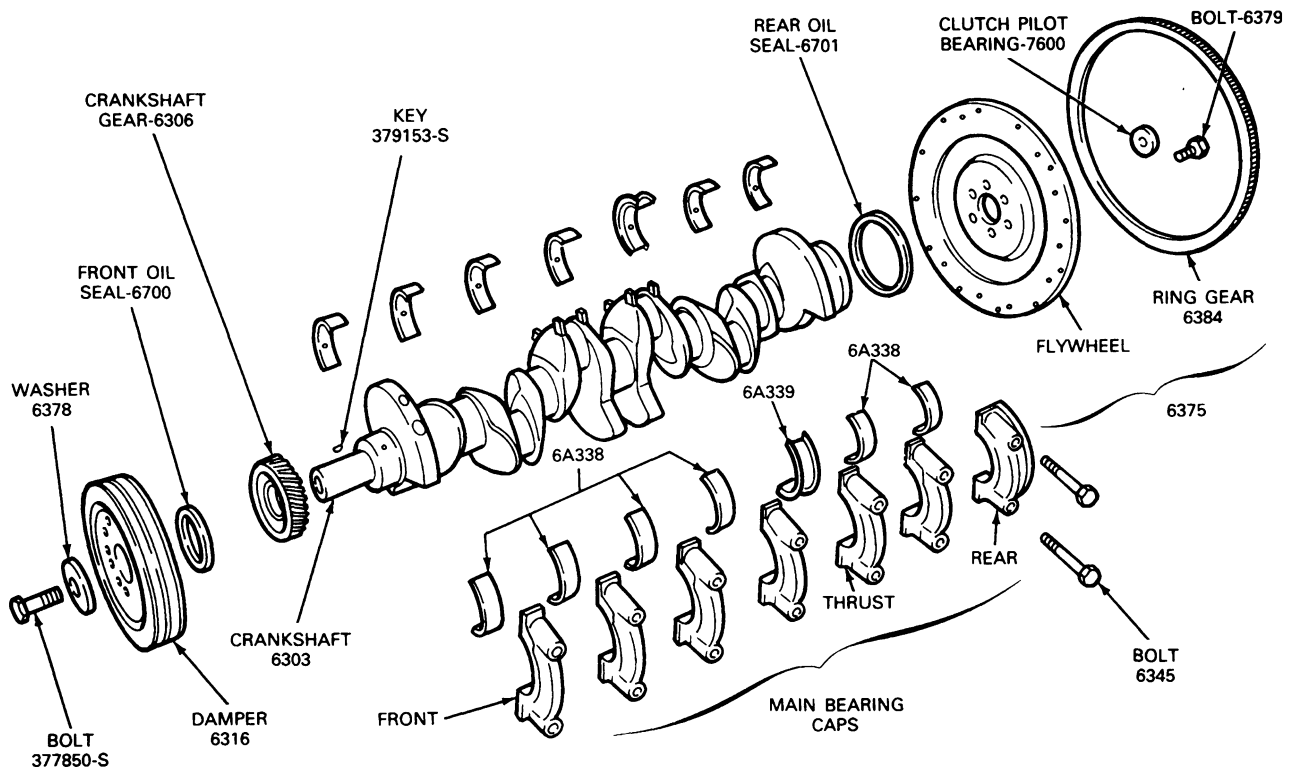
29. Perform the EEC Quick Test to check the function of the EEC system. Refer to the Powertrain Control/Emissions Diagnosis Manual.⁵

30. Start the engine and check for leaks. Then, install the engine cover and close the hood and door.

Crankshaft

The crankshaft and related parts are shown in the illustration.

Crankshaft, Disassembled View



A10367-2A

Removal

1. Install the engine on a work stand. Remove the spark plugs to allow easy rotation of the crankshaft. Drain the crankcase.
2. Remove the oil level dipstick.
3. Remove the crankshaft damper attaching bolt and lockwasher. Remove the crankshaft damper.
4. Remove the cylinder front cover and gasket.
5. Remove the flywheel and engine rear cover plate.

6. Turn the engine on the work stand so that the bottom of the engine is up. Remove the oil pan, gaskets and seals. Remove the oil pump and inlet tube assembly. Discard the oil pump gasket.

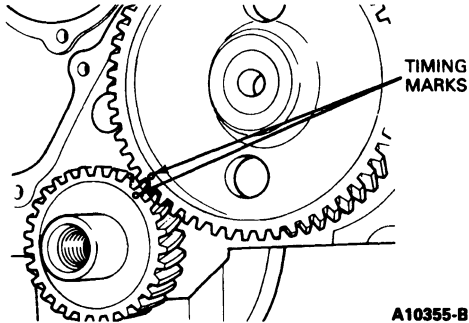
NOTE: Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations.

7. Turn the crankshaft until the connecting rod from which the cap is being removed is at the bottom of the stroke. Remove the connecting rod cap and bearings. Push the connecting rod and piston assembly up in the cylinder. **Do not turn the crankshaft completely around as the rod bolts may damage the crankpin journals.** Repeat this procedure and remove all connecting rod caps.

⁵ Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

8. Remove the clutch pilot bearing if necessary.
9. Align the timing marks. Remove the crankshaft gear as outlined.



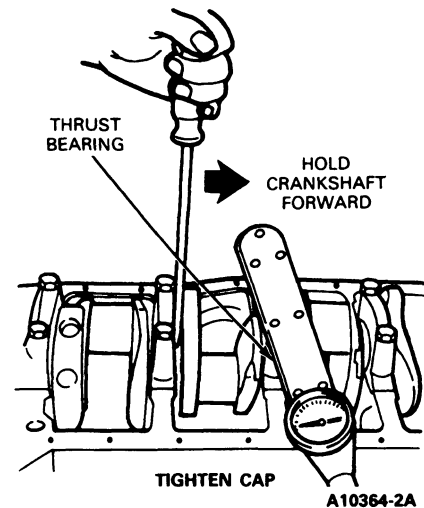
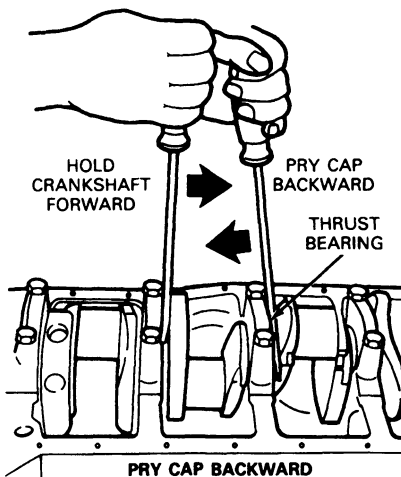
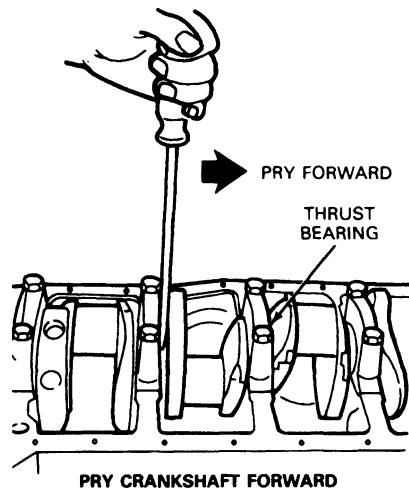
10. Remove the main bearing caps and bearings and rear bearing seal.
11. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged.

NOTE: Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

Refer to Section 03-00 for the cleaning and inspection procedures. Be sure the oil seal surfaces on the crankshaft and crankshaft damper are properly cleaned.

Installation

1. Remove the main bearing inserts from the block and bearing caps.

Thrust Bearing, Installation

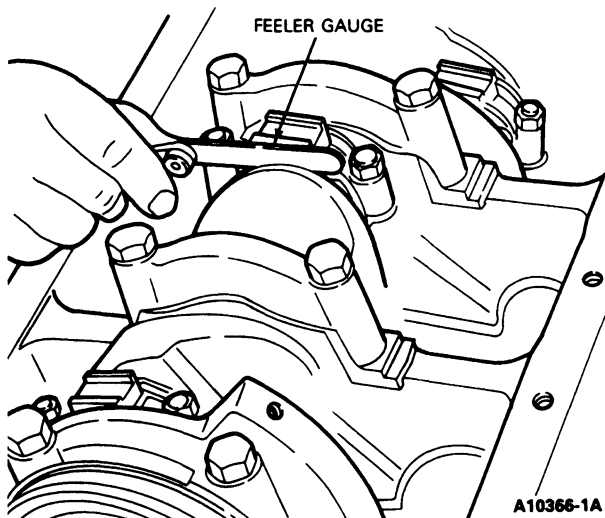
2. Remove the bearing inserts from the connecting rod caps.
3. Clean the crankshaft rear oil seal recess in the cylinder block and rear main bearing cap.
4. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.
5. Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided. Be sure the oil holes in the bearing inserts are aligned with the oil holes in the cylinder block.
6. Install the lower main bearing inserts in the bearing caps with the tang fitted in the slot.
7. Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.
8. Check the clearance of each main bearing. Refer to Section 03-00 under Fitting Main and Connecting Rod Bearings. Seal the rear main bearing-to-block mating surfaces as directed in Main Bearing, Installation.
9. Apply a light coat of heavy engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). **Be sure that the main bearing caps are installed in their original locations.** Tighten the bearing cap bolts to 82-94 N·m (60-70 ft·lb).
10. Install the thrust bearing cap with the bolts finger-tight.
11. Pry the crankshaft forward against the thrust surface of the upper half of the bearing.

12. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.

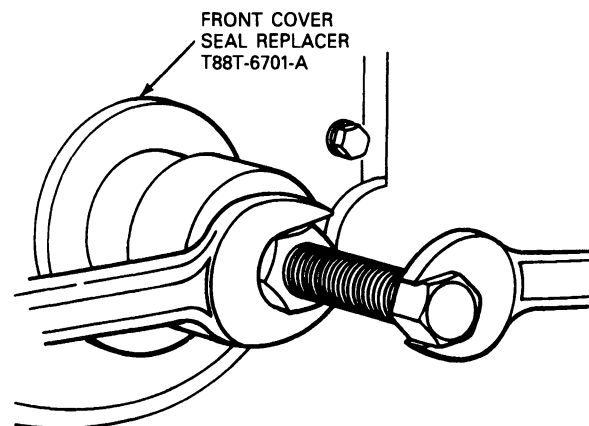
13. Retain the forward pressure on the crankshaft. Tighten the cap bolts to 82-94 N·m (60-70 ft·lb).

REMOVAL AND INSTALLATION (Continued)

14. Check the crankshaft end play. Refer to Section 03-00.
15. If the end play exceeds the service limit, replace the thrust bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks or foreign matter. If the thrust faces are not damaged or dirty, they probably need re-aligning. Install the thrust bearing and align the faces following the recommended procedure (steps 10 through 13 above). Then, check the end play.
16. Coat a new crankshaft rear oil seal with oil and install using Rear Oil Seal Replacer T89P-6701-AH. Refer to One-Piece Rear Oil Seal Installation in Section 03-00. Inspect the seal to be sure it was not damaged during installation.
17. Install the bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement.
18. If the bearing clearances are to specifications, apply a light coat of engine oil to the journals and bearing.
19. Turn the crankshaft throw to the bottom of its stroke and pull the piston all the way down until the connecting rod bearing seats on the crankshaft journal.
20. Install the connecting rod cap and tighten the nuts to specifications.
21. Check the connecting rod side clearance on each crankshaft journal after the piston and connecting rod assemblies have been installed. Refer to Specifications in this section.



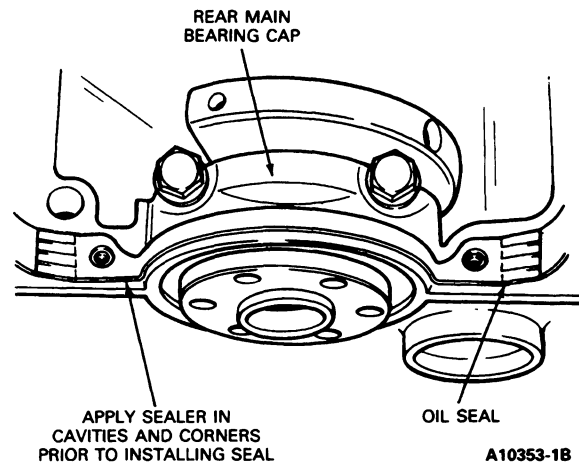
22. Clean the oil pan, oil pump and oil pump screen.
23. Install the inlet tube and screen on the oil pump. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump. Tighten the attaching bolts to 14-20 N·m (10-15 ft-lb).
24. Install the clutch pilot bearing on a crankshaft for a manual transmission. Refer to Clutch Pilot Bearing, Removal and Installation.
25. Turn the engine on the work stand so that the rear of the engine is up. Position the engine rear cover plate on the cylinder block. Position the flywheel on the crankshaft. Coat the threads of the attaching bolts with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent oil-resistant sealer and install the bolts. Tighten the bolts to 102-115 N·m (75-85 ft-lb).
On a flywheel for a manual transmission, locate the clutch disc following the procedure in Section 07-00B. Install the pressure plate. Tighten the attaching bolts to 102-115 N·m (75-85 ft-lb).
26. Turn the engine on the work stand so that the front end is up.
27. Install the crankshaft gear following the procedure under Timing Gear, Installation.
28. Install a new grease-coated crankshaft front oil seal in the cylinder front cover using Front Cover Seal Replacer T70P-6B070-A. Install the cylinder front cover and crankshaft damper by following the procedure outlined under Cylinder Front Cover Installation.



A10352-B

REMOVAL AND INSTALLATION (Continued)

29. Apply Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent oil-resistant sealer in the cavities between the rear bearing cap and cylinder block. Install a new seal in the rear main bearing cap and apply a bead of Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent oil-resistant sealer to the tapered ends of the seal. Install new side gaskets on the oil pan with Gasket and Trim Adhesive D7AZ-19B508-AA (ESE-M2G52-A) or equivalent oil-resistant sealer. Position a new oil pan-to-cylinder front cover seal on the oil pan and install the oil pan.



30. Install the oil level dipstick.
31. Remove the engine from the work stand and install it in the vehicle. Fill the crankcase. Fill and bleed the cooling system. Refer to Section 03-03.
32. Start the engine and check all gaskets and hose connections for leaks.
33. Check the ignition timing and adjust to specifications on the engine decal.

Camshaft Bearings

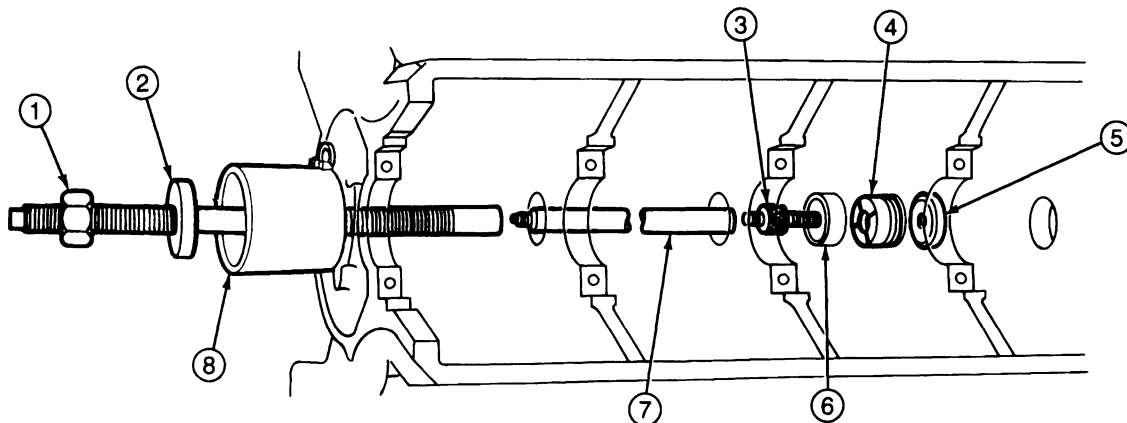
Camshaft bearings are available prefinished to size for standard and 0.381mm (0.015-inch) undersize journal diameters.

Removal

1. Remove the engine and install on a work stand.

Camshaft Bearings, Removal/Installation

2. Remove the camshaft, flywheel and crankshaft. Push the pistons to the top of the cylinders.
3. Remove the camshaft rear bearing bore plug. Refer to Section 03-00. Remove the camshaft bearings with Camshaft Bearing Set T65L-6250-A.



A9045-D

Item	Part Number	Description
1	—	Pulling Screw
2	—	Pulling Plate

(Continued)

Item	Part Number	Description
3	—	Expanding Mandrel
4	—	Expanding Collet

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
5	—	Backup Nut
6	6262	Bearing, Camshaft (Part Number Given is For Reference Only)
7	—	Puller Screw Extension

(Continued)

Item	Part Number	Description
8	—	Front Spacer NOTE: All items except #6 (Bearing) are included in Camshaft Bearing Set T65L-6250-A

TA9045A

- Select the proper size expanding collet and backup nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing and tighten the backup nut on the expanding mandrel until the collet fits the camshaft bearing.
- Assemble the puller screw and extension, if necessary, as shown and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning.
- To remove the front bearing, install the puller screw from the rear of the cylinder block.

Installation

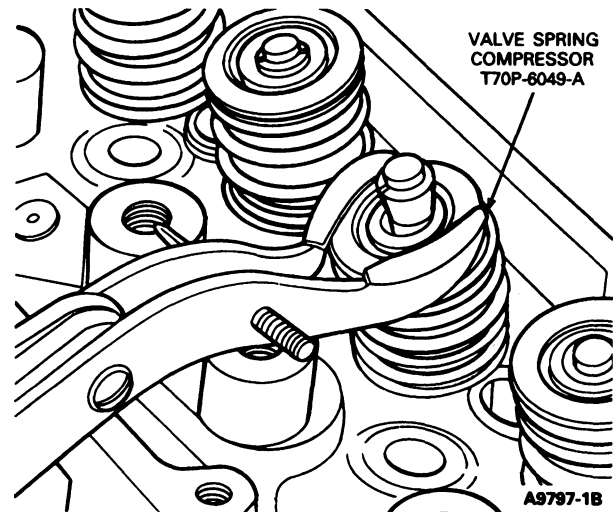
- Position the new bearings at the bearing bores, and press them in place with Camshaft Bearing Set T65L-6250-A. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. **Failure to use the correct expanding collet can cause severe bearing damage.** Align the oil holes in the bearings with the oil holes in the cylinder block before pressing bearings into place. **Be sure the front bearing is installed 0.51-0.89mm (0.020-0.035 inches) below the front face of the cylinder block.**
- Install the camshaft rear bearing bore plug. Refer to Section 03-00.
- Install the camshaft, crankshaft, flywheel and related parts. Do not check connecting rod and main bearing clearances as a part of camshaft bearing replacement.
- Install the engine in the vehicle.

DISASSEMBLY AND ASSEMBLY

NOTE: Lightly oil attaching bolt and stud threads before installing except those specifying special sealant.

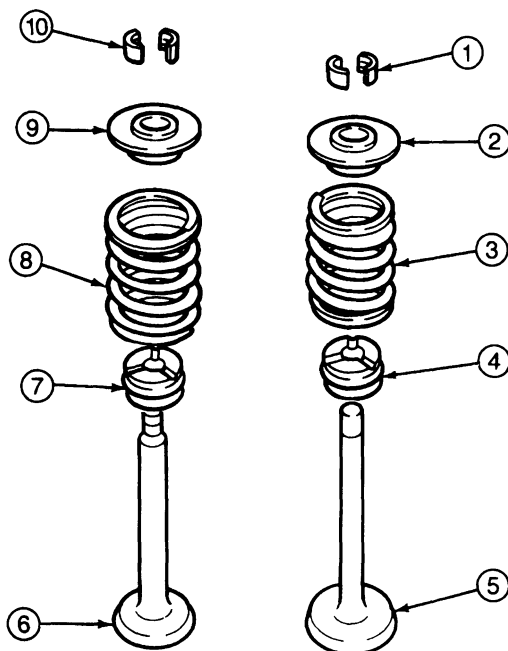
Cylinder Head**Disassembly**

- Remove the coolant outlet housing and thermostat. Discard the gasket.
- Remove the upper intake and throttle body.
- Remove the lower intake manifold and exhaust manifold from the cylinder head. Discard the gasket.
- Remove the spark plugs.
- Remove the deposits from the combustion chambers and valve heads with a scraper and a wire brush before removing the valves. Be careful not to scratch the cylinder head gasket surface.
- Compress the valve springs using Valve Spring Compressor T70P-6049-A, then remove the valve spring retainer locks and release the spring.



- Remove the spring retainer, spring, stem seal and valve. Discard the valve stem seals.

DISASSEMBLY AND ASSEMBLY (Continued)



A10368-B

Item	Part Number	Description
1	6518	Keys
2	6514	Retainer
3	—	Valve Spring
4	6A517	Oil Seal
5	6507	Intake Valve
6	6505	Exhaust Valve
7	6A517	Oil Seal
8	—	Valve Spring
9	6514	Retainer

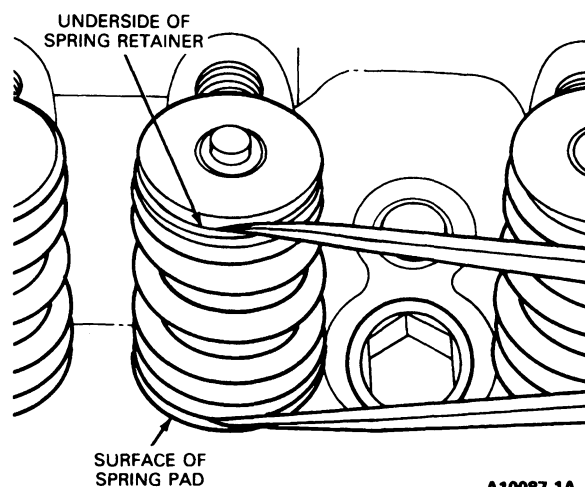
TA10368A

Assembly

1. Lubricate the valve guides and valve stems with heavy engine oil. Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the tip of the valve stems.
2. Install each valve in the valve guide from which it was removed or to which it was fitted.
3. Install new valve stem seals. Use a 5/8-inch deep well socket and a light hammer or mallet to seat the seal on the valve guide or use Valve Stem Seal Replacer T87L-6571-BH. Place the spring in position over the valve and install the valve spring retainer and sleeve, if so equipped. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and fulcrum bolt.

4. Install the valve spring over the valve. **Make sure the closed coil end is placed against the cylinder head.**
5. Position the spring retainer on all valve springs. Make sure that a positive rotating retainer is used on all of the exhaust valves.
6. Compress the spring. Install the keys. Tap the retainers after assembly to seat the keys.
7. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers.

Check the dividers against a scale. If the assembled height is greater than the specified limit, install the necessary 0.76mm (0.030-inch) thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension. **Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.**

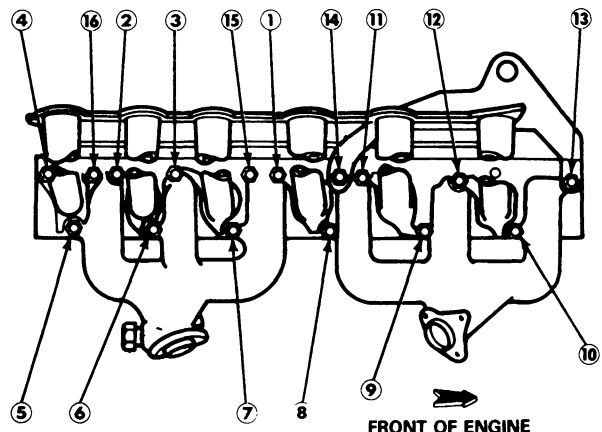


A10087-1A

DISASSEMBLY AND ASSEMBLY (Continued)

8. Position a new intake manifold gasket on the cylinder head. Install the lower intake manifold and exhaust manifolds. Tighten the intake and exhaust manifold bolts and nuts in an opposing pattern to 30-43 N·m (22-32 ft-lb).

NOTE: Combination intake / exhaust gasket is not to be used on a new exhaust manifold. Gasketing of the exhaust manifold is only recommended when the original exhaust manifold is installed.



A10704-1A

9. Install the upper intake and throttle body.
 10. Using a new gasket coated with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent water-resistant sealer, install the thermostat and coolant outlet elbow. Refer to Section 03-03. Tighten the attaching bolts to specifications.

Valve Tappet

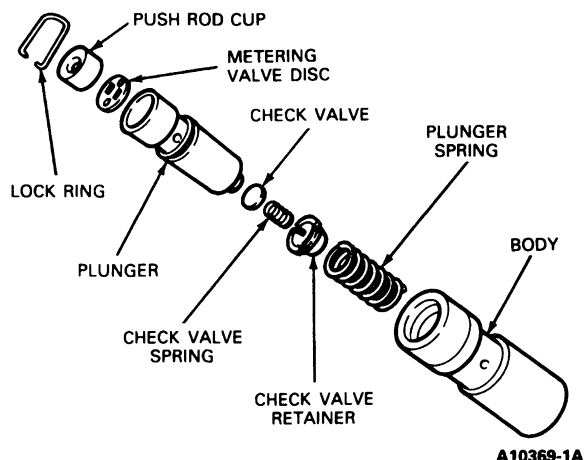
Valve tappets should always be tested after assembly. Refer to the test procedures in Section 03-00.

Disassembly

Each valve tappet is a matched assembly. If the parts of one tappet are mixed with those of another, improper valve operation may result. Disassemble and assemble each tappet separately. Keep the tappet assemblies in proper sequence so that they can be installed in their original bores.

1. Grasp the lock ring with needlenose pliers to release it from the groove. It may be necessary to depress the plunger to fully release the lock ring.
2. Remove the push rod cup, metering valve (disc), plunger and spring.
3. Invert the plunger assembly and remove the check valve retainer by carefully prying up on it with a screwdriver. Remove the check valve (disc or ball check) and spring.

For the cleaning and inspection procedures, refer to Section 03-00.



A10369-1A

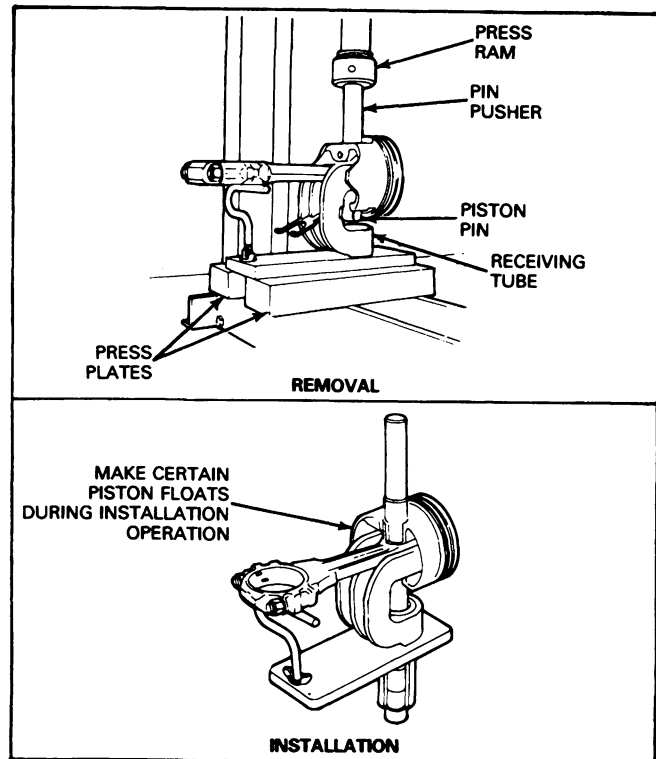
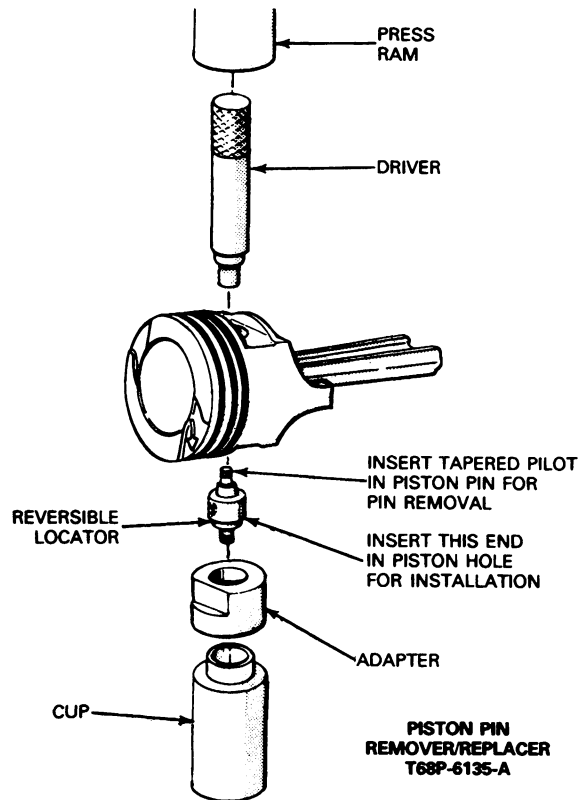
Assembly

1. Place the plunger upside down on a clean work bench.
2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).
3. Position the check valve retainer over the check valve and spring. Push the retainer down into place on the plunger.
4. Place the plunger spring and then the plunger (open end up) into the tappet body.
5. Position the metering valve (disc) in the plunger and then place the push rod cup in the plunger.
6. Depress the plunger and position the closed end of the lock ring in the groove of the tappet body. With the plunger still depressed, position the open ends of the lock ring in the groove. Release the plunger and then depress it again to fully seat the lock ring.
7. Use the hydraulic valve tappet leakdown tester to fill the tappets with test fluid. Refer to Section 03-00.

Piston and Connecting Rod**Disassembly**

1. Remove the bearing inserts from the connecting rod and cap.
2. Mark the pistons and pins to make sure of assembly with the same rod and installation in the same cylinder from which they were removed.
3. Remove the piston rings. Using an arbor press and Piston Pin Remover / Replacer T81P-6135-A, press the piston pin from the piston and connecting rod.

Refer to Section 03-00 for cleaning, inspection and repair procedures.

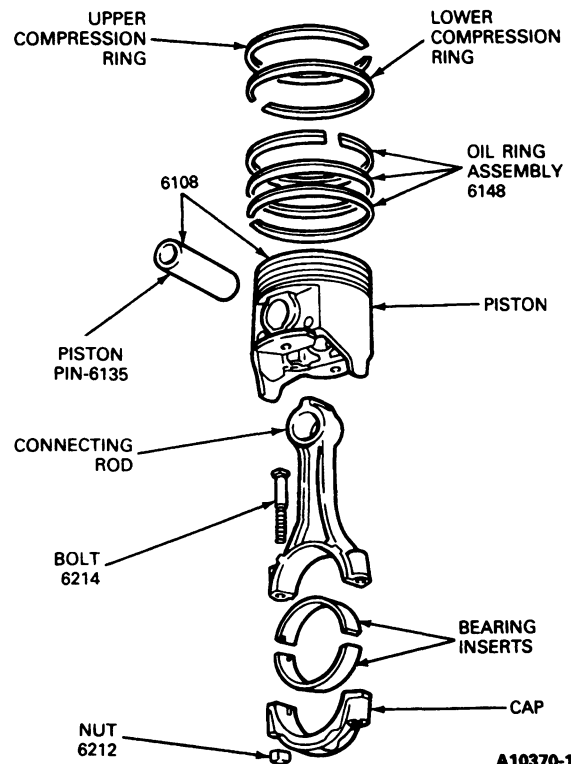
DISASSEMBLY AND ASSEMBLY (Continued)**Piston Pin, Removal and Installation**

A4871-2D

Assembly

The piston, connecting rod and related parts are shown in the illustration. Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod. Refer to Section 03-00.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications.

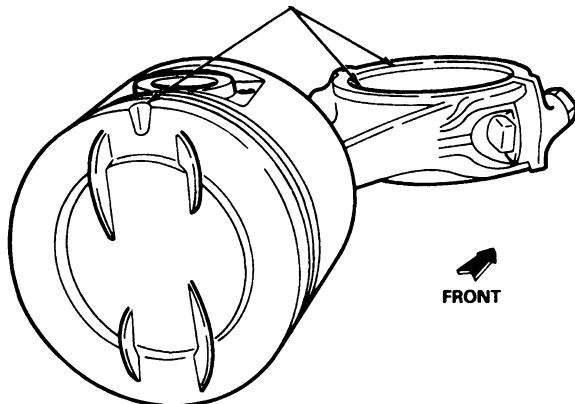


A10370-1A

DISASSEMBLY AND ASSEMBLY (Continued)

1. Apply a light coat of engine oil to all parts.
Assemble the piston to the connecting rod with the bearing tang side of the connecting rod and the indentation notch in the piston positioned as shown.

POSITION BEARING TANG SIDE OF
ROD TO LEFT (TOWARDS CAMSHAFT)
WITH PISTON INDENTATION FORWARD



FRONT

A10371-1A

2. Start the piston pin in the piston and connecting rod. Using an arbor press, press the piston pin through the piston and connecting rod until the pin is centered in the connecting rod. To install piston pin use Piston Pin Remover / Replacer T81P-6135-A.
3. Check the end gap of all piston rings with a feeler gauge. It must be within specifications listed at end of this section. Install the piston rings following the instructions on the package.
4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. **If the lower lands have steps, the piston should be replaced.**
5. Make sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

Cylinder Block

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs. Refer to Section 03-00.

Disassembly

1. Mount the old engine in a work stand and completely disassemble it, removing the cylinder head and manifolds as an assembly. Follow engine components removal and installation procedures.

2. Ridge-ream the cylinder bores before removing the piston assemblies.
3. Remove the cylinder head locating dowels.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder block in the work stand and transfer all serviceable parts removed from the old cylinder block following engine components removal and installation procedures.
3. Install the cylinder head locating dowels and block drain plugs.
4. Check all assembly clearances and correct as necessary.

Cylinder Assembly**Disassembly**

1. Mount the old engine in a work stand.
2. Remove the cylinder head and manifolds as an assembly.
3. Remove all serviceable parts not furnished with the new cylinder assembly, including the cylinder block drain plugs and cylinder head locating dowels.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder assembly in a work stand and transfer all serviceable parts removed from the old cylinder assembly following engine components removal and installation procedures.
3. Install the cylinder head locating dowels and block drain plugs. Install the cylinder head and manifolds as an assembly.
4. Check all assembly clearances and correct as necessary.

CLEANING AND INSPECTION

Refer to cleaning and inspection procedures in Section 03-00.

ADJUSTMENTS**Valve Clearance**

A 1.52mm (0.060 inch) shorter push rod or a 1.52mm (0.060 inch) longer push rod is available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Ford Master Parts List for the appropriate color code.

ADJUSTMENTS (Continued)

Valve stem-to-valve rocker arm clearance should be within specifications with the hydraulic tappet completely collapsed. Refer to Specifications. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if it is not compensated for, the hydraulic valve tappet will collapse and cease to function, and could prevent the valve seat face from properly seating on the valve seat. Valve will be held open.

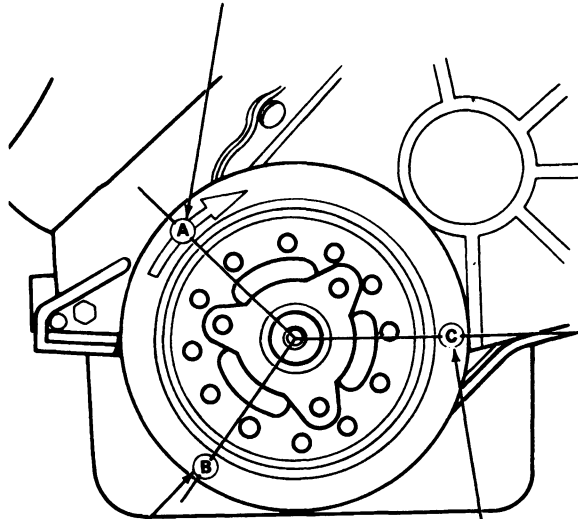
The positive stop rocker arm bolt eliminates the necessity of adjusting the valve clearance. However, to obtain the specified valve clearance, it is important that all valve components be in a serviceable condition and installed and tightened to specifications.

To determine whether a shorter or a longer push rod is necessary, make the following check.

1. Install an auxiliary starter switch. **Crank the engine with the ignition switch in the OFF position.**
2. Make two chalk marks on the crankshaft damper. Space the marks approximately 120 degrees apart so that, with the timing mark, the damper is divided into three equal parts (120 degrees is one-third of the distance around the damper circumference).

STEP 1 - SET NO. 1 PISTON ON T.D.C. AT END OF COMPRESSION STROKE ADJUST NO. 1 INTAKE AND EXHAUST

STEP 4 - CHECK NO. 6 INTAKE AND EXHAUST



STEP 2 - CHECK NO. 5 INTAKE AND EXHAUST

STEP 5 - CHECK NO. 2 INTAKE AND EXHAUST

STEP 3 - CHECK NO. 3 INTAKE AND EXHAUST

STEP 6 - CHECK NO. 4 INTAKE AND EXHAUST

A10096-1A

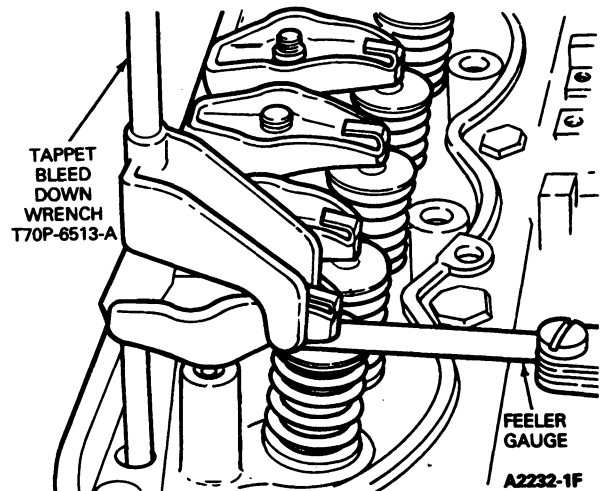
3. Tighten the rocker arm bolts of the No. 1 intake and exhaust valves to specifications with No. 1 piston on TDC at the end of the compression stroke.

Then slowly supply pressure to bleed down the hydraulic tappet until the plunger is completely bottomed using Tappet Bleed Down Wrench T70P-6513-A.

Hold the tappet in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

If the clearance is less than specifications, install a shorter push rod.

If the clearance is greater than specifications, install a longer push rod.



4. Repeat this procedure for the remaining set of valves, turning the crankshaft with an auxiliary starter switch, one-third turn at a time, in the direction of rotation. At the same time, adjust the valves in the firing order sequence, 1-5-3-6-2-4.

SPECIFICATIONS

Refer to the following charts for engine specifications.

GENERAL SPECIFICATIONS

Engine	Bore and Stroke	Firing Order	Oil Pressure Hot @ 2000 RPM kPa (PSI)	Engine Type and Number of Cylinders
4.9L (300 CID) I-6	4.00 x 3.98	153624	275 (40-60)	O.H.V. I-6

CYLINDER HEAD

Engine	Combustion Chamber Volume C.C.③	Valve Guide Bore Diameter		Valve Seat Width①		Valve Seat Runout TIR Maximum	Valve Arrangement Front to Rear	Gasket Surface Flatness②	Rocker Arm Fulcrum Thread Diameter Std.①
		Intake	Exhaust	Intake	Exhaust				
4.9L (300)	65.4- 68.4	.3433- .3443	.3433- .3443	.060- .080	.070- .090	.002	E-I-E-I-E-I- E-I-E-I-E-I	.006 in any 6 in. .007 overall	5/16-18

① Valve seat angle — 45°.

② Gasket surface finish — RMS 60-150.

③ Compression pressure (PSI) of the lowest cylinder must be at least 75% of the highest to be within specification.

VALVE ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

Engine	Rocker Arm Lift Ratio to 1	Push Rod Runout TIR Maximum	Valve Tappet or Lifter			Collapsed Tappet Gap (Clearance)	
			Standard Diameter	Clearance to Bore①	Hydraulic Lifter Leakdown Rate②	Allowable	Desired
4.9L (300 CID) I-6	1.61	.015	.8740-.8745	.0007-.0027	10 to 50 seconds for 1/16 travel	.100-.200	.125-.175

① Service limit — .005.

② Time required for plunger to leakdown .0625 under load of 50 lbs. using leakdown fluid in tappet.

VALVE SPRINGS

Engine	Valve Spring Compression Pressure Lbs. @ Specified Height		Valve Spring Free Length (Approximate)		Valve Spring Assembled Height②		Valve Spring Out Of Square
	Intake①	Exhaust	Intake	Exhaust	Intake	Exhaust	
4.9L (300 CID) I-6	66-74 @ 1.640 166-184 @ 1.240	66-74 @ 1.470 166-184 @ 1.070	1.96	1.78	1.61-1.67	1.44-1.50	5/64 (.078)

① Service limit — 10% loss of pressure.

② Pad to retainer.

VALVES

Engine	Valve Stem to Guide Clearance①		Valve Head Diameter②		Valve Face Runout TIR Maximum
	Intake	Exhaust	Intake	Exhaust	
4.9L (300 CID) I-6	.0010-.0027	.0010-.0027	1.769-1.793	1.551-1.569	.0020

① Service clearance — .0055 Maximum.

② Valve face angle — 44°.

CA4986-2F

SPECIFICATIONS (Continued)

VALVES (Continued)

Engine	Valve Stem Diameter					
	Standard		.015 Oversize		.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
4.9L (300 CID) I-6	.3416-.3423	.3416-.3423	.3566-.3573	.3566-.3573	.3716-.3723	.3716-.3723

CAMSHAFT

Engine	Lobe Lift ^①		Camshaft End Play		Camshaft Journal To Bearing Clearance ^②
	Intake	Exhaust	End Play	Service Limit	
4.9L (300 CID) I-6	.249-.247 ^③	.249-.247 ^③	.001-.007	.009	.001-.003

① Maximum allowable lift loss — .005.

② Service clearance — .006.

③ F-150 4 x 2 w/2.47:1 or 2.75:1 axle ratio and manual transmission (49S).

CAMSHAFT DRIVE

Engine	Camshaft Journal Diameter — Standard ^①				Camshaft Bearing Inside Diameter				Camshaft Front Bearing Location ^②	Assembled Gear Face Runout ^③	
	No. 1	No. 2	No. 3	No. 4	No. 1	No. 2	No. 3	No. 4		Crankshaft	Camshaft
4.9L (300 CID) I-6	2.017-2.018	2.017-2.018	2.017-2.018	2.017-2.018	2.019-2.020	2.019-2.020	2.019-2.020	2.019-2.020	.020-.035	.005	.005

① Camshaft journal runout — .008 TIR maximum.

② Distance in inches that front edge of the bearing is installed below the front face of the cylinder block.

③ Gear backlash — .004-.010.

CYLINDER BLOCK

Engine	Cylinder Bore Diameter ^①	Main Bearing Bore Diameter ^②	Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness	Head Gasket Surface Finish	Tappet Bore Diameter
4.9L (300 CID) I-6	4.0000-4.0048	2.5902-2.5910	.5155-.5165	.003 in any 6 in. .006 overall	RMS 60-150	.8752-.8767

① Maximum out-of-round .0015, Service limit — .005, Maximum taper service limit — .010, Cylinder bore surface finish RMS 18-38, Bore taper service limit — .010

② Crankshaft to rear face of block runout. TIR maximum .005.

CRANKSHAFT AND FLYWHEEL

Engine	Main Bearing Journal Diameter ^①	Main Bearing Journal Runout TIR Maximum ^②	Main Bearing Thrust Face Runout TIR Maximum	Main Bearing Journal Taper Maximum Per Inch	Thrust Bearing Journal Length	Main and Rod Bearing Journal Finish RMS Maximum	Main Bearing Thrust Face Finish RMS Maximum
4.9L (300 CID) I-6	2.3982-2.3990	.002	.001	.0005	1.1990-1.2010	12	35 Front — 25 Rear

① Maximum out-of-round — .0006.

② Service limit — .005.

CRANKSHAFT AND FLYWHEEL (Continued)

Engine	Connecting Rod Journal Diameter ^①	Connecting Rod Journal Taper Per Inch Maximum	Crankshaft Free End Play ^②	Flywheel Clutch Face Runout Assembled	Flywheel Ring Gear Lateral Runout TIR		Flywheel Clutch Face Run-out
					Std. Trans.	Auto. Trans.	
4.9L (300 CID) I-6	2.1228-2.1236	.0006	.004-.008	.010	.040	.060	0.010

① Maximum out-of-round — .0006.

② Service limit — .012.

CA4967-2E

SPECIFICATIONS (Continued)

CRANKSHAFT BEARINGS

Engine	Connecting Rod Bearing to Crankshaft Clearance Selective Fit			Main Bearing to Crankshaft Clearance Selective Fit		
	Desired	Allowable	Bearing Wall Thickness Std.①	Desired	Allowable	Bearing Wall Thickness Std.①
4.9L (300 CID) I-6	.0008-.0015	.0007-.0024	.0752-.0757	.0008-.0015	.0010-.0028	.0951-.0956

① For .002 undersize add .001 to standard wall thickness.

CONNECTING ROD

Engine	Piston Pin Bore or Bushing I.D.	Rod Bearing Bore I.D.①	Rod Length Center to Center	Connecting Rod Alignment Maximum Total Difference		Rod to Crankshaft Assembled Side Clearance③
				Twist②	Bend②	
4.9L (300 CID) I-6	.9734-.9742	2.2750-2.2758	6.2082-6.2112	.024	.012	.006-.013

① Connecting rod bearing bore maximum out-of-round — .006.

② Pin bushing and crankshaft bore must be parallel and in same vertical plan within specified total difference when measured at the ends of an 8-inch long bar, 4 inches on each side of rod centerline.

③ Service limit — .018.

PISTON

Engine	Diameter①			Piston to ② Bore Clearance Selective Fit	Piston Pin Bore Diameter	Ring Groove Width Compression		
	Coded Red	Coded Blue	.003 Oversize			Top	Bottom	Oil
4.9L (300 CID) I-6②	3.9982-3.9988	3.9994-4.0000	4.0008-4.0014	.0010-.0018	.9754-.9757	.080-.081	.080-.081	.188-.189

① Measured at the piston pin bore centerline at 90° to the pin.

② Rebuild specification only.

PISTON PIN

Engine	Length	Diameter			To Piston Pin Bore Clearance①	To Connecting Rod Bushing Clearance
		Standard	.001 Oversize	.002 Oversize		
4.9L (300 CID) I-6	3.150-3.170	.9749-.0754	.9760-.9763	.9770-.9773	.0002-.0004②	Interference Fit

① Selective Fit.

② Under 8500 Lbs. GVW-.0003-.0005.

PISTON RINGS

Engine	Ring Width Compression		Side Clearance Compression①			Ring Gap Compression		
	Top	Bottom	Top	Bottom	Oil	Top	Bottom	Oil②
4.9L (300 CID) I-6	.0774-.0781	.0770-.0780	.0019-.0036	.002-.004	Snug	.010-.020	.010-.020	.015-.055

① Service limit — .002 maximum increase in clearance.

② Steel rail.

OIL PUMP AND OIL CAPACITY

Engine	Relief Valve Spring Pressure Lbs. @ Specified Length	Driveshaft to Housing Clearance	Relief Valve to Housing Clearance	Rotor Assembly End Clearance	Outer Race to Housing Clearance	Engine Oil Capacity			Inner② to Outer Rotor Tip Clearance
						U.S. Quarts	Imperial Quarts	Liters	
4.9L (300 CID) I-6	20.6-22.6 @ 2.49	.0015-.0030	.0015-.0030	.004 Maximum	.001-.013	5	4-2	4-7	.012 Maximum

① Add 1 U.S. Quart (or equivalent in Imperial Quarts or Liters) when replacing filter.

② With feeler gauge inserted ½ inch minimum and rotor removed from pump housing.

CA4968-2F

TORQUE LIMITS — 4.9L (300 CID) I-6 ENGINE

NOTE: All values are in N·m (ft·lbs) unless otherwise noted. Oil threads with engine oil unless the threads require oil or water-resistant sealer. The standard torque limits listed below are applicable for all functions not listed in the special torque chart.

1/4-20	5/16-18	5/16-24	3/8-16	3/8-24	7/16-14	7/16-20	1/2-13	9/16-18
8-12 (6-9)	17-24 (12-18)	19-27 (14-20)	30-43 (22-32)	37-51 (27-38)	55-75 (40-55)	55-81 (40-60)	75-109 (55-80)	116-162 (85-120)

CA4969-2C

SPECIFICATIONS (Continued)

PIPE THREADS

1/8-27	1/4-18	3/8-18	1/2-14
7-11 (5-8)	17-24 (12-18)	30-44 (22-33)	34-47 (25-35)

TORQUE SPECIFICATIONS

Item	Torque	
	N-m	Ft-Lbs
Connecting Rod Nut	55-61	40-45
Cylinder Front Cover	17-24	12-18
Cylinder Head Bolts	^a	^{ab}
Damper to Crankshaft	177-203	130-150
EGR Valve to Intake Manifold	18-26	13-19
Flywheel to Crankshaft	102-115	75-85
Main Bearing Cap Bolts	82-94	60-70
Manifold to Cylinder Head — Intake ^b	30-43	22-32
Manifold to Cylinder Head — Exhaust ^b	30-43	22-32
Exhaust Manifold-to-Muffler Inlet Pipe	34-49	25-36
Oil Filter Insert to Cylinder Block	20-48	15-35
Oil Filter to Cylinder Block	1/2 turn after gasket contacts sealing surface — oiled gasket	
Oil Inlet Tube to Pump	14-20	10-15
Oil Pan Drain Plug	21-33	15-25
Oil Pan to Cylinder Block ^b	20-24	15-18
Oil Pump to Cylinder Block	14-20	10-15
Oil Inlet Tube to Main Bearing Cap	30-43	22-32
Pulley to Damper Bolt	48-67	35-50
Rocker Arm Bolt	24-31	17-23
Spark Plug to Cylinder Head	14-20	10-15
Valve Rocker Arm Cover ^b	8-14	(70-120 In-Lbs)
Valve Push Rod — Cover to Cylinder Block	2-3	(18-27 In-Lbs)
Water Outlet Housing	17-24	12-18
Water Pump to Block / Front Cover	17-24	12-18
Thermactor Pump Pulley to Pump Hub	12-15	(110-130 In-Lbs)
Throttle Body Attaching Nuts	19-27	14-20
Camshaft Thrust Plate to Cylinder Block	16-24	12-18
Distributor Clampdown	24-33	17-25
Intake Manifold Vacuum Fittings	8-13	6-10
Timing Pointer to Front Cover	17-24	12-18
Thermactor Air Manifold to Cylinder Head (Nut and Ferrule Assy.)	19-22	14-16
Thermactor Air Check Valve to Thermactor Air Manifold	22-26	16-19
Pressure Plate and Cover Assy. to Flywheel	27-39	20-29

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Item	Torque	
	N-m	Ft-Lbs
Alternator / Thermactor Pump Bracket to Engine (all except bottom bolt)	40-55	30-40
Alternator / Thermactor Pump Bracket to Engine (bottom bolt)	53-71	39-53
Alternator Pivot Bolt	53-72	39-53
Thermactor Pump Pivot Bolt	40-55	30-41
Alternator Adjusting Bolt	40-55	30-41
Thermactor Pump Attaching Bolt	40-55	30-40
Air Conditioning Compressor to Mounting Bracket Bolts	24-31	18-23
Power Steering Pump to Mounting Bracket Bolts	40-55	30-40
Power Steering Pump / Air Conditioning Compressor Bracket to Cylinder Head Bolts	40-55	30-40
Power Steering Pump / Air Conditioning Compressor Bracket to Block Bolts and Nuts	55-70	40-50
Fan Blade to Fan Clutch Bolts	16-24	12-18
Fan Clutch to Water Pump	41-135	30-100

^aProgressively increase the tightness in three steps using this sequence:

1st step — tighten all bolts to 67-75 N-m (50-55 ft-lb)





2nd step — tighten all bolts to 82-88 N-m (60-65 ft-lb)

3rd step — tighten all bolts to 94-115 N-m (70-85 ft-lb)

^bFollow bolt tightening sequence in this section.

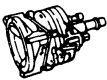


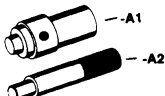
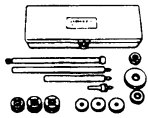

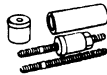
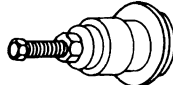

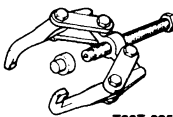
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SPECIAL SERVICE TOOLS / EQUIPMENT



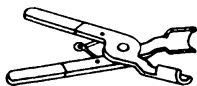
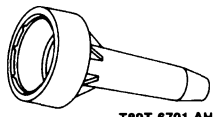
Tool Number / Description	Illustration
T59L-100-B Impact Slide Hammer	 T59L-100-B
T58L-101-B Puller	 T58L-101-B
TOOL-4201-C Dial Indicator with Bracketry	 TOOL-4201-C
T70P-6000 Engine Lifting Bracket	 T70P-6000

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

Tool Number/ Description	Illustration
T64L-6011-EA Cylinder Ridge Reamer	 T64L-6011-EA
T73L-6011-A Cylinder Hone Set	 T73L-6011-A
T61P-6019-B Front Cover Aligner	 T61P-6019-B
T81P-6135-A Piston Pin Remover/Replacer Adapters	 T81P-6135-A
T65L-6250-A Camshaft Bearing Set	 T65L-6250-A
T65L-6306-A Camshaft Gear Replacing Adapter	 T65L-6306-A
T52L-6306-AEE Crankshaft Sprocket and Damper Replacer	 T52L-6306-AEE
T88T-6701-A Front Cover Seal Remover	 T88T-6701-A
T58P-6316-D Crankshaft Damper Remover	 T58P-6316-D
T82T-6256-A Camshaft Gear Puller	 T82T-6256-A

(Continued)

Tool Number/ Description	Illustration
TOOL-6331-E Main Bearing Insert Tool	 TOOL-6331-E
T70P-6049-A Valve Spring Compressor	 T70P-6049-A
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A
T89T-6701-AH Rear Oil Seal Replacer	 T89T-6701-AH

SPECIAL SERVICE TOOLS

Tool Number	Description
D81L-6002-C	Piston Ring Compressor
D79L-6731-A	Oil Filter Wrench

ROTUNDA EQUIPMENT

Tool Number	Description
014-00036	Engine Sling
014-00133	Floor Crane
066-00017	Transmission Jack

SECTION 03-01B Engines, 5.0L MFI V-8, 5.8L MFI W-V-8 and 5.8L MFI Lightning W-V-8

SUBJECT	PAGE	SUBJECT	PAGE
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Engine	03-01B-1	E-150-250-350	03-01B-19
Exhaust Emission Control System.....	03-01B-5	F-150-250-350 and Bronco.....	03-01B-18
DIAGNOSIS AND TESTING	03-01B-5	Engine Rear Mounts.....	03-01B-19
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Cylinder Block Assembly (6009)	03-01B-63	F-150-250-350 and Bronco.....	03-01B-19
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Clutch Pilot Bearing	03-01B-40	Oil Pump, F-150-250-350 and Bronco.....	03-01B-23
Connecting Rod Bearings	03-01B-43	PCV Valve and Hoses	03-01B-16
Crankcase Vent Hose Assembly	03-01B-15	Pistons and Connecting Rods	03-01B-43
Crankcase Ventilation System	03-01B-15	Tappet	03-01B-26
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Crankshaft Rear Oil Seal	03-01B-41	Arm.....	03-01B-24
Cylinder Front Cover and Timing Chain	03-01B-33	Valve Spring, Retainer and Stem Seal.....	03-01B-25
E-150-250-350	03-01B-36	Water Pump	03-01B-32
F-150-250-350 and Bronco.....	03-01B-33	E-150-250-350	03-01B-33
Cylinder Heads	03-01B-27	F-150-250-350 and Bronco.....	03-01B-32
Electronic Fuel Injection	03-01B-18	SPECIAL SERVICE TOOLS/EQUIPMENT	03-01B-72
Engine Assembly	03-01B-46	SPECIFICATIONS	03-01B-66
E-150-250-350	03-01B-48	VEHICLE APPLICATION	03-01B-1

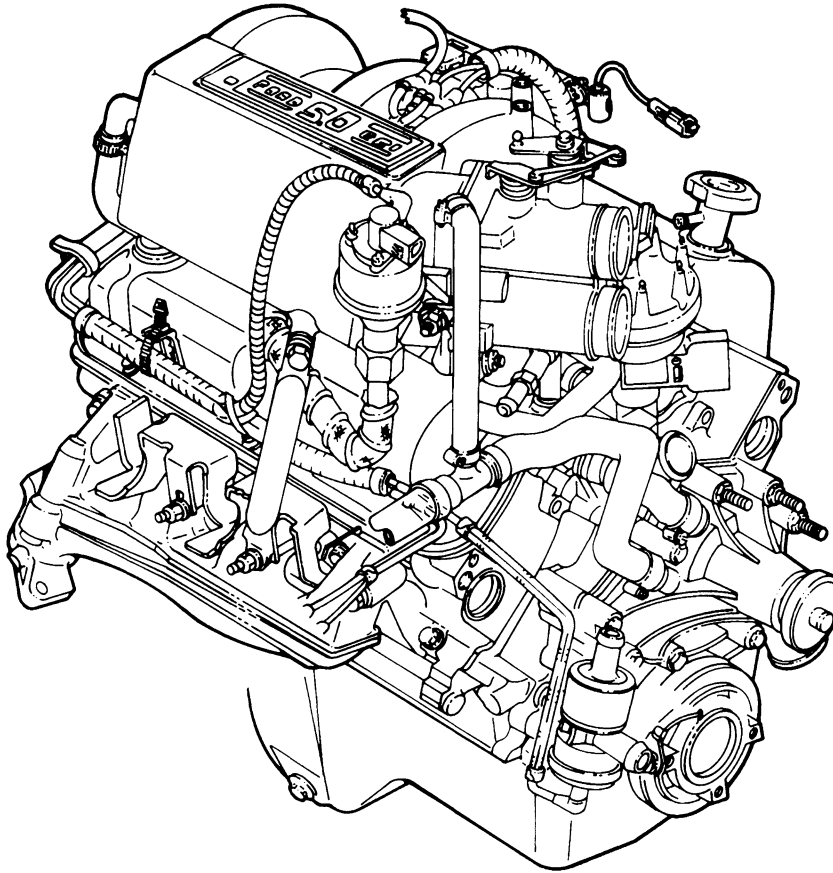
VEHICLE APPLICATION

E-150-250-350, F-150-250-350 and Bronco Vehicles
Equipped with 5.0L or 5.8L MFI Engines and the
Lightning Truck Equipped with the 5.8L MFI Lightning
W-V-8

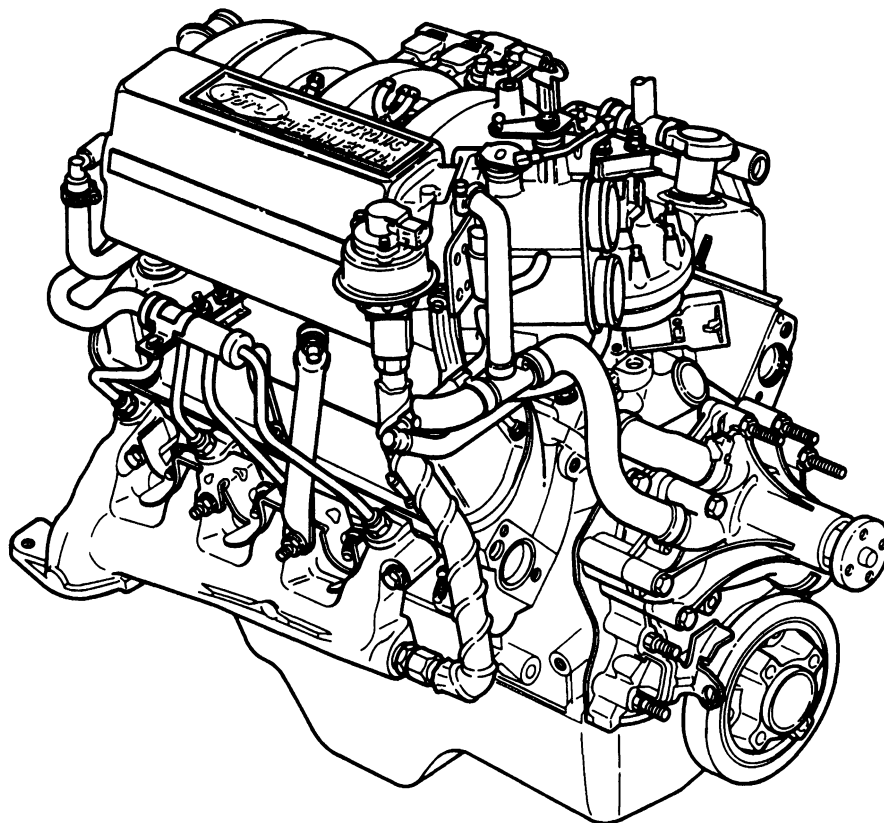
DESCRIPTION AND OPERATION

Engine

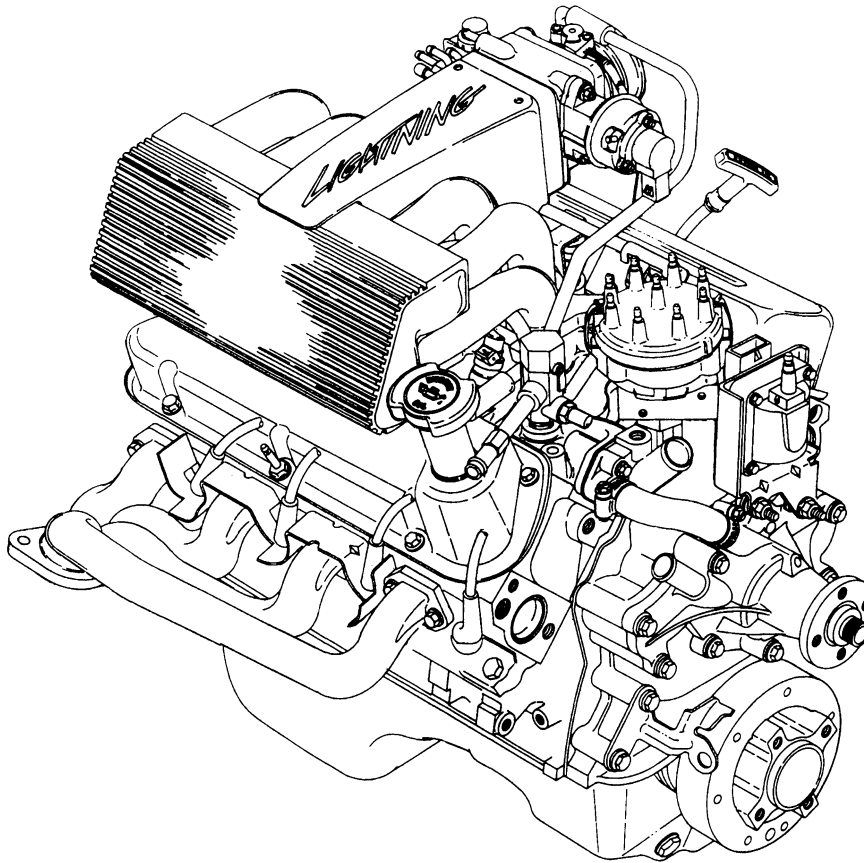
The 5.0L (302 CID) MFI V-8, 5.8L (351 CID) MFI W-V-8 and the 5.8L MFI Lightning W-V-8 engines have the same basic design. The cylinder block for these engines is of special high-grade cast iron, thin-wall construction. The crankshaft has five main bearings and is precision-cast nodular iron. Pistons are aluminum alloy, tin plated. Valve rocker arms are individually bolt-mounted. The valve tappets are hydraulic. These engines are also equipped with aluminum intake manifold systems.

DESCRIPTION AND OPERATION (Continued)**5.0L Engine**

A15190-C

DESCRIPTION AND OPERATION (Continued)**5.8L Engine**

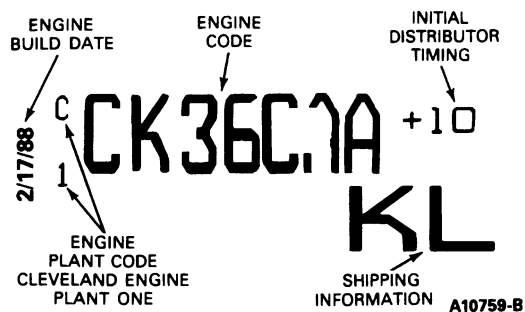
A10765-C

DESCRIPTION AND OPERATION (Continued)**5.8L Lightning Truck Engine**

A17838-A

Engine Code Information Label

The engine code information label, located on the side of the right rocker arm cover, contains the engine build date, engine plant code, the engine code, and the initial distributor timing.

**Emission Calibration Label**

The emission calibration number label is located on the left side door or left door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.

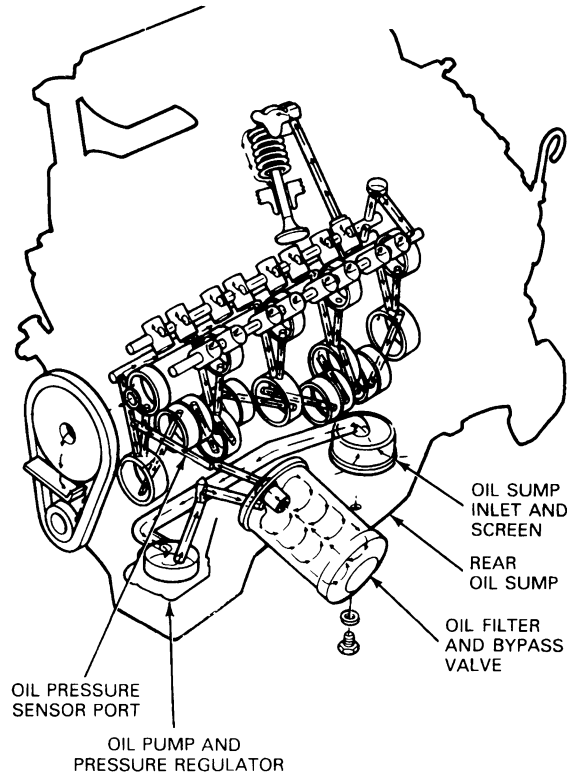
NOTE: It is critical that the engine codes and the calibration number be used when ordering parts or making inquiries about the engine.

**CALIBRATION
ÉTALONNAGE
CALIBRACIÓN**

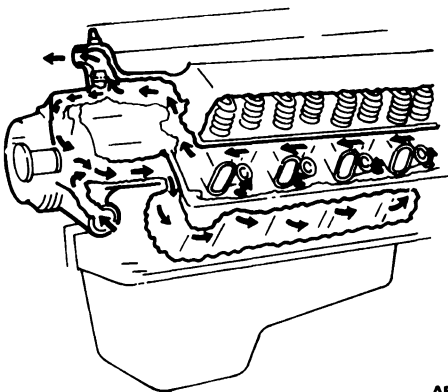


2-54E-R00 E8AE-6E061-ABY

A10693-B

DESCRIPTION AND OPERATION (Continued)**Lubrication System, 5.0L / 5.8L Engines, 5.8L Lightning Similar**

A10766-B

Cooling System

A5505-B

Exhaust Emission Control System

Operation and required maintenance of the exhaust emission control devices used on these engines are covered in the Powertrain Control / Emissions Diagnosis Manual¹.

Crankcase Ventilation System

These engines are equipped with a positive closed-type crankcase ventilation system directing the crankcase vapors to the intake manifold for combustion.

DIAGNOSIS AND TESTING

Refer to Diagnosis and Testing in Section 03-00.

REMOVAL AND INSTALLATION

WARNING: TO AVOID THE POSSIBILITY OF PERSONAL INJURY OR DAMAGE TO THE VEHICLE, DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS BEEN FIRST EXAMINED FOR POSSIBLE CRACKS AND SEPARATION.

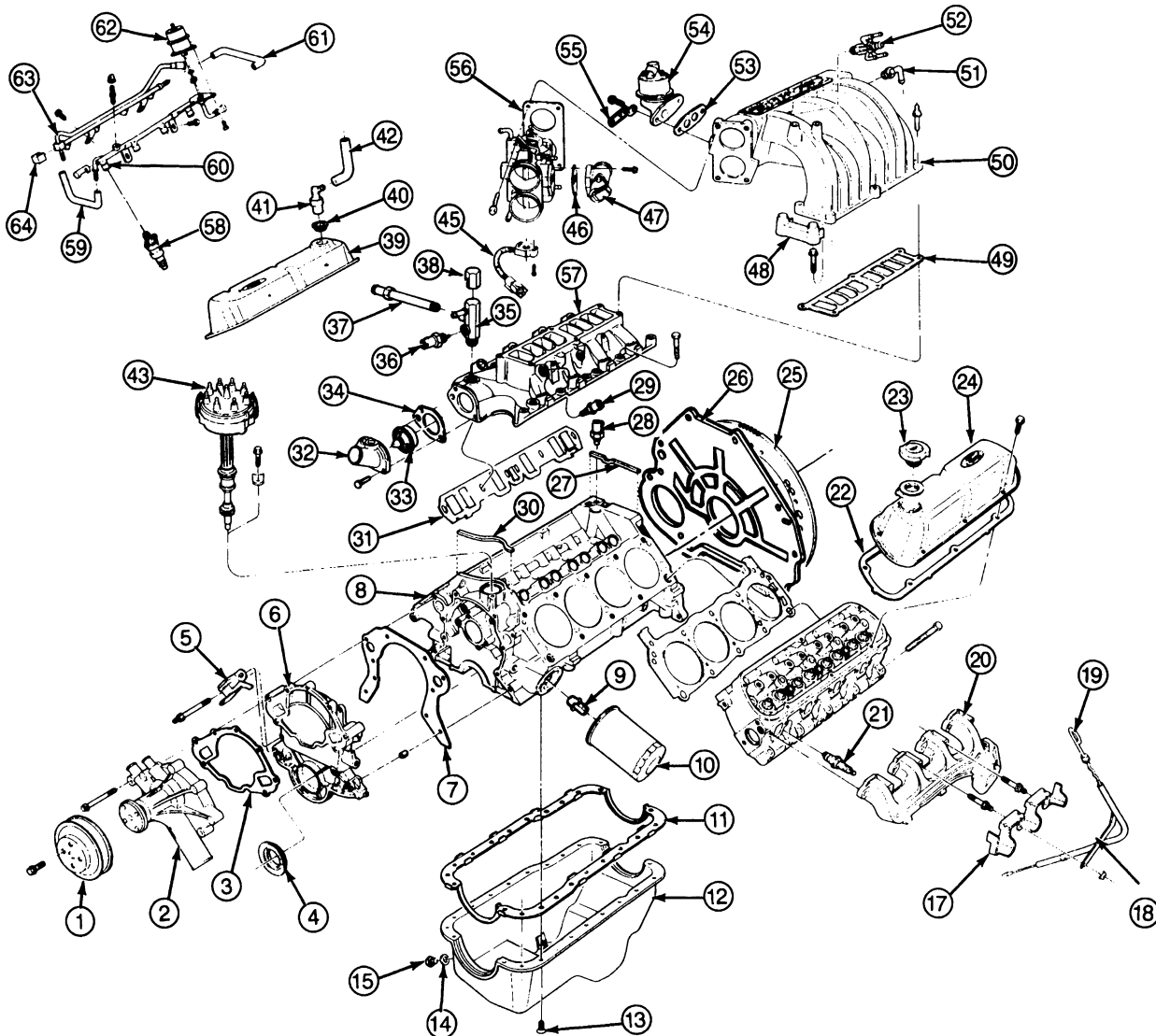
NOTE: The following procedures can be performed with the engine in the vehicle. Lightly oil attaching bolt and stud threads before installation, except those specifying special sealant.

Refer to Section 03-00 for Cleaning, Inspection and Test procedures.

Engine Components

Engine components shown are typical and provide a reference for procedures. The numbers shown are basic part numbers corresponding with the Ford Master Parts Catalog.

¹ Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)**External Engine Components, 5.0L MFI**

A15191-C

Item	Part Number	Description
1	8509	Pulley
2	8501	Water Pump
3	8507	Gasket — Water Pump Housing
4	6700	Seal — Cylinder Front Cover
5	6023	Pointer — Timing
6	6059	Cover Assembly — Cylinder Front
7	6020	Gasket — Cylinder Front Cover
8	6010	Block Assembly
9	6890	Insert — Oil Filter Adapter
10	6714	Oil Filter

(Continued)

Item	Part Number	Description
11	6710	Gasket — Oil Pan
12	6675	Pan Assembly — Oil
13	387549	Bolt
14	6734	Seal — Oil Drain Plug
15	6730	Drain Plug — Oil
16	6049	Head — Cylinder
17	12A087	Heat Shield
18	6754	Tube Assembly — Oil Level Indicator
19	6750	Indicator — Oil Level
20	9428	Manifold — Exhaust (RH)
	9431	Manifold — Exhaust (LH)
21	12405	Spark Plug

(Continued)

REMOVAL AND INSTALLATION (Continued)

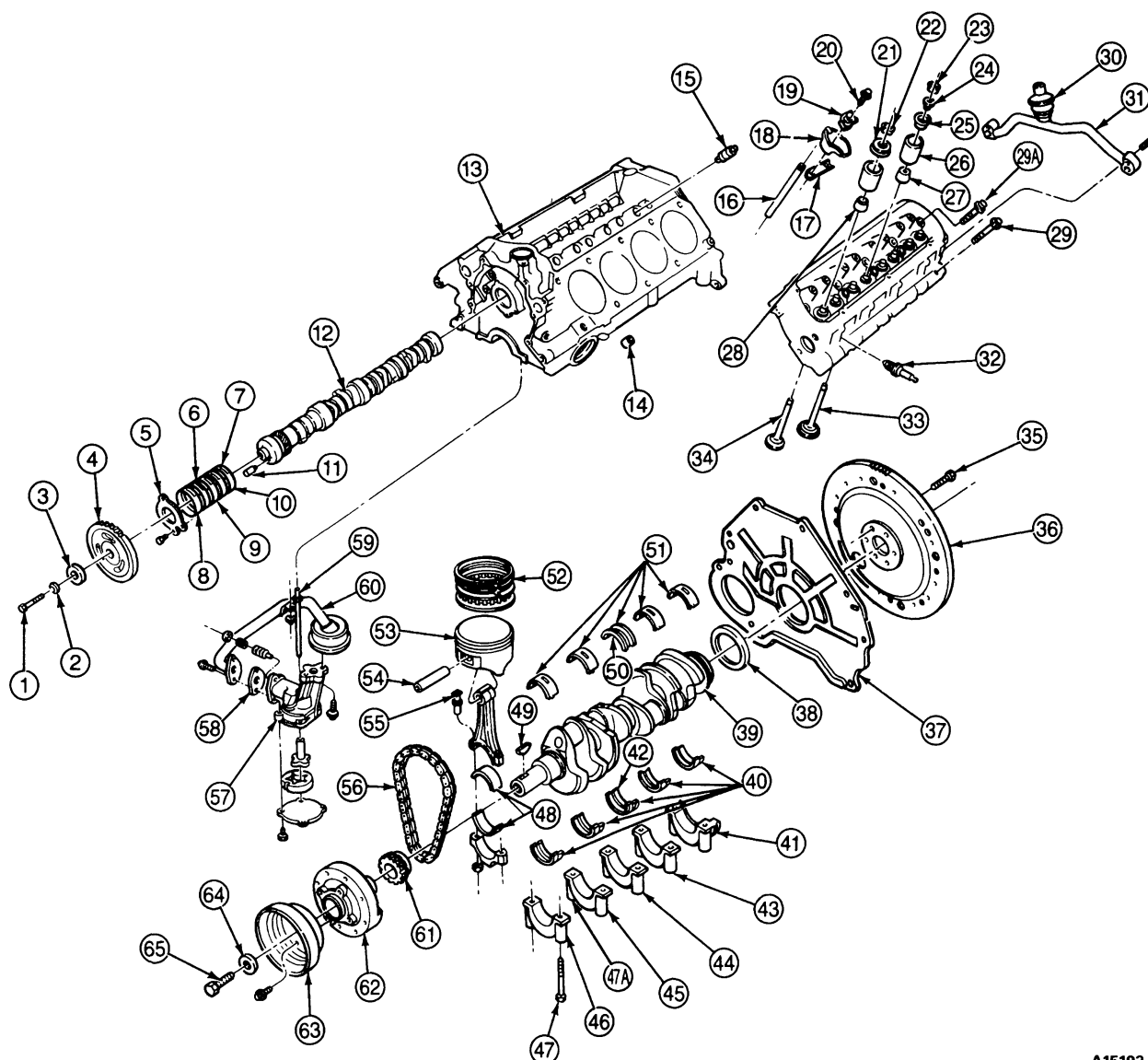
Item	Part Number	Description
22	6584	Gasket — Valve Rocker Arm Cover
23	6766	Cap Assembly — Oil Filler
24	6A505	Cover Assembly — Valve Rocker Arm (LH)
25	6375	Flywheel
26	6A373	Plate Assembly — Engine Rear
27	9A424	Gasket — Manifold
28	12A699	Sensor Assembly — Eng. Spark Knock Intensity
29	12A697	Sensor Assembly — Intake Air Temperature
30	9A425	Gasket — Manifold
31	9439	Gasket — Intake Manifold to Cylinder Head
32	8592	Connection — Water Outlet
33	8575	Thermostat — Water
34	8255	Gasket — Water Outlet Conn.
35	18A568	Connector — Sensor
36	12A648	Sensor Assembly — Engine Coolant Temperature
37	18K396	Tube — Heater Hot Water
38	8A565	Cap — Protective
39	6582	Cover Assembly — Valve Rocker Arm (RH)
40	6K780	Grommet — PCV Valve
41	6B890	Valve Assembly — PCV

(Continued)

Item	Part Number	Description
42	6A664	Hose — Crankcase Ventilation
43	12106	Cap — Distributor
45	9B989	Throttle Position Assembly
46	9F670	Gasket — Air-By-Pass
47	9F715	Valve Assembly — IAC/BPA
48	9F460	Shield — Intake Manifold
49	9H486	Gasket — Intake Manifold, Upper
50	9425	Manifold — Intake, Upper
51	9A474	Fitting — Intake Manifold Vacuum Outlet
52	9D446	Fitting — Intake Manifold Vacuum Tree
53	9D476	Gasket — EGR Valve
54	9F483	Valve Assembly — EGR Pressure External
55	14A163	Retainer — Wiring Harness
56	9E936	Gasket — Throttle Body
57	9K461	Manifold — Intake, Lower
58	9F593	Injector Assembly — Fuel
59	9F793	Connecting Hose — Fuel Rail Front
60	9D280	Manifold — Fuel Injection Supply (LH)
61	9F793	Connecting Hose — Fuel Rail Rear
62	9C968	Regulator Assembly — Fuel Pressure
63	9D280	Manifold — Fuel Injection Supply (RH)
64	9J314	Cap — Protective

REMOVAL AND INSTALLATION (Continued)

Internal Engine Components, 5.0L MFI



A15193-C

Item	Part Number	Description
1	43002	Bolt — Camshaft Retaining
2	6278	Washer — Camshaft Sprocket
3	6278	Washer — Camshaft Sprocket
4	6256	Sprocket — Camshaft
5	6269	Plate — Camshaft Thrust
6	6267	Bearing — Camshaft Front Intermediate
7	6270	Bearing — Camshaft Rear Intermediate
8	6261	Bearing — Camshaft Front
9	6262	Bearing — Camshaft Center
10	6263	Bearing — Camshaft Rear

(Continued)

Item	Part Number	Description
11	384940	Pin — Dowel
12	6250	Camshaft
13	6010	Block Assembly
14	6A008	Dowel — Cylinder Head to Cylinder Block
15	6500	Tappet Assembly — Valve
16	6565	Rod — Valve Push
17	6A588	Fulcrum Guide
18	6564	Arm — Valve Rocker
19	6A528	Fulcrum
20	390385	Bolt — Rocker Arm
21	6A516	Retainer — Valve Spring (Exhaust)

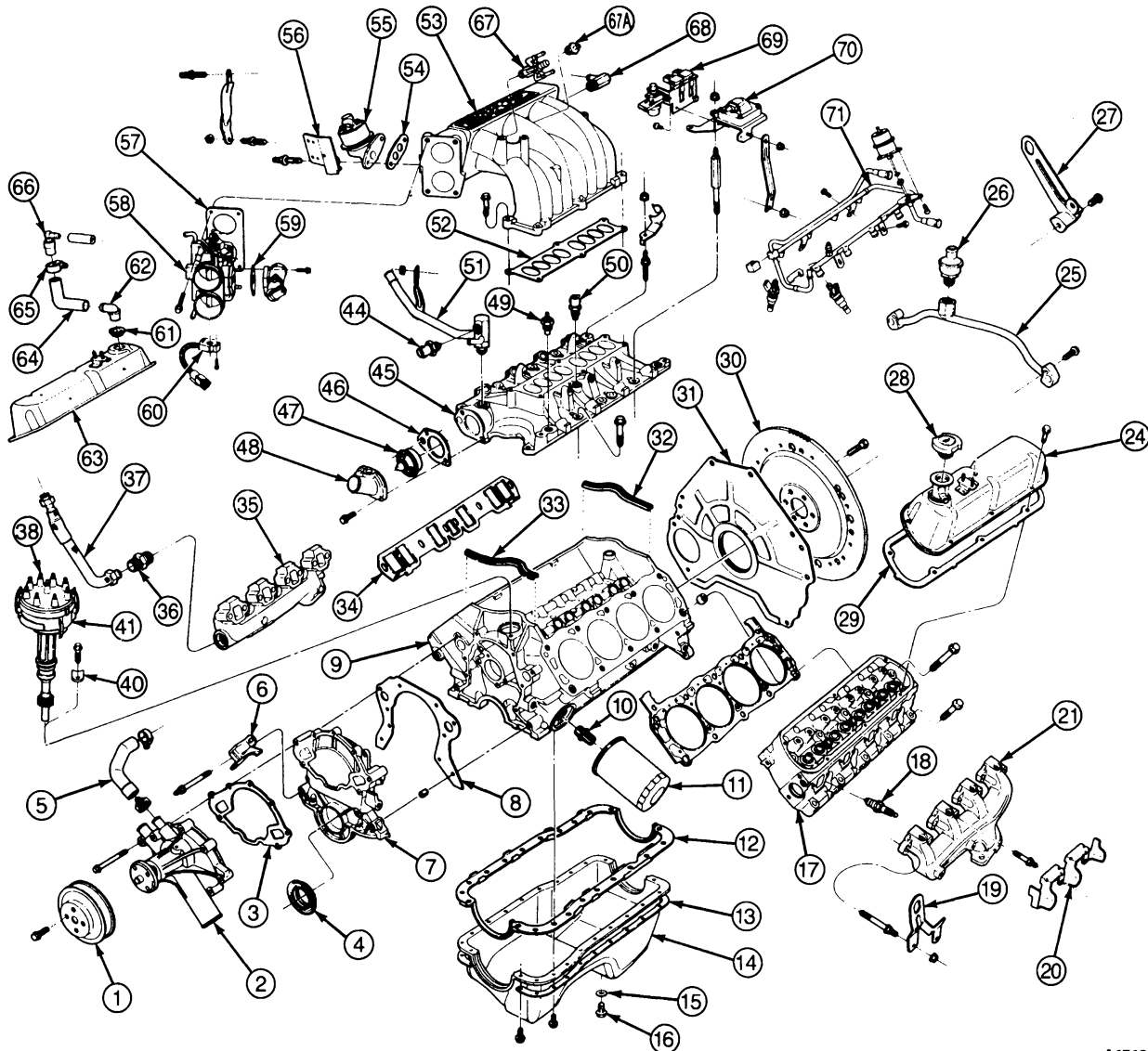
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
22	6518	Key — Valve Spring Retainer
23	6518	Key — Valve Spring Retainer
24	6517	Sleeve — Valve Spring Retainer
25	6514	Retainer — Valve Spring
26	6513	Spring — Valve
27	6A517	Valve Stem Seal
28	6571	Seal — Valve Stem
29	391413	Bolt 7 / 16-14 x 2.49 (10 Req)
29A	391414	Bolt 7 / 16-14 x 4.11 (10 Req)
30	9A487	Valve Assembly — Exhaust Air Supply Check
31	9B449	Tube Assembly — Exhaust Air Supply Manifold
32	12405	Spark Plug
33	6507	Valve — Intake
34	6505	Valve — Exhaust
35	384918	Bolt — Flywheel to Crankshaft
36	6375	Flywheel Assembly
37	6A373	Packing Seal — Crankshaft Rear
38	6701	Packing Seal — Crankshaft Rear
39	6303	Crankshaft Assembly
40	6A338	Bearing — Main Set
41	6325	Cap — Main Bearing
42	6A339	Bearing — Main Thrust
43	6327	Cap — Main Bearing

(Continued)

Item	Part Number	Description
44	6330	Cap — Main Bearing
45	6334	Cap — Main Bearing
46	6329	Cap — Main Bearing
47	384664	Bolt 1/2-13 x 3.5 — Crankshaft Main Bearing Cap (9 Req)
47A	386562	Stud 3/8-16-7 / 16-14 x 4.09 (1 Req)
48	6211	Bearing — Connecting Rod
49	388907	Key — Woodruff
50	6337	Bearing — Crankshaft Main
51	6333	Bearing — Crankshaft Main
52	6148	Ring Set — Piston
53	6110	Piston Assembly
54	6135	Pin — Piston
55	6214	Bolt — Connecting Rod
56	6268	Chain — Timing
57	6600	Pump Assembly — Oil
58	6625	Gasket — Oil Pump Inlet Tube
59	6A618	Shaft Assembly — Oil Pump Intermediate
60	6622	Screen, Tube and Cover Assembly — Oil Pump
61	6306	Sprocket — Camshaft
62	6316	Damper Assembly — Crankshaft
63	6312	Pulley Assembly — Crankshaft
64	6378	Washer — Crankshaft Pulley Retaining
65	388813	Bolt — Crankshaft Pulley Retaining

REMOVAL AND INSTALLATION (Continued)**External Engine Components, 5.8L MFI**

A15195-C

Item	Part Number	Description
1	8509	Pulley — Water Pump
2	8501	Pump Assembly — Water
3	8507	Gasket — Water Pump Housing
4	6700	Seal — Cylinder Front Cover Oil
5	8A506	Hose — Water Pump
6	6023	Pointer — Timing
7	6059	Cover Assembly — Cylinder Front
8	6020	Gasket — Cylinder Front Cover
9	6010	Block Assembly
10	6890	Insert — Oil Filter Mounting

(Continued)

Item	Part Number	Description
11	6714	Filter Assembly — Oil
12	6710	Gasket — Oil Pan
13	6694	Reinforcement — Oil Pan
14	6675	Pan Assembly — Oil
15	6734	Gasket — Oil Pan Drain Plug
16	6730	Plug — Oil Pan Drain
17	6049	Head — Cylinder
18	12405	Spark Plug
19	17A084	Lifting Eye
20	12A087	Heat Shield
21	9431	Manifold — Exhaust (LH)
24	6A505	Cover Assembly — Valve Rocker Arm (LH)

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REMOVAL AND INSTALLATION (Continued)

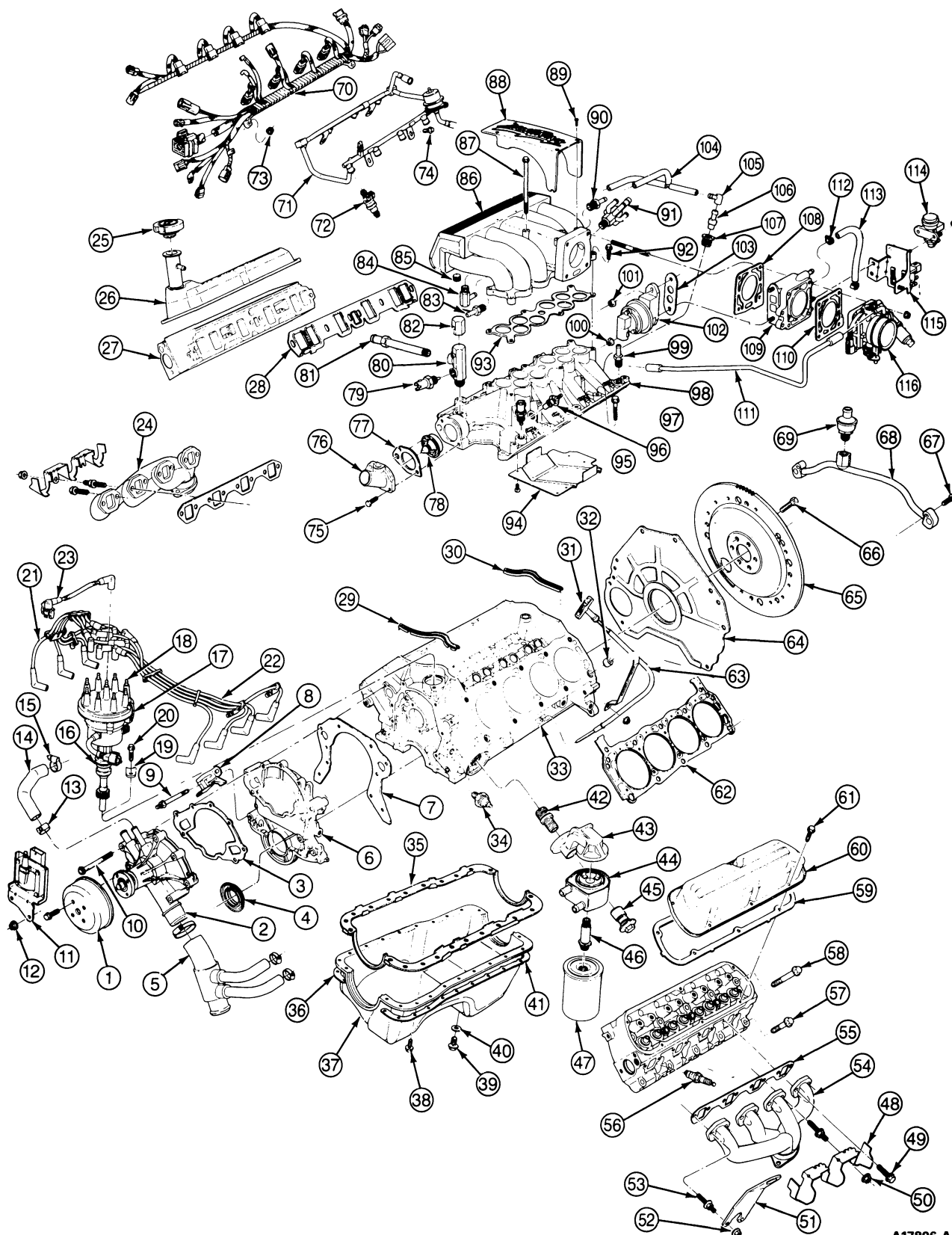
Item	Part Number	Description
25	9B449	Tube Assembly — Exhaust Air Supply Manifold
26	9A487	Valve Assembly — Exhaust Air Supply Check
27	17K004	Lifting Eye
28	6766	Cap Assembly — Oil Filler and Breather
29	6584	Gasket — Valve Rocker Arm Cover
30	6375	Flywheel Assembly
31	6A373	Plate Assembly — Engine Rear
32	9A424	Gasket — Manifold Rear
33	9A425	Gasket — Manifold Front
34	9439	Gasket — Intake Manifold to Cylinder Head
35	9430	Manifold — Exhaust (RH)
36	9F485	Fitting — Exhaust Recirculating Valve
37	9D477	Tube — Exhaust Recirculating Valve
38	12160	Cap — Distributor
40	12170	Clamp — Distributor
41	12A217	Adaptor — Distributor Assembly
44	12A648	Sensor Assembly — Engine Coolant Temperature
45	9K461	Lower Intake Manifold Assembly
46	8255	Gasket — Water Outlet Connection
47	8575	Thermostat — Water
48	8592	Connection — Water Outlet

(Continued)

Item	Part Number	Description
49	10884	Sensor — Water Temperature Indicator
50	12A697	Sensor Assembly — Intake Air Temperature
51	18B402	Tube — Heater Hot Water
52	9H486	Gasket — Intake Manifold Upper
53	9424	Manifold — Intake
54	9D476	Gasket — EGR Valve Assembly
55	9F483	Valve Assembly — EGR External
56	14A163	Retainer — Wiring Harness
57	9E936	Throttle Body Gasket
58	9E926	Throttle Body Assembly
59	9F670	Gasket — Air By-Pass Valve
60	9B989	Position Sensor — Throttle
61	6K780	Grommet — PCV
62	6762	Elbow — PCV
63	6582	Cover Assembly — Valve Rocker Arm (RH)
64	6A886	Extension Tube — PCV
65	389772	Clamp
66	6B890	Valve Assembly — PCV
67	9D446	Tree — Vacuum
67A	391016	Vacuum Fitting
68	9A474	Fitting and Cap Assembly — Intake Manifold
69	9J459/9S448	Solenoid Assembly
70	12A310	Coil — Assembly
71	9F793	Manifold — Fuel Injection Supply
72	9F593	Injector Assembly — Fuel

REMOVAL AND INSTALLATION (Continued)

External Engine Components, 5.8L Lightning Truck Engine



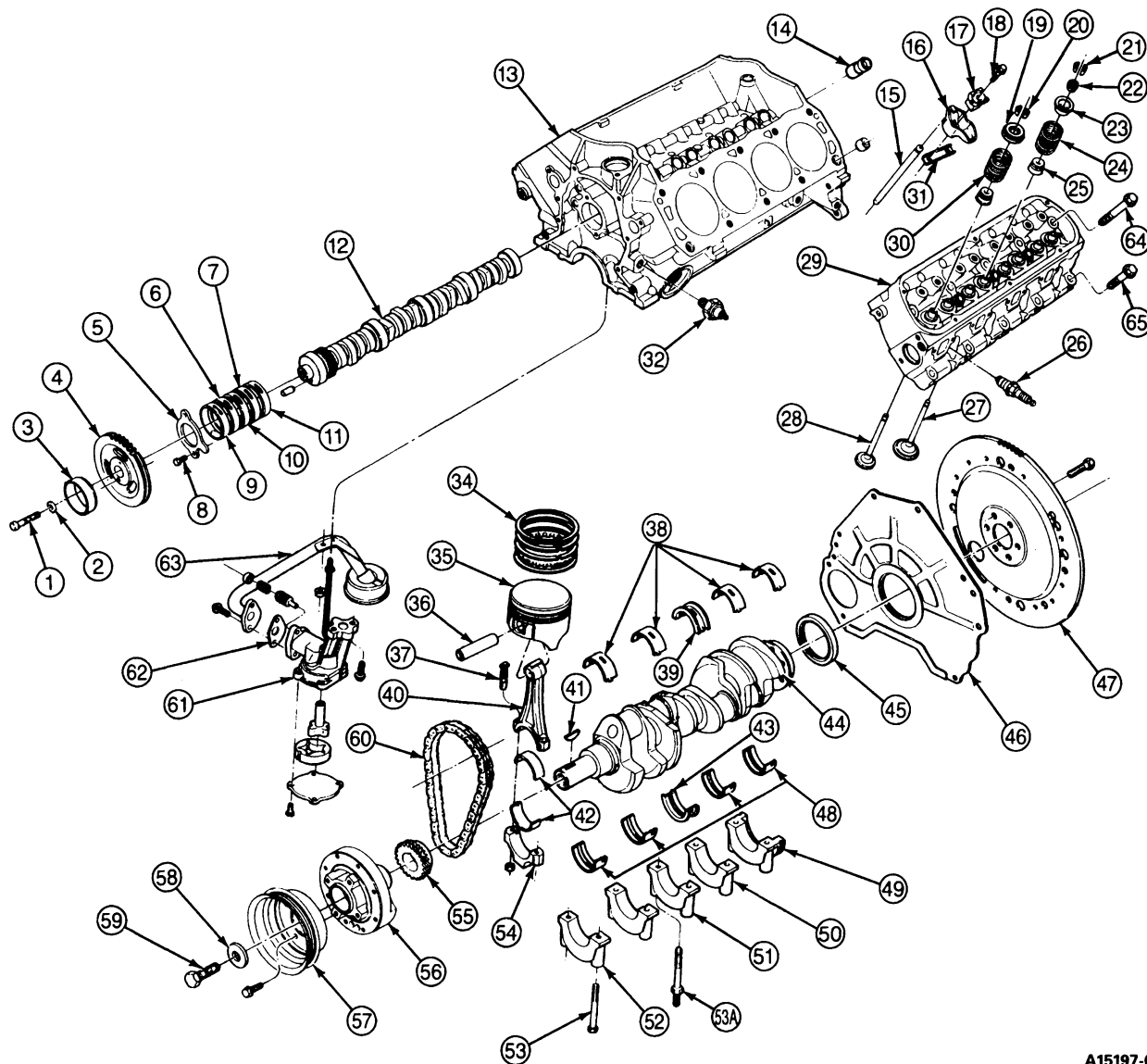
A17896-A

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	8A528	Pulley, Water Pump
2	8501	Water Pump Assembly
3	8507	Gasket, Water Pump Housing
4	6700	Seal, Cylinder Front Cover Oil
5	6K741	Oil Cooler Adaptor Assembly
6	6059	Cover Assembly, Cylinder Front
7	6020	Gasket, Cylinder Front Cover
8	6023	Pointer, Timing
9	388522-S8	Stud
10	388895	Bolt
11	12A310	Coil Assembly
12	45357	Nut
13	389772	Clamp
14	8A506	Heater Hose
15	383522	Clamp
16	12127	Distributor Assembly
17	12A217	Adaptor, Distributor Assembly
18	12106	Distributor Cap
19	12270	Clamp
20	42955	Screw
21	12280	Wire Set, Right
22	12281	Wire Set, Left
23	12A012	Coil Wire
24	9428	Exhaust Manifold, Right
25	6766	Cap, Oil Fill
26	6582	Cover, Valve Rocker Arm, Right
27	6049	Head Assembly, Cylinder
28	9439	Gasket, Lower Intake-to-Cylinder Head
29	9A425	Seal, Intake Manifold-to-Block, Front
30	9A424	Seal, Intake Manifold-to-Block, Rear
31	6750	Oil Level Indicator
32	6A008	Dowel
33	6010	Block
34	9278	Sender, Oil Pressure
35	6710	Gasket, Oil Pan
36	6A674	Reinforcement, Oil Pan, Right
37	6675	Oil Pan
38	390658	Bolt
39	6730	Plug, Oil Pan
40	6734	Gasket
41	6694	Reinforcement, Oil Pan, Left
42	6890	Insert, Oil Filter Mount
43	6881	Adaptor, Insert Oil Filter
44	6A642	Cooler, Oil
45	6894	Bolt
46	6L626	Insert, Oil Filter
47	6714	Oil Filter
48	12A087	Heat Shield
49	382951	Bolt
50	383745	Nut
51	17A084	Lifting Eye, Front
52	383745	Nut
53	389201	Stud
54	9429	Exhaust Manifold, Left
55	9448	Gasket
56	12405	Spark Plug
57	391280	Bolt
58	391279	Bolt

Item	Part Number	Description
59	6584	Gasket
60	6A513	Cover, Valve Rocker Arm, Left
61	390822	Screw
62	6051	Gasket, Cylinder Head
63	6754	Tube, Oil Level Indicator
64	6A372	Plate, Engine, Rear
65	6375	Flywheel Assembly
66	391284	Bolt
67	56124	Bolt
68	9B449	Tube Assembly
69	9A487	Valve Assembly, Exhaust Air Supply
70	9D930	Wiring Assembly, Fuel Charging
71	9F792	Fuel Rail Manifold Assembly
72	9F593	Fuel Injector Assembly
73	387564	Nut
74	56703	Bolt
75	57636	Bolt
76	8592	Housing, Thermostat
77	8575	Gasket
78	8255	Thermostat
79	12A648	Engine Coolant Temperature (ECT) Sensor
80	18A568/18559	Coolant Tree
81	18K396	Tube, Heater Water
82	8A565	Shield
83	373724	Nipple
84	391273	Elbow
85	87717	Plug
86	9425	Manifold, Upper Intake
87	390653	Bolt
88	9E434	Cover
89	390652	Screw
90	9A474	Nipple
91	9D446	Vacuum Fitting
92	391136	Bolt
93	9H486	Gasket
94	6L678	Baffle
95	10884	Water Temperature Sender
96	12A697	Intake Air Temperature (IAT) Sensor
97	388058	Bolt
98	9J447	Manifold, Lower Intake
99	373724	Nipple
100	376785	Nut
101	376838	Nut
102	9F483	EGR Valve
103	9D476	Gasket
104	6C342	Hose Assembly, PCV
105	6B892	Elbow
106	6A666	PCV Valve Assembly
107	6K780	Grommet
108	9E464	Gasket
109	9H474	EGR Spacer
110	9E933	Gasket
111	6758	Hose, Fresh Air
112	383520	Clamp
113	9F476	Hose
114	9J459	EGR Vacuum Regulator
115	9S448	Valve and Bracket Assembly
116	9E926	Throttle Body Assembly

CA17896-A

REMOVAL AND INSTALLATION (Continued)**Internal Engine Components, 5.8L MFI and 5.8L MFI Lightning Truck Engine**

A15197-C

Item	Part Number	Description
1	43002	Bolt
2	6278	Washer — Camshaft Sprocket
3	6A295	Eccentric — Camshaft Fuel Pump
4	6256	Sprocket — Camshaft
5	6269	Plate — Camshaft Thrust
6	6267	Bearing — Camshaft Front Intermediate
7	6270	Bearing — Camshaft Rear Intermediate
8	390392	Bolt — Camshaft Thrust Plate
9	6261	Bearing — Camshaft Front

(Continued)

Item	Part Number	Description
10	6262	Bearing — Camshaft Center
11	6263	Bearing — Camshaft Rear
12	6250	Camshaft
13	6010	Block Assembly
14	6500	Tappet Assembly — Valve
15	6565	Rod — Valve Push
16	6564	Arm — Valve Rocker
17	6A528	Seat — Valve Rocker Arm Fulcrum
18	390385	Bolt — Rocker Arm
19	6A516	Retainer/Rotator — Valve Spring (Exhaust)
20	6518	Key — Valve Spring Retainer (Exhaust)

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
21	6518	Key — Valve Spring Retainer (Intake)
22	6517	Sleeve — Valve Spring Retainer
23	6514	Retainer — Valve Spring (Intake)
24	6513	Spring — Valve
25	6A517	Valve Stem Seal
26	12405	Spark Plug
27	6507	Valve — Intake
28	6505	Valve — Exhaust
29	6049	Head — Cylinder
30	6513	Spring — Valve
31	6A588	Fulcrum Guide
32	9278	Gauge Assembly — Oil Pressure Engine
34	6148	Ring Set — Piston
35	6110	Piston Assembly
36	6135	Pin — Piston
37	6214	Bolt — Connecting Rod
38	6333	Bearing — Crankshaft Main
39	6337	Bearing — Crankshaft Main
40	6200	Rod Assembly — Connecting
41	394230	Key — Woodruff
42	6211	Bearing — Connecting Rod
43	6A339	Bearing — Main Thrust
44	6300	Crankshaft Assembly
45	6701	Packing Seal — Crankshaft Rear

(Continued)

Item	Part Number	Description
46	6A373	Plate — Engine Rear
47	6375	Flywheel Assembly
48	6A338	Bearing — Crankshaft Main (Except Center)
49	6325	Cap — Main Bearing
50	6327	Cap — Main Bearing
51	6330	Cap — Main Bearing
52	6329	Cap — Main Bearing
53	390602	Bolt — Crankshaft Main Bearing Cap (9 Required)
53A	—	Stud — 3/8-16-1/2-13x4.70 (1 Required)
54	6210	Cap — Main Bearing
55	6306	Sprocket — Crankshaft
56	6316	Damper Assembly — Crankshaft
57	6312	Pulley Assembly — Crankshaft
58	6378	Washer — Crankshaft Pulley Retaining
59	376706	Bolt
60	6268	Chain — Timing
61	6600	Pump Assembly — Oil
62	6625	Gasket — Oil Pump Inlet Tube
63	6622	Screen, Tube and Cover Assembly — Oil Pump
64	—	Bolt — 1/2-13x4 (10 Required)
65	—	Bolt — 1/2-13x2.5 (10 Required)

TA15197A

Crankcase Ventilation System

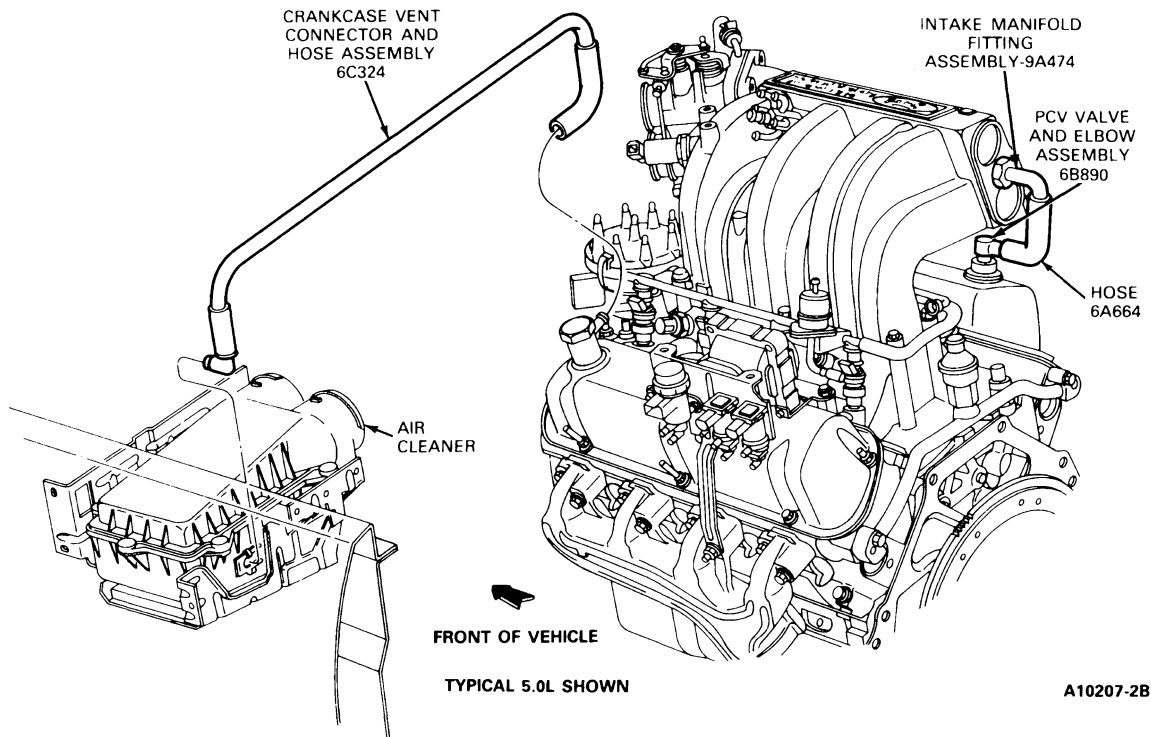
Typical crankcase ventilation system components for the various applications are shown. **Any modifications of the system prior to the first sale and registration of the vehicle is subject to Federal (U.S.A.) law, and to the penalties under the laws of some states thereafter.**

2. Remove the air cleaner and / or associated parts and intake duct assembly.
3. Disconnect the crankcase vent tube from the rear of upper intake manifold.

For installation, follow removal steps in reverse order.

Crankcase Vent Hose Assembly**Removal and Installation**

1. Disconnect crankcase vent hose from left rocker cover fill tube nipple.

REMOVAL AND INSTALLATION (Continued)**Non-A/C and Non-Super Cooling, Typical 5.0L Shown****A/C and Super Cooling****Removal and Installation**

1. Disconnect the crankcase vent front hose from the air cleaner.
2. Remove the air cleaner and/or associated parts and intake duct assembly. If so equipped, disconnect the oil filler pipe hose from the left rocker arm cover.
3. Disconnect the crankcase vent rear hose from the rear of the upper intake manifold.

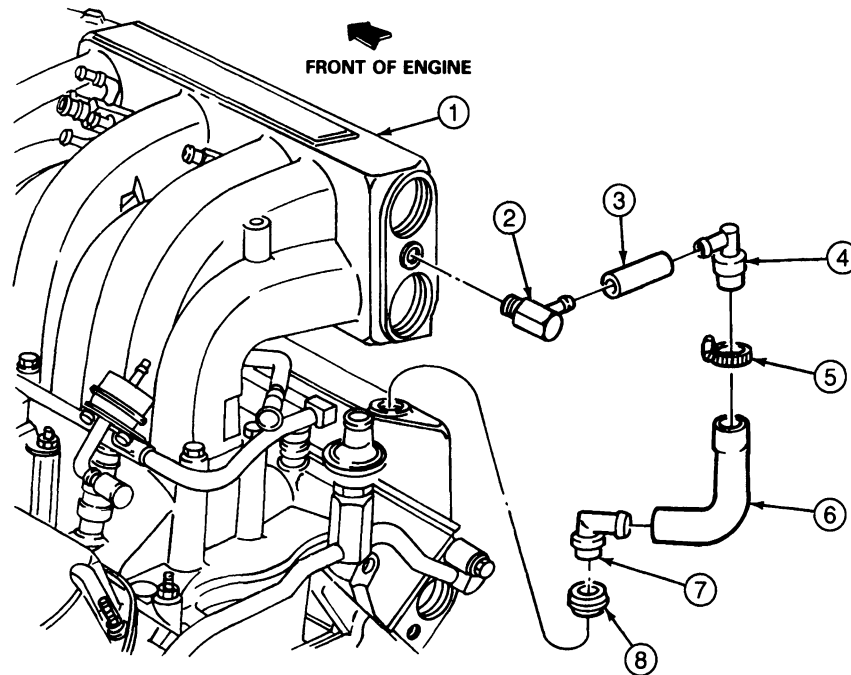
For installation, follow removal procedures in reverse order.

1. On E-150-250-350 vehicles, remove inside engine cover.
2. Loosen clamp and pull PCV valve from both hoses.
3. Inspect hoses for cracks and hardening and replace if necessary.

For installation, follow removal procedures in reverse order.

PCV Valve and Hoses**Removal and Installation**

NOTE: On 5.0L engines, the PCV valve is located in a grommet in the right valve cover. To replace, simply remove hose from valve, pull valve from grommet and install new valve. Reinstall hose to valve.

REMOVAL AND INSTALLATION (Continued)**PCV Valve and Hoses, 5.8L Engine**

A15804-A

Item	Part Number	Description
1	9424	Upper Intake Manifold
2	9A474	Intake Manifold Fitting Assembly Apply Sealer D8AZ-19554-A (ESE-M4G194-B) to Threads. Torque to 8 to 11 N·m (6-8 Ft-Lb). Advance to Position Shown. Do Not Back Up.

(Continued)

Item	Part Number	Description
3	381188	Hose
4	6A666	Valve (Positive Crankcase Ventilation)
5	8287	Clamp
6	6A666	Hose
7	6762	Elbow
8	6K780	Grommet

TA15804A

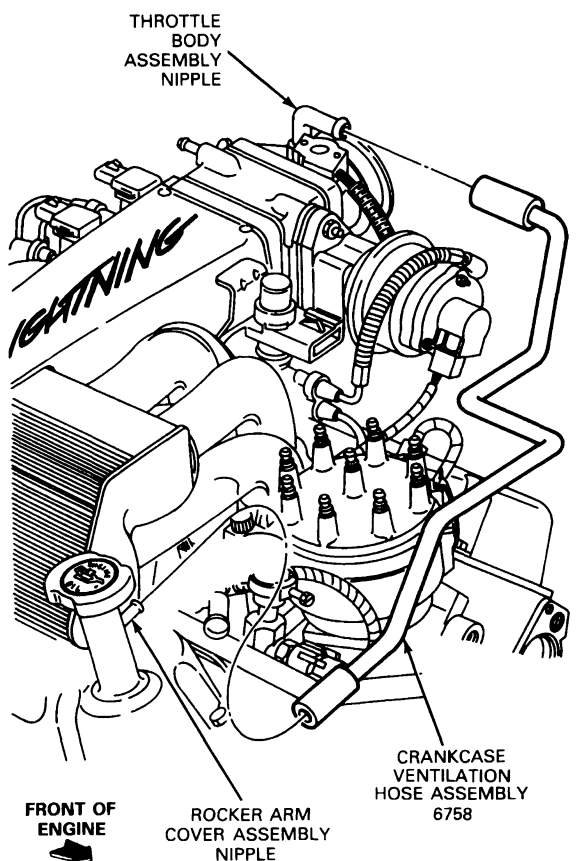
5.8L Lightning Truck Engine**Removal and Installation**

1. Disconnect crankcase vent hose from right rocker arm cover assembly nipple and from throttle body assembly nipple.

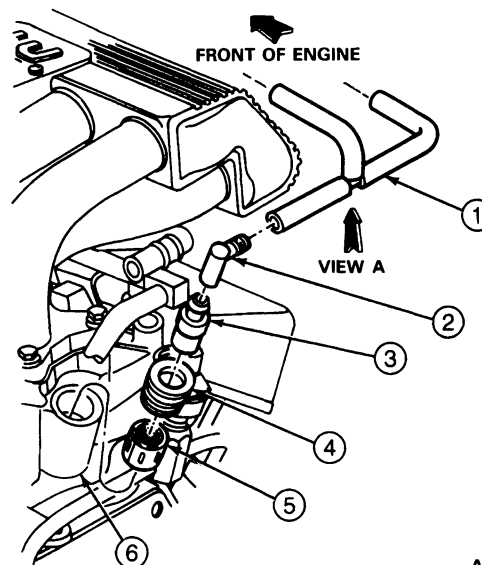
REMOVAL AND INSTALLATION (Continued)

2. Install hose assembly to throttle body nipple and to right rocker arm cover assembly nipple. Make sure hose is properly routed and that no kinks are present. Also make sure that hose ends are fully seated onto nipples.

NOTE: Removal of the PCV valve may require removal of the upper intake manifold. Refer to Section 03-04D.



A17839-A



A17866-A

Item	Part Number	Description
1	6C342	Hose Assembly
2	6B892	Elbow
3	6A666	PCV Valve
4	6K780	Grommet
5	6A631	Element
6	9K461	Manifold, Lower Intake

TA17866A

Electronic Fuel Injection

Refer to Section 03-04A for removal and installation of MFI components.

Engine Front Mounts

The front mounts are located on each side of the cylinder block. The procedures given apply to either a right or left installation. However, a sheet metal shield on the left side only is used on F-Series trucks.

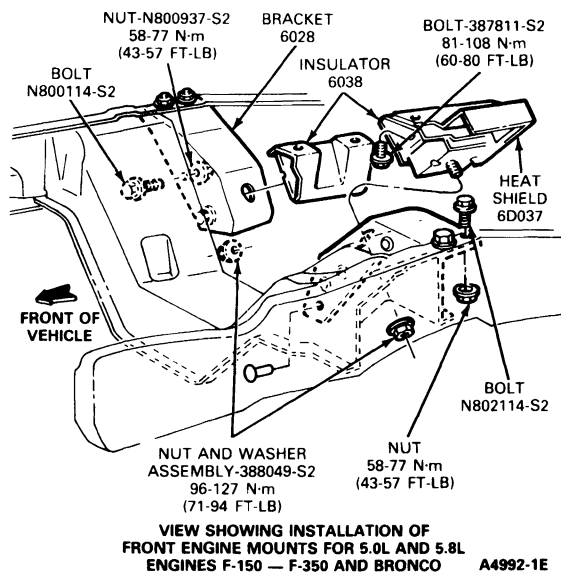
F-150-250-350 and Bronco**Removal**

1. Remove the bolts attaching the fan shroud to the radiator and position the shroud over the fan.
2. Remove the nut and washer attaching the support insulator to the chassis bracket.
3. Raise the engine.
4. Remove the bolts and lockwashers attaching the support insulator to the cylinder block and remove the insulator and heat shield (left side only).

REMOVAL AND INSTALLATION (Continued)

Installation

1. Position the support insulator and heat shield (left side only) to the cylinder block and install the attaching bolts and lockwashers loosely.
2. Lower the engine, guiding the support insulator stud into the support bracket. Tighten the insulator-to-engine bolts to 68-94 N·m (50-70 ft-lb).
3. Install the insulator-to-chassis bracket nut and washer. Tighten the nut to 88-115 N·m (65-85 ft-lb).
4. Install the fan shroud attaching bolts.



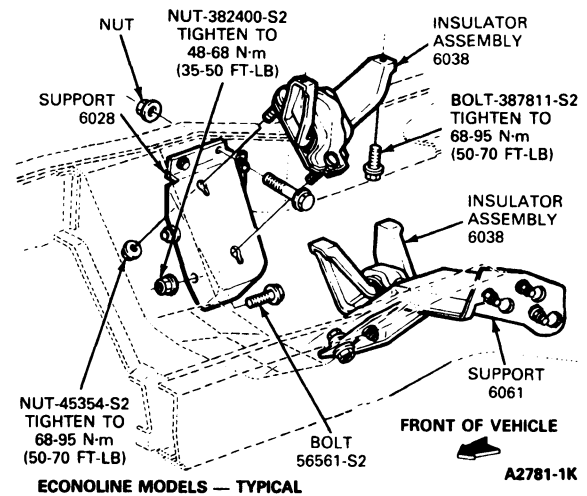
E-150-250-350

Removal

1. Remove fan shroud bolts. Remove the insulator-to-support nuts.
2. Position transmission jack under engine assembly. Lift engine assembly and then remove starter. Refer to Section 03-06A.
3. Remove insulator-to-engine bolts and alternator splash shield. Remove the insulators.

Installation

1. Clear threaded holes in engine block of debris using a 7 / 16-14 bottoming tap.
2. Install insulators to engine using **new** bolts. Tighten to 68-95 N·m (50-70 ft-lb).
3. Install starter. Refer to Section 03-06A. Then, lower the engine assembly. Move transmission jack out of the way.
4. Replace the insulator-to-support nuts and tighten to 68-95 N·m (50-70 ft-lb). Install fan shroud and bolts.



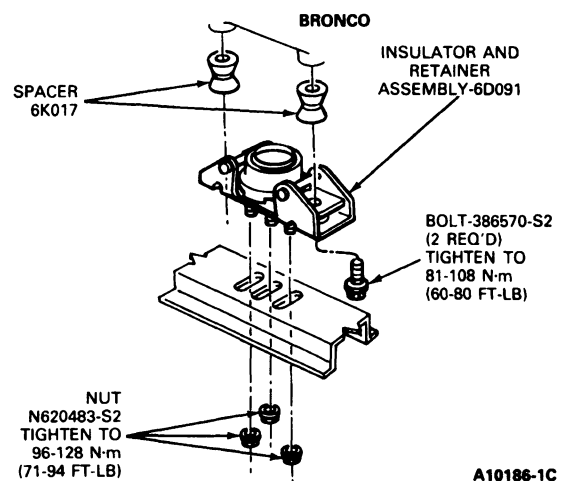
Engine Rear Mounts

The procedures apply to F-150-250-350 and Bronco and E-150-250-350 center mount vehicles.

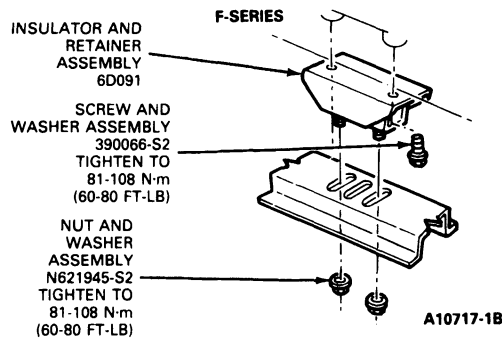
F-150-250-350 and Bronco

Removal and Installation

1. Remove the support insulator-to-crossmember attaching nuts.
2. Raise the transmission with a floor jack to provide clearance and remove the two bolts, insulator and spacers.



REMOVAL AND INSTALLATION (Continued)

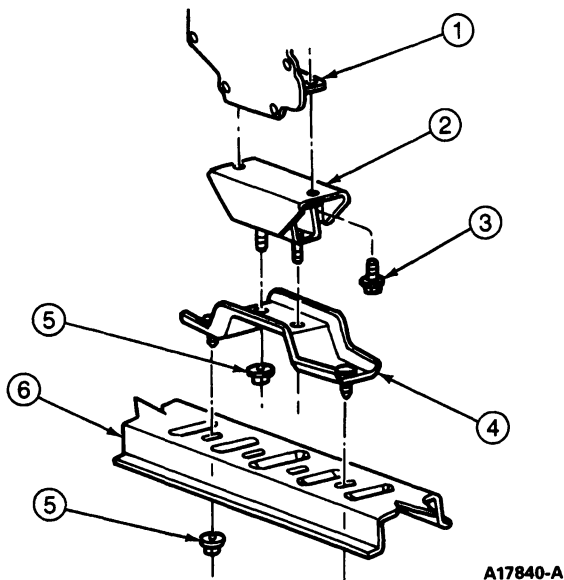


For installation, follow removal procedures in reverse order. Tighten bolts to 81-108 N·m (60-80 ft-lb). Tighten nuts to 68-95 N·m (50-70 ft-lb).

5.8L Lightning Engine

1. Position a transmission jack under the transmission and remove the bolts that attach the insulator and retainer assembly to the transmission.
2. Remove the nuts that attach the insulator and retainer assembly to the adaptor.
3. Raise the transmission up just enough to allow the removal of the insulator and retainer assembly and remove the assembly.
4. If required, remove the nuts that attach the adaptor to the crossmember and remove the adaptor.

For installation, follow removal steps in reverse order. Tighten bolts and nuts to 80-110 N·m (59-81 ft-lbs).



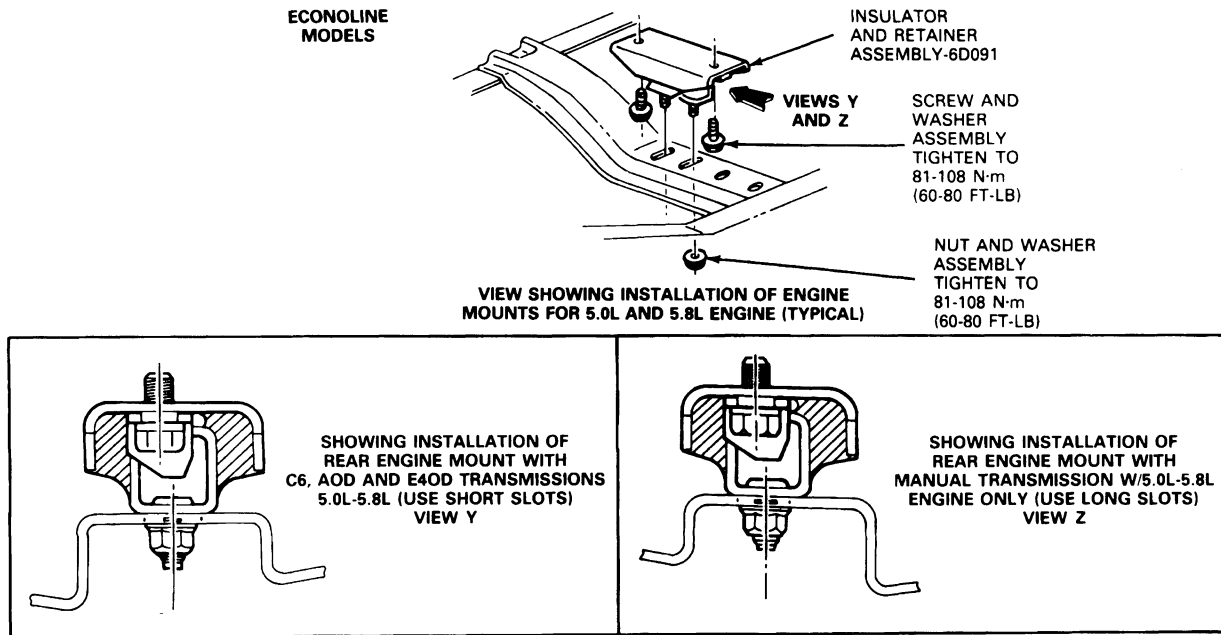
Item	Part Number	Description
1	7005	E4OD Transmission (Reference)
2	6D091	Insulator and Retainer Assembly
3	390066-S2	Screw and Washer, 1/2-13 x 1.25 80-110 N·m (59-81 Ft-Lb)
4	7108	Transmission Support Bracket
5	N621945-S2	Nut and Washer, M12-1.75 80-110 N·m (59-81 Ft-Lb)
6	5060	Support (Crossmember)

E-150-250-350**Removal and Installation**

CAUTION: On 138-inch wheel base vehicles, first remove the fuel reservoir to eliminate any part damage due to removal of rear transmission support crossmember. Refer to Section 10-01A.

1. Raise the vehicle on a hoist.
2. Remove the insulator support nuts securing the rear insulator support to the frame crossmember.
3. Raise the transmission with Transmission Jack, Rotunda 066-00017 or equivalent, so that the insulator support clears the frame.
4. Remove the insulator support bolts securing the rear insulator support to the transmission, then remove the insulator.

For installation, follow removal steps in reverse order. Tighten all hardware to 68-95 N·m (50-70 ft-lb).

REMOVAL AND INSTALLATION (Continued)**Engine Mount, Installation, Econoline**

A6536-E

Oil Pan**F-150-250-350 and Bronco****Removal**

1. Remove the bolts attaching the fan shroud to the radiator and position the shroud over the fan.
2. Remove the upper intake manifold. Refer to Section 03-04A.
3. Remove the nuts and lockwashers attaching the engine support insulators to the chassis bracket.
4. Disconnect the oil cooler line at the left side of the radiator if equipped with an automatic transmission.
5. Remove exhaust system. Refer to Section 09-00.
6. Raise the engine and place wood blocks securely under the engine supports.
7. Drain the crankcase.
8. Support transmission with jack stand and remove transmission crossmember.
9. Remove the oil pan attaching bolts and lower the oil pan onto the crossmember.
10. Remove the two bolts attaching the oil pump screen and cover assembly to the oil pump. Remove nut attaching oil pump screen and cover assembly to the number 3 main bearing cap stud. Lower the screen and cover assembly into the oil pan.
11. Remove the oil pan from the vehicle.

Installation

1. Clean oil pan, inlet tube and gasket surfaces. Inspect the gasket sealing surface for damages and distortion due to overtightening of the bolts. Repair and straighten as required.
2. Position a new oil pan gasket to the cylinder block.
3. Position the oil pickup tube and screen to the oil pump, and install the lower attaching bolt and gasket loosely. Install nut attaching oil pump pickup tube to number 3 main bearing cap stud.
4. Install the upper pickup tube bolt. Tighten the pickup tube bolts to specifications.
5. Position oil pan and reinforcements in place. Install and alternately tighten all bolts (except for the four nearest the crankshaft) to 9-14 N-m (84-120 in-lb). Tighten four remaining bolts to 16-24 N-m (12-18 ft-lb). Refer to the following illustration.
6. Install the transmission crossmember and remove jack stand.
7. Raise the engine and remove the wood blocks.
8. Lower the engine and install the insulator-to-chassis bracket nuts and washers. Tighten the nuts to 73-100 N-m (54-74 ft-lb).
9. Install the exhaust system. Refer to Section 09-00.
10. If equipped with an automatic transmission, connect the oil cooler line at the radiator.

REMOVAL AND INSTALLATION (Continued)

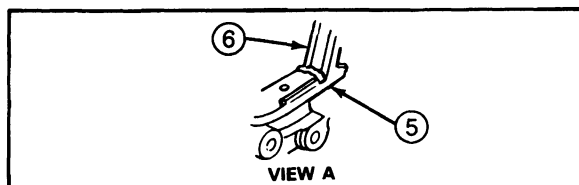
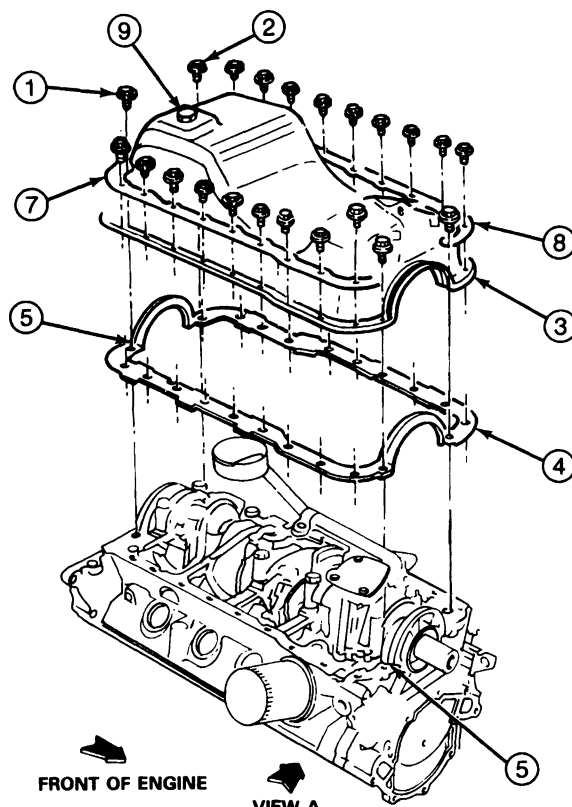
11. Install the upper intake manifold. Refer to Section 03-04A.
12. Install the fan shroud attaching bolts.
13. Fill the crankcase with the proper grade and quantity of engine oil. Install the oil dipstick. Start the engine and operate it until it reaches normal operating temperature, then check for leaks.

E-150-250-350**Removal**

1. Remove air filter assembly and /or associated parts and disconnect battery ground cable.
2. Drain coolant and remove upper radiator hose.
3. Remove fan shroud and fan.
4. Remove oil filler tube.
5. Disconnect power steering hose from steering gear.
6. Remove oil dipstick and tube.
7. Disconnect junction block from bracket.
8. If equipped, disconnect auxiliary heater hoses from engine.
9. Remove inside engine cover and remove upper intake manifold as outlined in Section 03-04A.
10. Raise vehicle.
11. Drain oil pan.
12. Remove exhaust pipe-to-manifold bolts, exhaust pipe-to-muffler clamp, and muffler support bolt.
13. Disconnect heated oxygen sensor (H02S)(9F472) and remove exhaust pipe and front catalytic converters.
14. Remove four engine mount retaining nuts.
15. Remove starter wiring clip.
16. Raise engine four inches and block.
17. Remove oil pan retaining screws and lower pan onto crossmember.
18. Remove oil pump retaining bolts and lower pump into oil pan.
19. Remove oil pan and oil pump intermediate shaft.
20. Lift oil pump out of pan.

Installation

1. Clean oil pan and cylinder block gasket surfaces. Inspect for damage to sealing surfaces and distortion of pan from over-tightening bolts. Repair and straighten as required.
2. Apply silicone rubber D6AZ-19562-BA (ESE-MRG 195-A) in two places at front cover, two places on flange, and two places on gasket at rear main bearing cap-to-block seam as shown and put gasket into place on block.



A13396-D

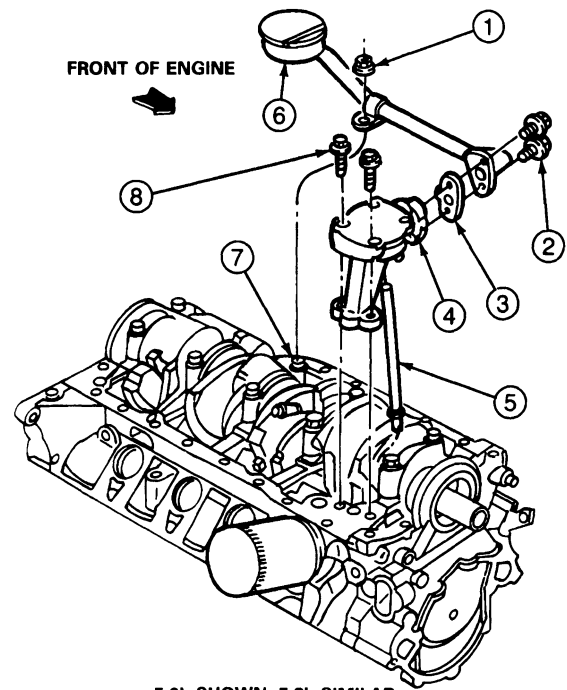
Item	Part Number	Description
1	390657	Bolt 5/ 16-18 x 1.12 16-24 N-m (12-18 Ft-Lb)
2	390658	Bolt 1/4-20 x .94 9-14 N-m (80-124 In-Lb)
3	6675	Oil Pan Assembly
4	6710	Gasket, Oil Pan
5	—	Apply Silicone Rubber D6AZ-19562-BA (ESE-M4G195-A) Sealer (2 Places)
6	6B041	Front Cover
7	6694	Reinforcement, Left Side
8	6A674	Reinforcement, Right Side
9	6730	Drain Plug, 20-33 N-m (15-25 Ft-Lb)

TA13396A

3. Set oil pump in place in oil pan.
4. Put oil pump intermediate shaft into place and position oil pan on front crossmember.

REMOVAL AND INSTALLATION (Continued)

5. Make sure intermediate shaft is properly seated and install oil pump and retaining bolts. Tighten oil pump bolts to 30-43 N·m (22-32 ft-lb).
6. Position oil pan and reinforcements in place. Install and alternately tighten all bolts (except for the four nearest the crankshaft) to 9-14 N·m (84-120 in-lb). Tighten four remaining bolts to 16-24 N·m (12-18 ft-lb). Refer to the following illustration.
7. Install starter wiring clip.
8. Raise engine, remove blocks, and lower engine onto mounts.
9. Install engine mount retaining nuts and tighten.
10. With help of assistant, install exhaust pipe and catalytic converters. Tighten exhaust pipe-to-manifold nuts to 33-49 N·m (24-36 ft-lb).
11. Connect heated oxygen sensor sensor.
12. Lower vehicle.
13. Install upper intake manifold, Section 03-04A.
14. Install inside engine cover.
15. If equipped, connect auxiliary heater hoses.
16. Connect junction block to bracket.
17. Install oil dipstick and tube.
18. Connect power steering hose to steering gear.
19. Install oil filler tube.
20. Install fan shroud and fan.
21. Install upper radiator hose.
22. Fill cooling system and engine oil.
23. Install air filter assembly and/or associated parts.
24. Start engine, bleed power steering system and check for leaks.



Item	Part Number	Description
1	33771	Nut 3/8-16 30-43 N·m (22-32 Ft-Lb)
2	391378	Screw and Washer 5/16-18 x 1.13 16-24 N·m (12-18 Ft-Lb)
3	6625	Gasket
4	6600	Oil Pump
5	6A618	Intermediate Driveshaft
6	6622	Oil Pump Screen and Cover Assembly (Typical)
7	—	Third Main (Reference)

TA 13397A

Oil Pump, F-150-250-350 and Bronco

NOTE: On E-150-250 5.0L (302 CID) V-8 engine vehicles, the oil pump and oil pan must be removed and installed together. Refer to the E-150-250-350 Oil Pan Removal and Installation procedures.

Removal

1. Remove the oil pan and related parts as outlined.
2. Remove the oil pump screen and cover assembly.
3. Remove the oil pump attaching bolts and intermediate driveshaft.

Installation

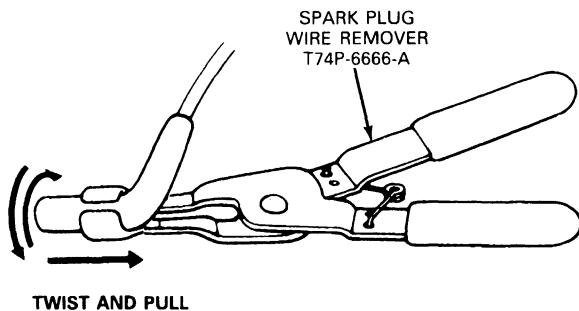
1. Prime the oil pump by filling the inlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.
2. Position the intermediate driveshaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.
3. With the stop properly positioned, insert the intermediate driveshaft into the oil pump. Install the pump and shaft as an assembly. **Do not attempt to force the pump into position if it will not seat readily. The driveshaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate driveshaft into a new position.** Tighten the oil pump attaching screws to 30-43 N·m (22-32 ft-lb).

REMOVAL AND INSTALLATION (Continued)

4. Clean the oil pump screen and cover assembly. Position assembly in place with a new gasket. Install attaching bolts and tighten to 16-22 N·m (12-18 ft-lb).
5. Install the oil pan and related parts as outlined.

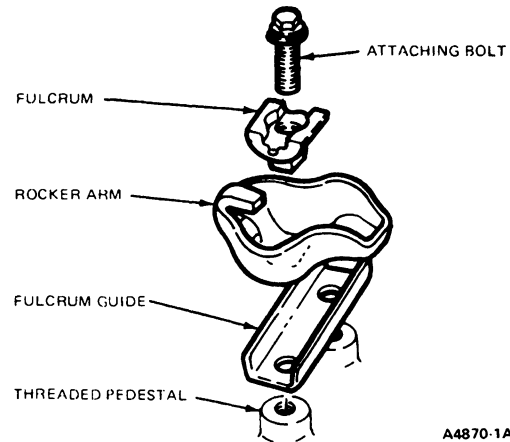
Valve Rocker Arm Cover and Rocker Arm**Removal**

1. Remove air cleaner and intake duct assembly.
2. Remove crankcase ventilation hose assembly.
3. Remove lifting eye for right rocker cover removal.
4. Remove lifting eye from left exhaust manifold for left rocker cover removal (5.8L Lightning only).
5. Remove oil filler pipe and inside engine cover (E-150-250-350).
6. If equipped with air conditioning, remove drive belt and compressor-to-bracket bolts and position compressor out of way (all except 5.8L Lightning).
7. Disconnect spark plug wires from spark plugs by grasping, twisting and pulling the molded cap using Spark Plug Wire Remover T74P-6666-A. Position wires out of way.



B3496-E

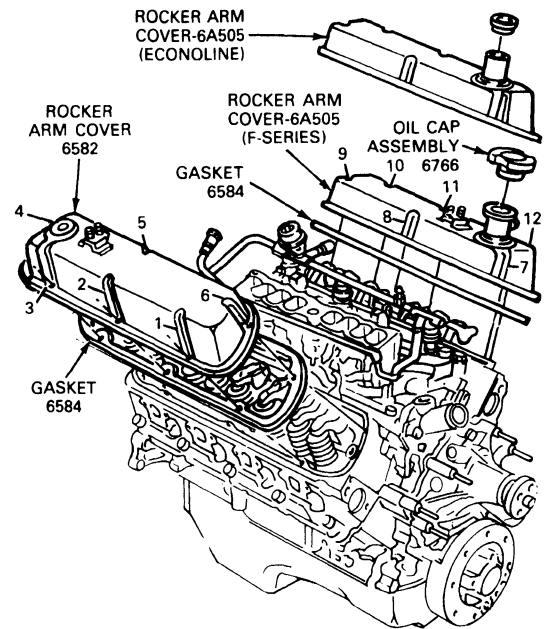
8. Remove upper intake manifold. Refer to Section 03-04A (5.8L Lightning only).
9. Remove nuts securing wiring harnesses to rocker covers, and position wiring harnesses out of way.
10. Remove vacuum harness and electrical connectors to vacuum solenoids mounted on rocker arm covers and position out of way (all except 5.8L Lightning).
11. Disconnect thermactor air supply hoses from canister or the chassis and position out of way.
12. Remove rocker cover attaching bolts and remove rocker covers.
13. Remove rocker arm attaching bolt, fulcrum, rocker arm and fulcrum guide.



A4870-1A

Installation

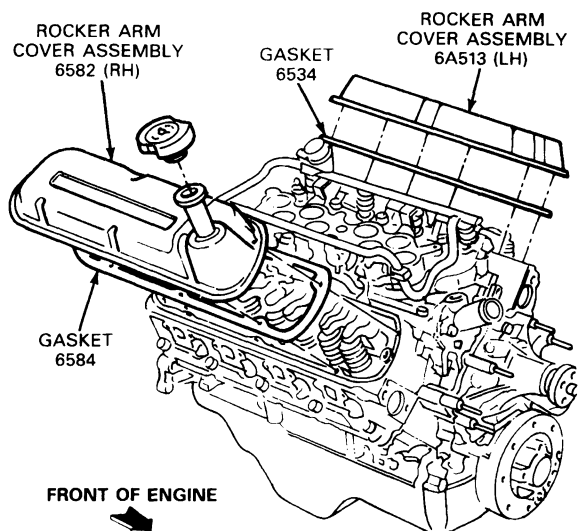
1. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the top of the valve stem, the fulcrum and socket.
2. Install the fulcrum guide, valve rocker arm, fulcrum and bolt. Tighten to 24-34N·m (18-25 ft-lb).
3. Clean and inspect gasket surfaces. Inspect the gasket sealing surface for damage and distortion due to overtightening of the bolts. Repair and straighten as required. Place the new gaskets in the covers, making sure that the tabs of the gasket engage the notches provided in the cover.

E-Series, F-Series Except 5.8L Lightning

A15264-A

REMOVAL AND INSTALLATION (Continued)

5.8L Lightning



A17897-A

4. Position the cover(s) on the cylinder head(s). Install the cover bolts and tighten to 16-20 N·m (11-14 ft-lb). Wait two minutes, then tighten bolts again to same specification.
5. Install vacuum harness bracket and attaching nut, if removed. Tighten to 17-24 N·m (12-18 ft-lb).
6. Connect vacuum harness and electrical connectors to the vacuum solenoids on the rocker covers (all except 351 BTE).
7. Position wiring harnesses over rocker covers and secure onto rocker cover studs and install attaching nuts.
8. Install upper intake manifold. Refer to Section 03-04A (5.8L Lightning).
9. Connect thermactor air supply hose.
10. Position and connect spark plug wires to spark plugs.
11. Position air conditioning compressor and install compressor-to-bracket bolts, if equipped.
12. Install drive belt. Refer to engine compartment belt routing decal.
13. Install inside engine cover and oil filler pipe (E-150-250-350).
14. Reinstall lifting eye(s).
15. Install crankcase vent hose assembly.
16. Install air cleaner and intake tube assembly.
17. Check and fill oil level as required. Check and fill cooling system as required. Start engine and check for leaks.

Valve Spring, Retainer and Stem Seal

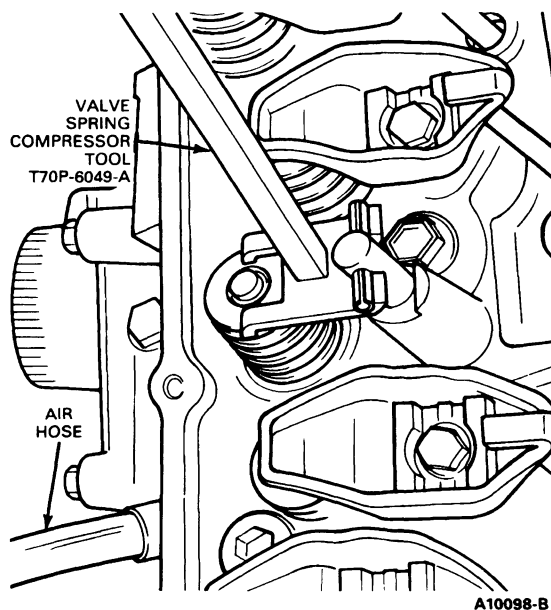
Removal

Broken valve spring or damaged valve stem seals and retainers may be replaced without removing the cylinder head, provided damage to valve or valve seat has not occurred.

1. Remove rocker arm cover as outlined.
2. Remove the applicable spark plug and bring the piston to the top of the bore to prevent accidental loss of the valve into the cylinder.
3. Remove the valve rocker arm fulcrum bolts, fulcrums, valve rocker arms and push rods from the applicable cylinder.
4. Install an air line with an adapter in the spark plug hole and apply air pressure to the cylinder.

NOTE: Failure of the air pressure to hold the valve(s) in the closed position is an indication of valve seat damage and requires removal of the cylinder head.

5. Install the fulcrum bolt and position Valve Spring Compressor Tool T70P-6049-A as shown. Compress the valve spring and remove the keys, sleeve, retainer or rotator and valve spring.



A10098-B

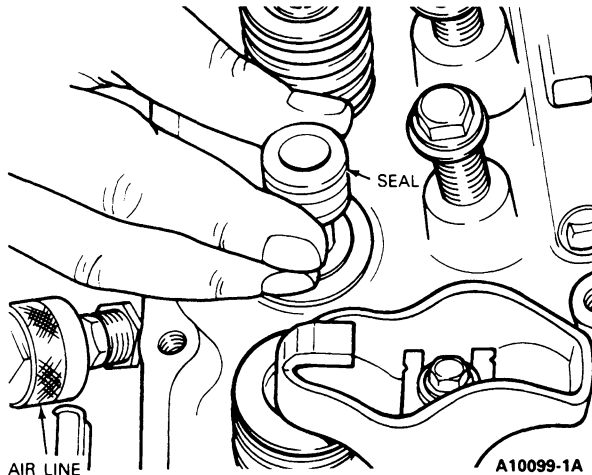
6. Remove and discard the valve stem seal.
7. **If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to fall into the cylinder.** A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.

REMOVAL AND INSTALLATION (Continued)

8. Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head. Refer to Section 03-00 for repair procedures.

Installation

1. If the condition of the valve proved satisfactory, lubricate the valve stem with engine oil of quality recommended in the Owner Guide. Hold the valve in the closed position and apply air pressure within the cylinder.
2. Install a new valve stem seal on the valve guide. Seal must be bottomed on guide. Place the spring in position over the valve and install the valve spring retainer and sleeve. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and fulcrum bolt.



3. Lubricate the push rod ends with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C 159-A) or equivalent and install the push rod. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C 159-A) or equivalent to the tip of the valve stem.
4. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C 159-A) or equivalent to the rocker arms and fulcrum. Install the valve rocker arms, fulcrum and fulcrum bolts. Tighten to 24-34 N·m (18-25 ft·lb).

5. Turn off the air and remove the air line and adapter. Install the spark plug and connect the spark plug wire.
6. Clean and install the rocker arm cover as described in this section.

Intake Manifold**Removal and Installation**

NOTE: For 5.0L and 5.8L upper and lower intake manifold removal and installation, refer to Section 03-04A.

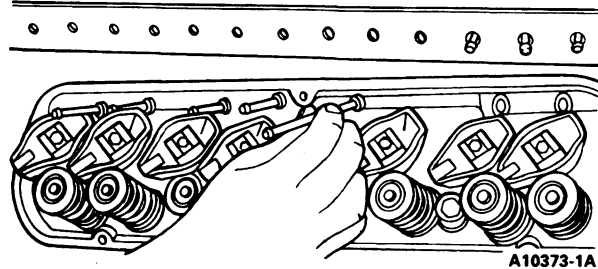
For 5.8L Lightning engine upper and lower intake manifold removal and installation, refer to Section 03-04D.

Tappet

Before replacing a hydraulic tappet for noisy operation, verify the noise is not caused by improperly adjusted valve-to-rocker arm clearance or by worn rocker arms or push rods.

Removal

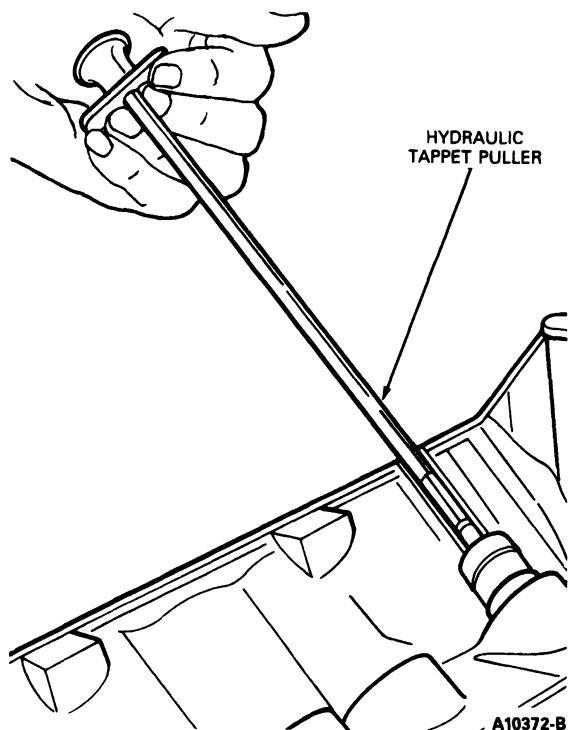
1. Remove the intake manifold and related parts. Refer to Section 03-04A or 03-04D.
2. Disconnect Thermactor air supply hose at the air pump and place it out of the way.
3. Remove the valve rocker arm cover, then loosen the valve rocker arm fulcrum bolts and rotate the rocker arms to the side.
4. Remove the valve push rods in sequence so that they can be installed in their original positions.



REMOVAL AND INSTALLATION (Continued)

5. Using suitable hydraulic tappet puller, remove the tappets and place them in a rack so that they can be installed in their original bores.

If necessary to disassemble a tappet, refer to Tappet Disassembly and Assembly.

**Installation**

Tappets and bores are to be lubricated with engine oil of the quality recommended in the Owner Guide before installation.

1. Clean the external surfaces and install the tappets in the bores from which they were removed using Hydraulic Tappet Puller T70L-6500-A. If a new tappet(s) is being installed, check the new tappet(s) for a free fit in the bore in which it is to be installed. Lubricate the tappet(s) and bore(s) with recommended quality engine oil before inserting the tappet.
2. Lubricate the ends of the push rods with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent and install the push rods in their original positions. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the valve stem tip.
3. Lubricate the rocker arms and fulcrums with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent and position the rocker arms over the push rods. Tighten rocker arm fulcrum bolts to 24-33 N·m (18-24 ft-lb).
4. Install the valve rocker arm covers.
5. Reconnect Thermactor air supply hose.
6. Install the intake manifold. Refer to Section 03-04A.

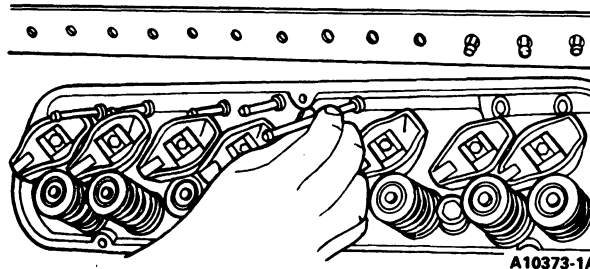
Cylinder Heads

If a cylinder head is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly, and transfer all valves, springs, spark plugs, etc., to the new cylinder head. Clean and inspect all parts, and reface the valves. Refer to Section 03-00. Check all assembly clearances before assembling the new or used parts to the new cylinder head.

Removal

1. Remove the upper and lower intake manifold. Refer to Section 03-04A.
2. Remove the rocker arm cover(s).
3. Lift tensioner and remove drive belt. Remove the ignition coil (on E-150-250-350 vehicles) and air cleaner inlet duct from the left cylinder head assembly.

If the left cylinder head is being removed, remove the air conditioning compressor / power steering bracket at the front of the cylinder head, complete with accessories. Remove oil dipstick and tube assembly and speed control bracket, if so equipped.
4. If the right cylinder head is to be removed, disconnect the alternator wiring harness and air pump hoses. Remove the three bolts attaching the alternator / air pump bracket to the cylinder head. Remove the alternator, air pump and bracket as an assembly from the engine.
5. Disconnect the exhaust manifold(s) from the muffler inlet pipe(s).
6. Loosen the rocker arm fulcrum bolts so that the rocker arms can be rotated to the side. Remove the push rods in sequence so that they may be installed in their original positions.



7. On E-150-250-350 vehicles, remove the bolts holding the Thermactor air supply manifold to the rear of the cylinder head and disconnect the hose at the air pump. Remove hose, pump valve and air supply manifold as an assembly.
8. On F-150-250-350 and Bronco vehicles, disconnect the Thermactor air supply hoses at the check valves and plug the check valve.
9. Install the cylinder head holding fixtures. Remove the cylinder head attaching bolts and lift the cylinder head off the block. Remove and discard the cylinder head gasket.

REMOVAL AND INSTALLATION (Continued)

Installation

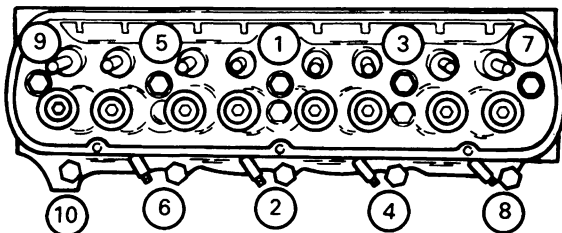
1. Clean the cylinder head, intake manifold, valve rocker arm cover and cylinder head gasket surfaces. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the cylinder head and block gasket surfaces. Refer to Section 03-00.
2. A specially treated composition gasket is used. **Do not apply sealer to a composition gasket.** Position the new cylinder head gasket over the cylinder dowels on the block. Position the cylinder head on the block and install the attaching bolts. Remove the holding fixtures.
3. The cylinder head bolts are tightened in two steps for all 5.8L engines, and in either two or three steps (torque-to-yield method) for the 5.0L engine depending on which type of head bolts are used.

- For all 5.8L engines, tighten head bolts as follows:
 - Tighten all bolts in sequence to 129-142 N·m (95-105 ft-lb).
 - Tighten all bolts in sequence to 142-152 N·m (105-112 ft-lb).

Depending on whether the head bolts are flanged hex head bolts or standard hex head bolts, follow the proper tightening procedure as follows:

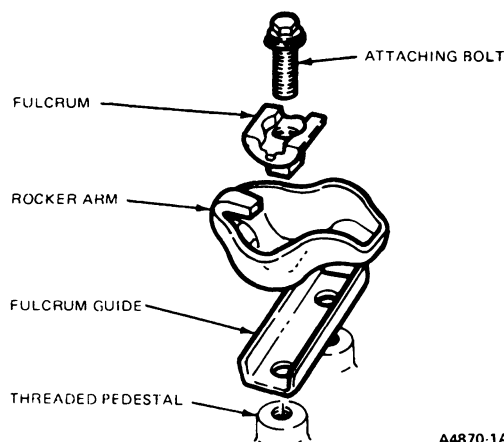
- 5.0L engine with flanged head bolts
 - Tighten all bolts in sequence to 34-47 N·m (25-35 ft-lb).
 - Tighten all bolts in sequence to 61-75 N·m (45-55 ft-lb).
 - Turn all bolts in sequence an additional 85-95 degrees.
- 5.0L engine with standard hex head bolts
 - Tighten all bolts in sequence to 75-88 N·m (55-65 ft-lb).
 - Tighten all bolts in sequence to 88-98 N·m (65-72 ft-lb).

When cylinder head bolts have been tightened following this procedure, it is not necessary to retighten the bolts after extended operation. However, the bolts may be checked and retightened if desired.



A10374-1A

4. Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod with compressed air. Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Visually check the push rods for straightness or check push rod runout with a dial indicator. Refer to Section 03-00. If runout exceeds the maximum limit at any point, discard the rod. **Do not attempt to straighten push rods.**
5. Lubricate the end of the push rods with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent and install them in their original positions. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the valve stem tips.
6. Lubricate the rocker arms and fulcrums with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent, then install the rocker arms.



A4870-1A

7. Position a new gasket(s) on the muffler inlet pipe(s), if so required. Connect the exhaust manifold(s) at the muffler inlet pipe(s). Tighten the nuts to 33-49 N·m (24-36 ft-lb).
8. If the right cylinder head was removed, install the air pump alternator bracket and accessories, ignition coil (E-150-250 vehicles) and air cleaner inlet duct on the right cylinder head. Refer to Section 03-05 to install drive belt and auto tensioner.

If the left cylinder head was removed, install the power steering and air conditioning compressor bracket, with accessories at the front of the cylinder head. Install the oil dipstick and tube assembly and speed control bracket, if so equipped.
9. Clean the valve rocker arm cover gasket surfaces. Secure the new gaskets in the covers with gasket cement to make sure of proper hole alignment. Install the valve rocker arm cover(s).
10. Install the intake upper and lower manifold and related parts. Refer to Section 03-04A.

REMOVAL AND INSTALLATION (Continued)

11. Install the Thermactor air supply manifold at the rear of the cylinder heads. Reconnect the air supply hose to the air pump (F-150), unplug the check valve and connect the Thermactor air supply hose.

Exhaust Manifolds**Removal**

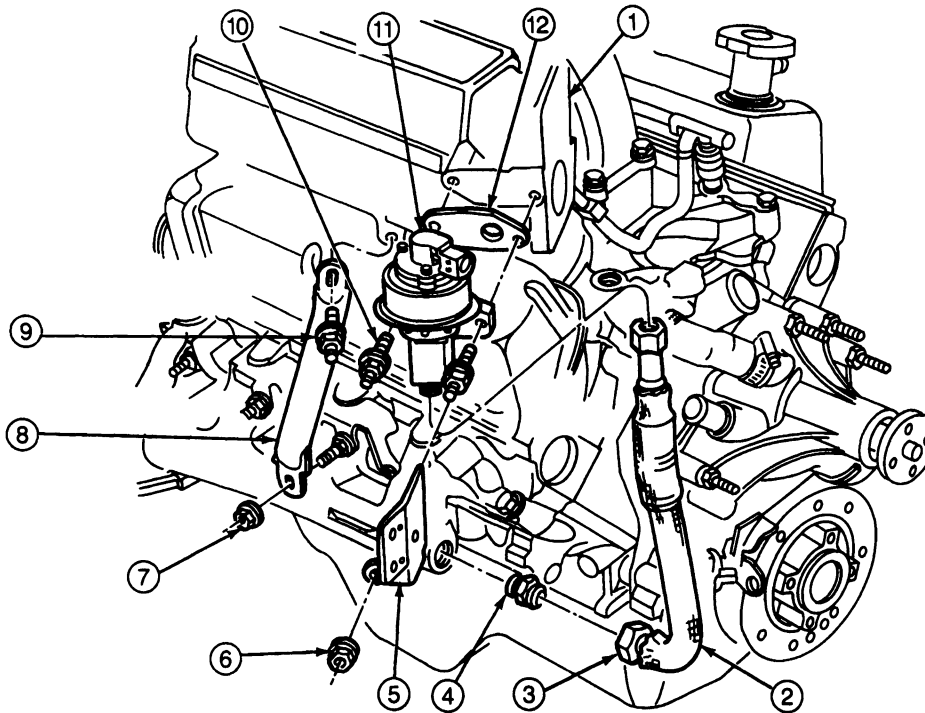
1. Raise vehicle.
2. Remove exhaust manifold-to-exhaust pipe nuts.
3. Lower vehicle.
4. On E-150-250-350 vehicles, remove inside engine cover.
5. For right hand exhaust manifold, remove air filter assembly and air intake tube.
6. Remove nuts and upper intake manifold support bracket, transmission dipstick tube bracket, engine oil dipstick tube bracket, and wire bracket.
7. Loosen tube nut securing EGR tube to exhaust manifold fitting. Disconnect EGR valve connector. Remove two nuts and wire bracket. Remove two studs, EGR valve and tube as an assembly, and gasket (5.8L only).

8. Remove nuts and spark plug heat shield.
9. Remove studs and bolts, right hand exhaust manifold, and gasket.

NOTE: Exhaust manifold fasteners vary by length and type both by location on the particular vehicle and by model. Keep track of what fasteners go in what holes.

NOTE: Bolt and stud location on 5.8L Lightning same as 5.0L / 5.8L.

10. For left exhaust manifold, remove Thermactor exhaust air supply manifold on vehicles with C6 transmission.
11. Remove nuts and front lifting eye.
12. Remove nuts and spark plug heat shield.
13. Remove studs and bolts, left exhaust manifold, and gasket.

EGR System, 5.8L Engine

A15808-A

REMOVAL AND INSTALLATION (Continued)

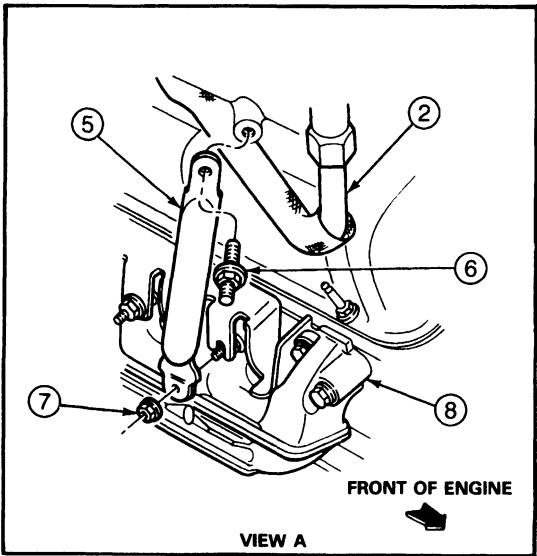
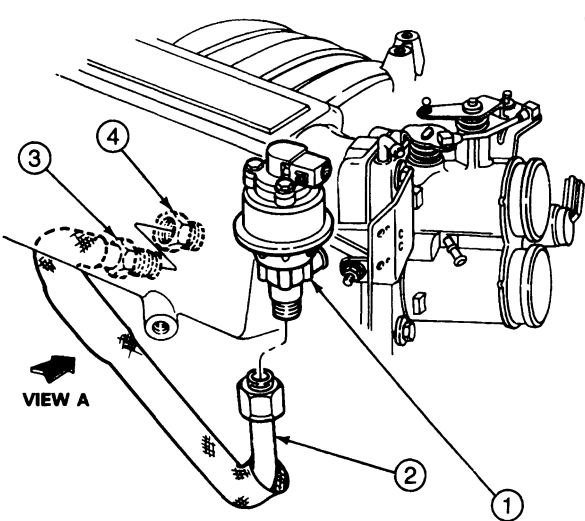
Item	Part Number	Description
1	9424	Upper Intake Manifold
2	9D477	EGR Tube Assembly
3		EGR Tube Assembly Nuts (2) 34-47 N·m (25-35 Ft-Lb)
4	9F485	Connector Fitting 54-68 N·m (40-50 Ft-Lb) (Must be installed with flanged shoulder toward exhaust manifold.)
5	14A163	Wiring Retainer

(Continued)

Item	Part Number	Description
6		Nut 5 / 16-18 16-24 N·m (12-18 Ft-Lb)
7		Nut 5 / 16-18 16-24 N·m (12-18 Ft-Lb)
8	9J444	Support
9		Stud 5 / 16-18 x 1.85 18-26 N·m (13-19 Ft-Lb)
10		Stud 5 / 16-18 x 1.85 (2) 18-26 N·m (13-19 Ft-Lb)
11	9F843	EGR Valve Assembly
12	9D476	Gasket

TA15808A

EGR System, 5.0L Engine



A16236-A

REMOVAL AND INSTALLATION (Continued)

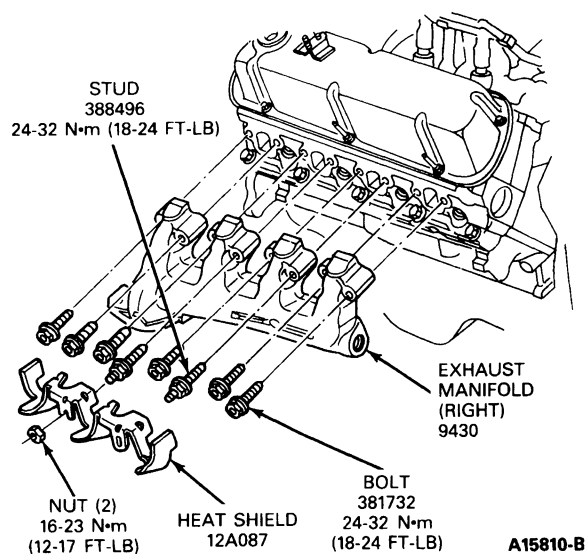
Item	Part Number	Description
1	9F483	Valve, Exhaust Gas Recirculation
2	9D477	Tube Assembly, EGR 34-47 N·m (25-35 Ft-Lb)
3	9D477	Tube Assembly, EGR 27-34 N·m (20-25 Ft-Lb)
4	N803575	Adaptor 34-47 N·m (25-35 Ft-Lb)

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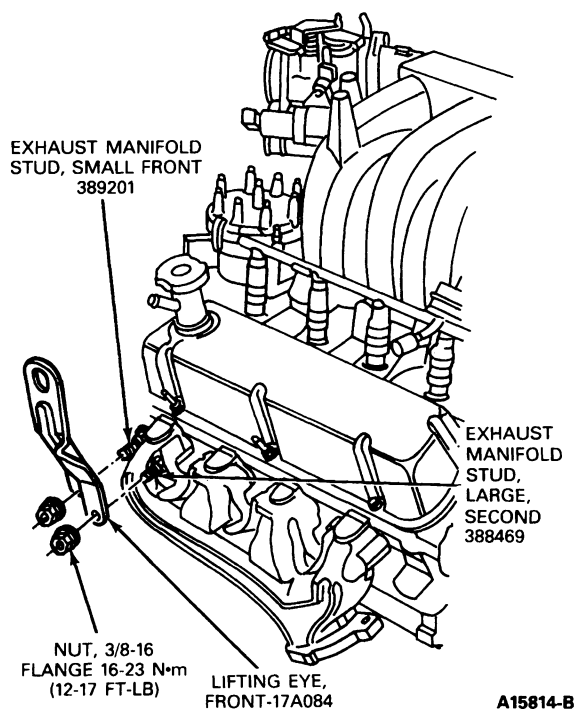
Item	Part Number	Description
5	9J444	Support
6	388377	5 / 16-18-18 x 1.85 Stud Hex Shoulder 20-27 N·m (15-20 Ft-Lb)
7	45358	3 / 8-16 Nut 16-24 N·m (12-18 Ft-Lb)
8	9430	Manifold, Exhaust

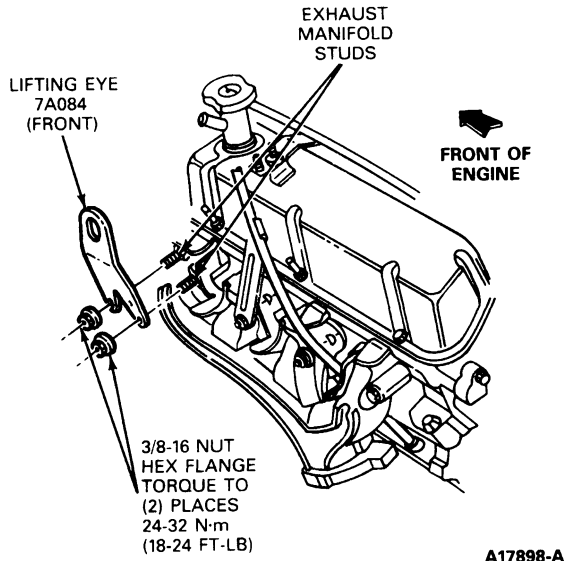
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Exhaust Manifold, 5.0L and 5.8L (5.8L Shown, 5.0L Similar)

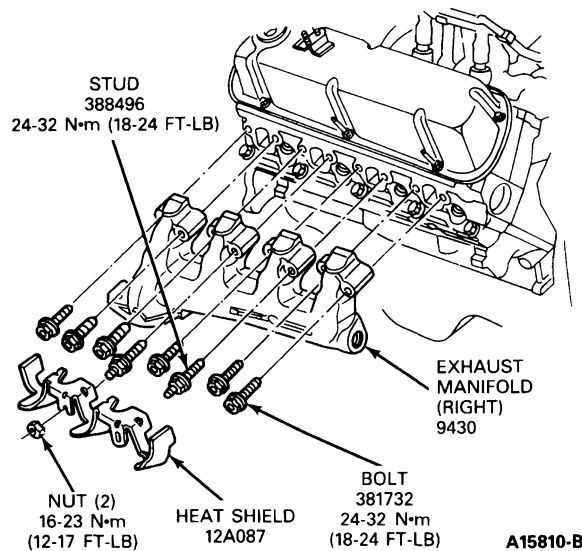


5.0L and 5.8L Front Lifting Eye



REMOVAL AND INSTALLATION (Continued)**Installation**

1. Clean mating surfaces of the exhaust manifold(s) and cylinder head(s). Clean the exhaust pipe spherical seat on the manifold(s) and the exhaust pipe(s) sealing area.
2. Inspect manifold(s) for cracks and damaged gasket surfaces. Use a straightedge to check for warped exhaust manifold cylinder head port branches. Replace unserviceable manifold(s).
3. Install new gasket, left exhaust manifold, studs, and bolts. Working from center to ends, tighten to 24-32 N·m (18-24 ft-lb).
4. Install spark plug heat shield and nuts. Torque heat shield nuts to 16-23 N·m (12-17 ft-lb).
5. Install front lifting eye and nuts. Tighten to 16-23 N·m (12-17 ft-lb).
6. Install gasket, right exhaust manifold, studs, and bolts. Working from center to ends, tighten to 24-32 N·m (18-24 ft-lb).

Exhaust Manifold, 5.0L and 5.8L (5.8L Shown, 5.0L Similar)

7. Install spark plug heat shield and tighten nuts to 16-23 N·m (12-17 ft-lb).
8. Inspect EGR tube and replace if rusted through or damaged. Install EGR tube loosely to manifold fitting. Install new gasket and valve to upper intake manifold. Tighten EGR valve studs to 18-26 N·m (13-19 ft-lb). Tighten tube-to-exhaust manifold fitting nut to 34-47 N·m (25-35 ft-lb).
9. Install wire bracket, transmission dipstick tube bracket, and upper intake manifold support bracket. Tighten nuts to 16-24 N·m (12-18 ft-lb).
10. On models with C6 transmission, install Thermactor air supply manifold. Tighten tube nuts to 20-34 N·m (15-25 ft-lb).
11. Install air filter assembly and air intake tube.
12. Raise vehicle and install new exhaust pipe-to-manifold gasket(s) and exhaust pipe(s). Tighten flange nuts to 34-52 N·m (18-24 ft-lb).
13. Lower vehicle, operate and check for leaks.

Water Pump**F-150-250-350 and Bronco****Removal**

1. Drain the cooling system. Refer to Section 03-03.
2. Remove drive belt.
3. Loosen the bolts on the fan clutch.
4. Remove the bolts securing the fan shroud to the radiator. Position the shroud over the fan.
5. Disconnect the radiator lower hose, heater hose and bypass hose at the water pump. Remove the fan, clutch and pulley. Remove the fan shroud.

REMOVAL AND INSTALLATION (Continued)

6. Remove the air conditioning compressor / power steering bracket and accessories to clear the stud bolt on the water pump housing.
7. Remove water pump attaching bolts and remove water pump from engine.

Installation

Before a water pump is installed, check it for damage. If it is damaged, replace it.

1. Remove all gasket material from the mounting surfaces of the cylinder front cover and water pump.
2. Position a new gasket, coated on both sides with Ford Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent, on the cylinder front cover; then install the pump.
3. Install the attaching bolts. Tighten bolts to 20-28 N·m (15-21 ft-lb).
4. Install the air conditioning compressor / power steering bracket over the stud bolts on the water pump and attach to cylinder head. Tighten bolts to 53-72 N·m (39-53 ft-lb). Check hoses for correct routing. For air conditioning service refer to Section 12-03. Refer to Section 11-00 for power steering service.
5. Position fan shroud over the water pump.
6. Install clutch assembly to the fan and tighten bolts to 16-24 N·m (12-18 ft-lb).
7. Position water pump pulley on hub and position the fan and clutch assembly to the water pump pulley. Install and tighten bolts to 16-24 N·m (12-18 ft-lb).
8. Install the fan shroud, radiator hose, heater hose and bypass hose.
9. Install the drive belt.
10. Fill and bleed the cooling system. Refer to Section 03-03. Operate the engine until normal operating temperatures have been reached and check for leaks.

E-150-250-350**Removal**

1. Remove the air cleaner and intake duct assembly, including the crankcase ventilation hose.
2. Drain the cooling system. Refer to Section 03-03.
3. Disconnect the radiator upper hose at the engine and lower hose at the radiator. Remove the radiator attaching bolts and nuts. Remove the radiator. Refer to Section 03-03.
4. Remove drive belt, fan, clutch and water pump pulley.

5. Disconnect heater hose and bypass hose at water pump.
6. Remove the air conditioner compressor / power steering pump bracket to clear the stud bolt on water pump housing.
7. Remove the bolts securing the water pump to the cylinder front cover. Remove the water pump.

Installation

Before a water pump is installed, check it for damage. If it is damaged, replace it.

1. Remove all gasket material from the mounting surfaces of the cylinder front cover and water pump.
2. Position a new gasket, coated on both sides with Ford Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent, on the cylinder front cover; then install the pump.
3. Install the attaching bolts and tighten to 20-28 N·m (15-21 ft-lb).
4. Connect the heater hose and bypass hose at the water pump.
5. Install the air conditioning compressor / power steering pump bracket and accessories to the cylinder head and water pump stud bolts. Tighten bolts to 53-72 N·m (39-53 ft-lb).
6. Install clutch assembly to fan and tighten bolts to 16-24 N·m (12-18 ft-lb).
7. Position water pump pulley on hub and position fan and clutch assembly to water pump. Install and tighten bolts to 16-24 N·m (12-18 ft-lb).
8. Install drive belt.
9. Install the radiator. Refer to Section 03-03. Connect lower hose at the radiator and upper hose at the engine.
10. Fill and bleed the cooling system. Refer to Section 03-03. Operate the engine until normal operating temperatures have been reached and check for leaks.
11. Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.

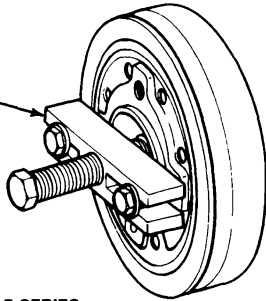
Cylinder Front Cover and Timing Chain**F-150-250-350 and Bronco****Removal**

1. Refer to Water Pump Removal in this section. Perform all steps except removal of the pump. Leave it attached to the front cover.

REMOVAL AND INSTALLATION (Continued)

2. Remove the crankshaft pulley from the crankshaft vibration damper. Remove the damper attaching bolt and washer. Install Damper Remover D80L-522-A or equivalents on the crankshaft vibration damper and remove the vibration damper.

CRANKSHAFT
DAMPER
REMOVER
D80L-522-A



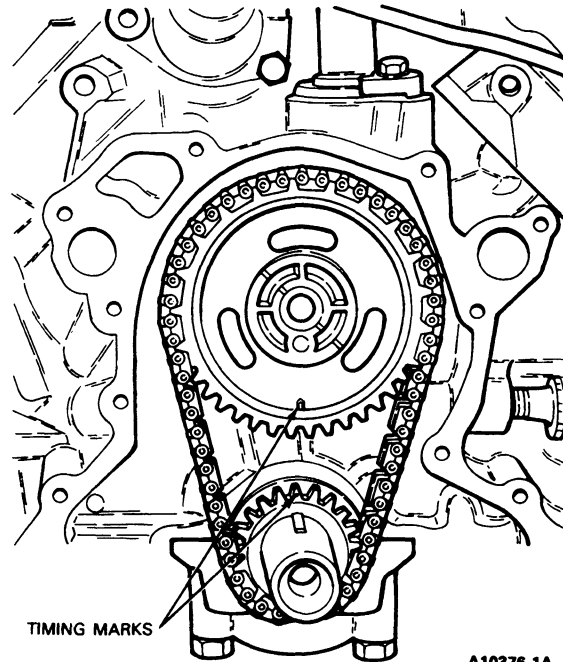
DAMPER REMOVAL — F-SERIES
AND BRONCO

A10375-E

3. Remove the oil pan-to-cylinder block front cover attaching bolts. Use a thin-bladed knife to cut the oil pan gasket flush with the cylinder block face prior to separating the cover from the cylinder block. Remove the cylinder front cover and water pump as an assembly.
4. Discard the cylinder front cover gasket.
5. Check the timing chain deflection. Refer to Section 03-00. If deflection exceeds specifications (12.7mm [0.50 inch]), replace the chain and sprockets.
6. Crank the engine until the timing marks on the sprockets are positioned as shown.
7. Remove the camshaft sprocket capscrew, washers and fuel pump eccentric. Slide both sprockets and the timing chain forward, and remove them as an assembly.

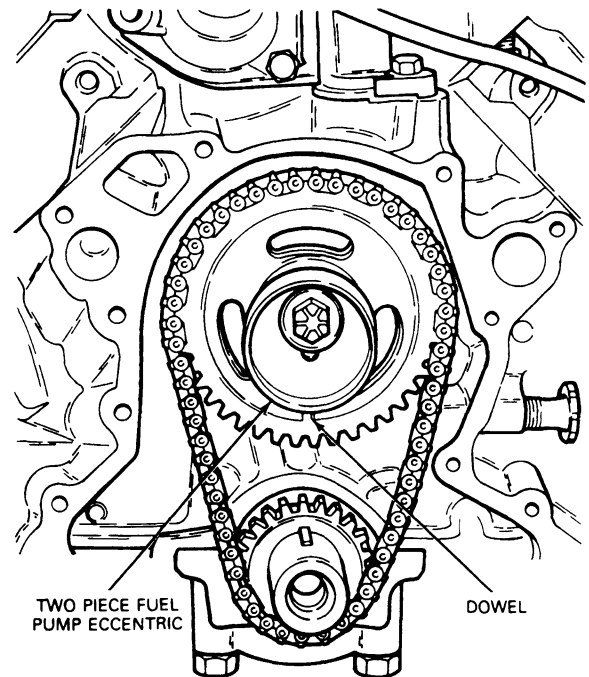
Installation

1. Position the sprockets and timing chain on the camshaft. Be sure the timing marks on the sprockets are positioned as shown.



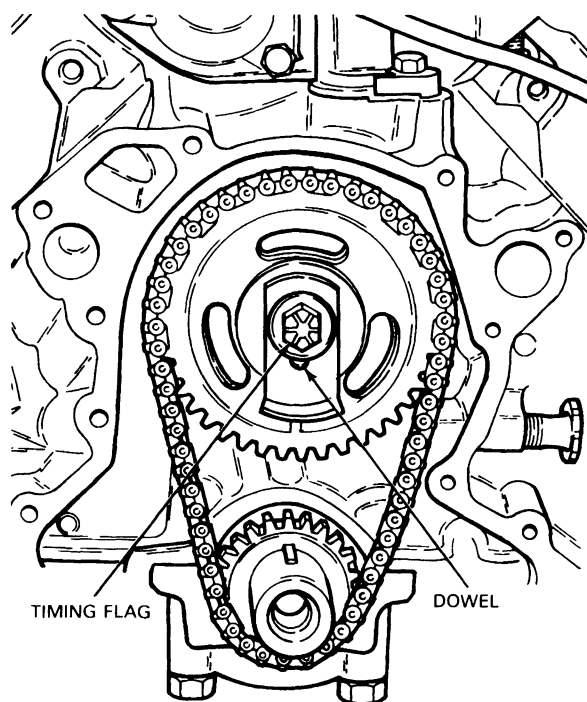
A10376-1A

2. Install the fuel pump eccentric or timing flag, washers and camshaft sprocket capscrew. Tighten the sprocket capscrew to 54-61 N·m (40-45 ft-lb).

5.8L Engine

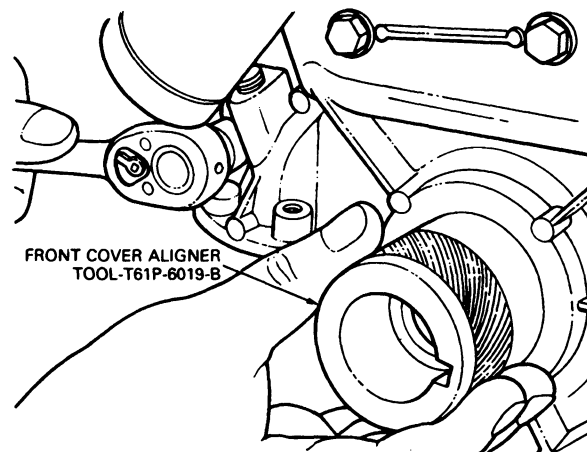
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REMOVAL AND INSTALLATION (Continued)



A17899-A

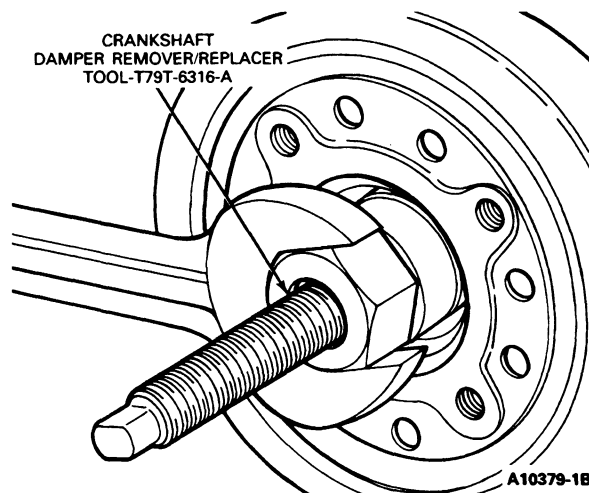
3. Clean the cylinder front cover, oil pan and the cylinder block gasket surfaces. Clean the oil pan gasket surface where the oil pan and front cover fasten.
Install a new oil seal as described in this section.
4. Lubricate the timing chain and sprockets with heavy engine oil.
5. Coat the gasket surface of the oil pan with sealer, then cut and position the required new gasket on the oil pan and apply sealer at the corners. Install the pan seal as required. Coat the gasket surfaces of the block and cover with Ford Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent, and position a new gasket on the block.
6. Position the cylinder front cover on the cylinder block. Use care when installing the cover to avoid seal damage or possible gasket mislocation.
7. Install the cylinder front cover-to-seal alignment using Front Cover Aligner Tool T61P-6019-B.



A9790-1A

8. It may be necessary to force the cover downward to slightly compress the pan gasket. This operation can be facilitated by using a suitable tool at the front cover attaching hole locations.
9. Coat the threads of the attaching screws with Ford Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent and install the screws. While pushing in on the alignment tool, tighten the oil pan-to-cover attaching screws to 16-24 N·m (12-18 ft·lb). Tighten the cover-to-cylinder block attaching screws to 16-24 N·m (12-18 ft·lb). Remove the alignment tool.
10. Apply Multi-Purpose Grease D0AZ-19584-AA or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal and to the front of the crankshaft for damper installation.
11. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft using Damper Remover / Replacer Tool T79T-6316-A. Install the capscrew and washer. Tighten the screw to 95-122 N·m (70-90 ft·lb). Install the crankshaft pulley.

CRANKSHAFT
DAMPER REMOVER/REPLACER
TOOL-T79T-6316-A



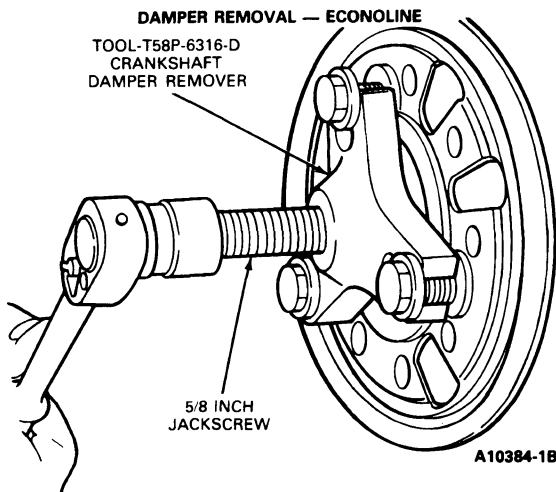
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REMOVAL AND INSTALLATION (Continued)

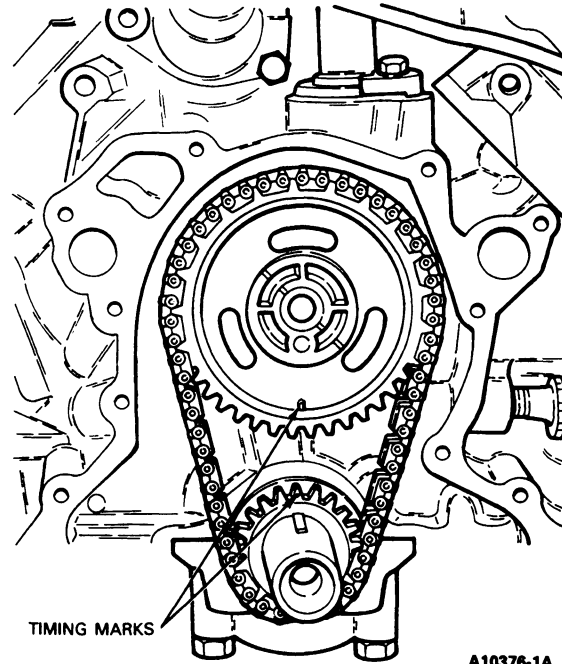
12. Complete the remaining steps under Water Pump Installation.
13. Fill and bleed the cooling system. Refer to Section 03-03.
14. Operate the engine at fast idle and check the coolant level and check for oil leaks. Check and adjust the ignition timing to specifications on engine decal.
15. Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.

E-150-250-350**Removal**

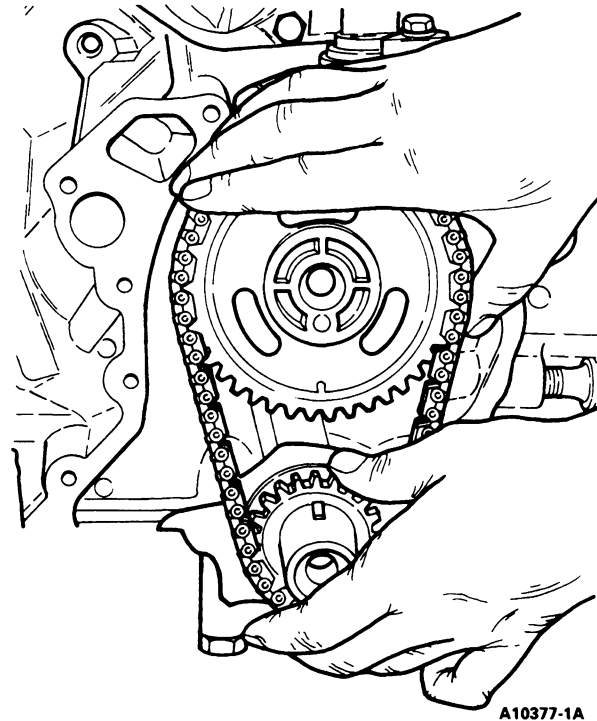
1. Drain radiator. Remove radiator. Refer to Section 03-03. Remove drive belt.
2. Remove upper radiator hose. Remove fan and shroud as an assembly. Raise vehicle on hoist.
3. Disconnect radiator lower hose at water pump. Disconnect fuel line at fuel pump and remove pump. Lower vehicle on hoist.
4. Remove the air conditioning compressor / power steering pump bracket and accessories.
5. Remove crankshaft pulley. Remove crankshaft vibration damper using Crankshaft Damper Remover T79T-6316-A. Remove oil pan-to-front cover bolts. Remove front cover and water pump as an assembly.



6. Discard the cylinder front cover gasket.
7. Check the timing chain deflection. Refer to Section 03-00. If deflection exceeds 12.7mm (.500 inches), replace the chain and sprockets.
8. Crank the engine until the timing marks on the sprockets are positioned as shown.



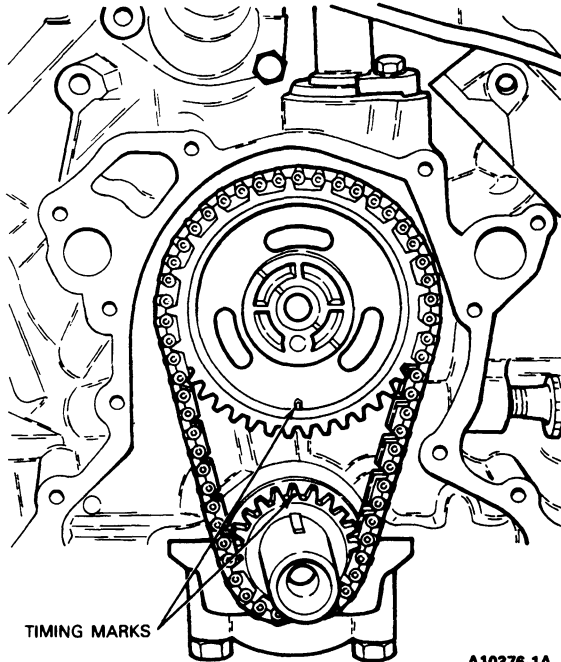
9. Remove the camshaft sprocket capscrew, washers and fuel pump eccentric. Slide both sprockets and the timing chain forward, and remove them as an assembly.



10. Clean front cover, fuel pump and damper. Lubricate seal. Clean gasket surface at pan and trim gasket. Clean front cover gasket surface at block.

REMOVAL AND INSTALLATION (Continued)**Installation**

1. Position the sprockets and timing chain on the camshaft. Be sure the timing marks on the sprockets are positioned as shown.



2. Install the fuel pump eccentric, washers and camshaft sprocket capscrew. Tighten the sprocket capscrew to 41-61 N·m (40-45 ft-lb).
3. Replace oil seal in front cover. Refer to Front Oil Seal in this section. Position gasket to front cover. Apply Silicone Rubber D6AZ-19562-AA or -BA (ESB-M4G92-A) or equivalent to oil pan and cylinder block junction. Cut pan gasket, then position to pan and front cover.

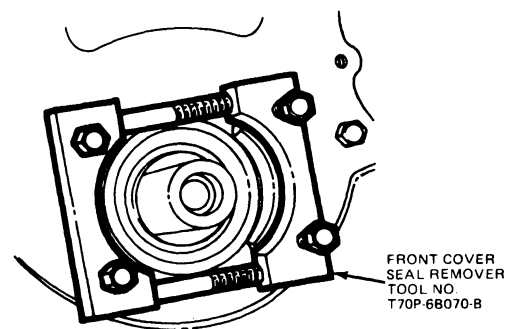
NOTE: When applying RTV sealant always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to set up and its sealing effectiveness may be reduced.

4. Install front cover. Install fuel pump. Install crankshaft vibration damper. Install crankshaft pulley and water pump.
5. Install bypass hose and connect heater hose.
6. Install air conditioning compressor / power steering pump bracket and accessories. Check hoses for condition and correct routing.
7. Install radiator upper hose. Raise vehicle on hoist. Connect fuel lines at pump.
8. Route the drive belt according to belt routing decal. Drain crankcase. Replace oil filter.

9. Lower vehicle on hoist. Install radiator. Fill crankcase. Fill and bleed cooling system. Refer to Section 03-03. Service air conditioning and power steering systems. Refer to Section 12-03 for air conditioning service and Section 11-00 for power steering service. Start engine and check for leaks.
10. Adjust engine timing to specification on engine decal.

Front Oil Seal**Removal**

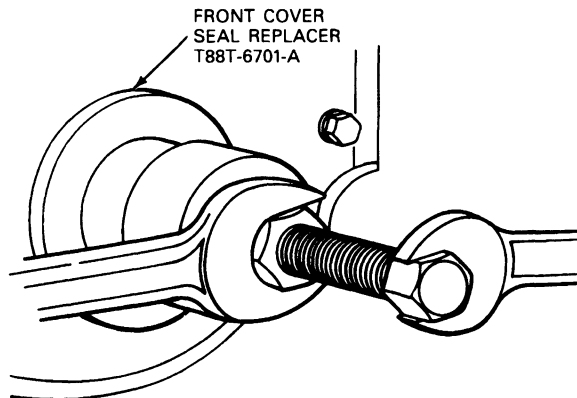
1. Remove the serpentine drive belt.
2. Remove the bolts attaching the fan shroud to the radiator.
3. Remove the fan clutch bolts from the water pump shaft. Remove the fan, clutch and shroud.
4. Remove the crankshaft pulley from the vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper and remove the vibration damper.
5. Place the Front Cover Seal Remover T70P-6B070-B onto the front cover plate over the front seal as shown. Tighten the two through-bolts to force the seal puller under the seal flange.
6. Tighten the four puller bolts alternately one-half turn at a time to pull the oil seal from the front cover.

**Installation**

1. Coat a new front cover plate oil seal with Lubriplate or equivalent. Place it onto Front Cover Seal Replacer T88T-6701-A. Place the sleeve and seal onto the end of the crankshaft and push it toward the engine until the seal starts into the front cover.

REMOVAL AND INSTALLATION (Continued)

- Place the installation screw, washer and nut onto the end of the crankshaft. Thread the screw into the crankshaft. Tighten the nut against the washer and installation sleeve to force the seal into the front cover plate. Remove the installation tool from the crankshaft.



A10352-B

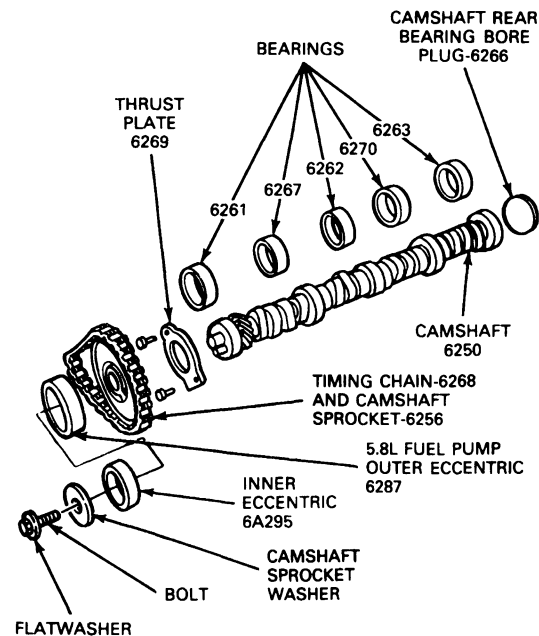
- Apply Multi-Purpose Grease DOAZ-19584-AA or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal and to the front of the crankshaft for damper installation.
- Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft. Install the capscrew and washer. Tighten the screw to 95-122 N·m (70-90 ft·lb). Install the crankshaft pulley. Make sure the pulley is bottomed on the damper pilot.
- Position the fan shroud over the water pump pulley. Install the fan and clutch. Install the fan shroud attaching screws.
- Route the drive belt according to the belt routing decal.

Camshaft

Removal

- On E-150-250-350 vehicles only, remove the grille.
- Drain the cooling system. Disconnect the radiator upper and lower hoses. Disconnect the transmission oil cooler lines, if so equipped. Remove the radiator. Refer to Section 03-03.
- Remove the air conditioner and power steering bracket and accessories.
- Remove the cylinder front cover and the timing chain following the procedure under Cylinder Front Cover and Timing Chain Removal in this section.

- Remove the intake manifold and throttle body (9E926) as an assembly. Refer to Section 03-04A.
- Remove the tappets following the procedure given under Disassembly and Assembly in this section.
- Remove the camshaft thrust plate. Carefully remove the camshaft by pulling toward the front of the engine. **Use caution to avoid damaging the camshaft bearings.**



A10380-D

Installation

- Oil the camshaft journals and apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the lobes. Carefully slide the camshaft through the bearings. Lubricate the camshaft thrust plate with recommended quality engine oil and install the camshaft thrust plate with the groove toward the cylinder block.
- Lubricate the tappets and tappet bores with heavy engine oil. Install the valve tappets in the bores from which they were removed.
- Lubricate the ends of the push rods with Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent and install the push rods in their original positions. Apply Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the valve stem tips. Lubricate the rocker arms and fulcrums with Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent and position the rocker arms over the push rods. Tighten bolts to 24-34 N·m (18-25 ft·lb).
- Install the intake manifold and related parts. Refer to Section 03-04A.

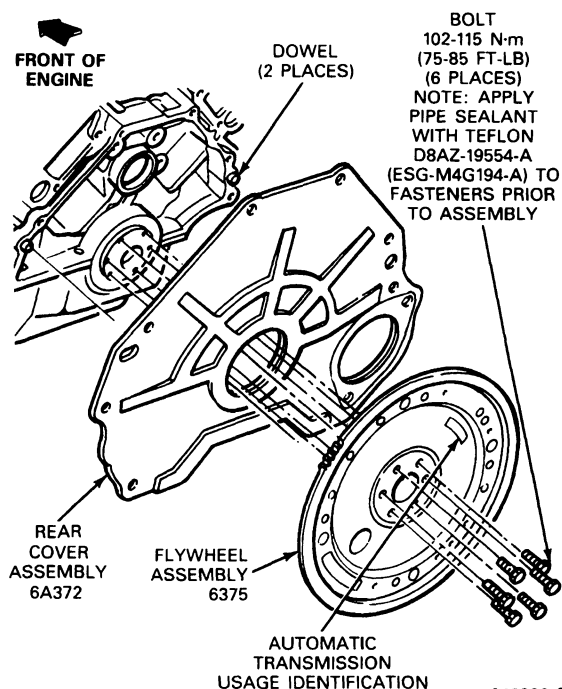
REMOVAL AND INSTALLATION (Continued)

5. Replace the crankshaft front oil seal. Install the timing chain, cylinder front cover and related parts as described in this section.
6. Perform a valve clearance check as outlined.
7. Install the valve rocker arm covers as described in this section.
8. Clean and install the crankcase ventilation system.
9. Install the radiator and connect the hoses. Refer to Section 03-03. Connect the oil transmission cooler lines, if so equipped.
10. Install air conditioner and power steering bracket and accessories. Refer to Section 12-03 for air conditioner service and Section 11-00 for power steering service.
11. Fill and bleed the cooling system. Refer to Section 03-03. Fill the crankcase with the proper grade and quality of engine oil.
12. Start the engine, then check and adjust the ignition timing (refer to the engine decal for correct settings). Connect the distributor and intake manifold vacuum hoses.
13. Operate the engine at fast idle and check all hose connections and gaskets for leaks. Operate the engine until engine temperatures have stabilized, then adjust the engine idle speed and idle fuel mixture (refer to specifications on engine decal). Re-tighten intake manifold bolts and nuts to 32-34 N-m (23-25 ft-lb).
14. Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.
15. On E-150-250-350 vehicles, install the grille.

Flywheel**Removal**

1. On a vehicle with a manual transmission, remove the transmission and flywheel housing, clutch pressure plate and disc. Refer to Group 08.
On a vehicle with an automatic transmission, remove the transmission and converter housing. Refer to Group 07.
2. To check flywheel face runout or to replace a flywheel ring gear for a manual transmission, refer to Section 03-00.

3. Remove the flywheel attaching bolts and remove the flywheel.



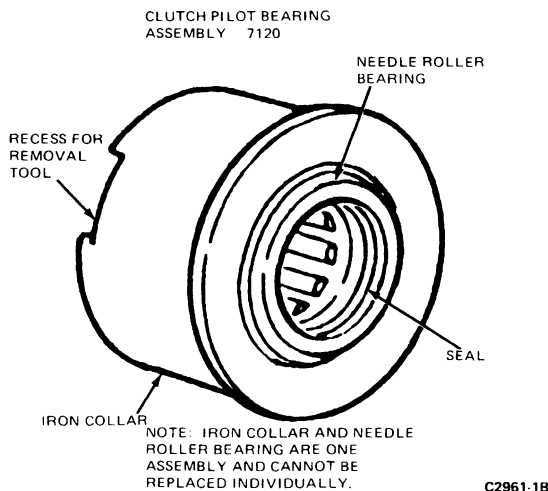
A13399-C

Installation

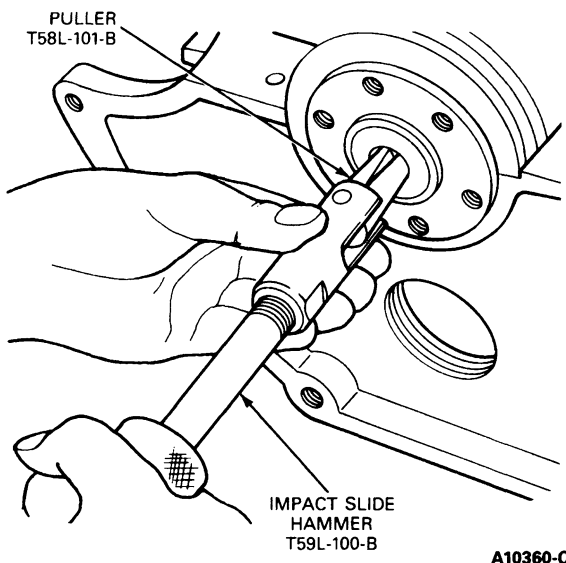
1. Coat the threads of the flywheel attaching bolts with oil-resistant Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A-Type II) or equivalent. Position the flywheel on the crankshaft flange. Install and tighten the bolts in sequence across from each other to 102-115 N-m (75-85 ft-lb).
2. On a vehicle with a manual transmission, check the flywheel runout. Refer to Section 03-00. Install the clutch pressure plate, disc and the transmission and flywheel housing. Refer to Group 08.
On a vehicle with an automatic transmission, check the flywheel runout. Refer to Section 03-00. Install the transmission and converter housing. Refer to Group 07.

REMOVAL AND INSTALLATION (Continued)**Clutch Pilot Bearing**

A needle roller bearing and adapter assembly is used as a clutch pilot bearing on F-150-250-350 and Bronco vehicles equipped with manual transmissions. It is inserted directly into the engine crankshaft. The bearing and adapter assembly is used with the bearing and adapter comprising an assembly that cannot be serviced separately. The clutch pilot bearing can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pre-greased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.

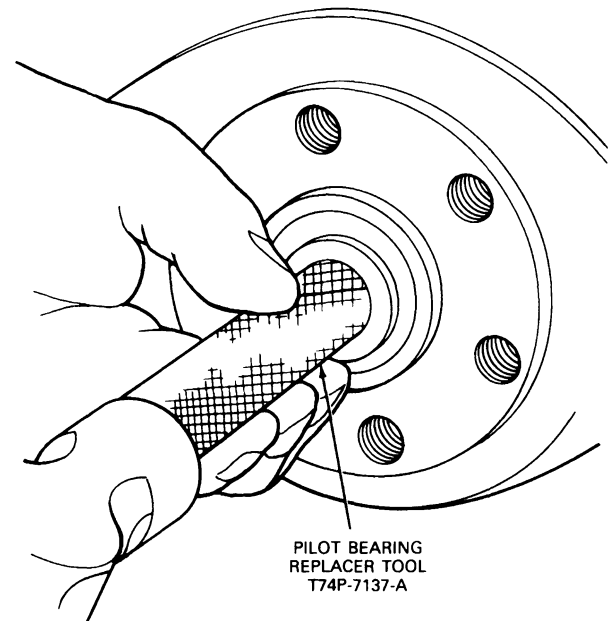
**Removal**

1. Remove the transmission and flywheel housing, clutch pressure plate, and disc. Refer to Group 08.
2. Using Impact Slide Hammer T59L-100-B and Puller Attachment T58L-101-B remove the pilot bearing.

**Installation**

1. Using suitable pilot bearing replacer tool install the pilot bearing with the seal facing the transmission so that the adapter is not cocked.
2. Install the clutch pressure plate, disc, and transmission and flywheel housing. Refer to Group 08.

NOTE: Care must be taken not to damage the bearing during transmission installation while the transmission input shaft is being inserted into the bearing.

**Camshaft Rear Bearing Bore Plug****Removal**

1. On a vehicle with a manual transmission, remove the transmission and flywheel housing, clutch pressure plate and disc. Refer to Group 08.
On a vehicle with an automatic transmission, remove the transmission and converter housing. Refer to Group 07.
2. Remove the flywheel attaching bolts and remove the flywheel. Remove the engine rear cover plate.
3. Replace the rear bearing bore plug. Refer to Section 03-00.

Installation

1. Coat the flywheel attaching bolts with oil-resistant Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A-Type II) or equivalent. Position the engine rear cover plate on the cylinder block dowels. Position the flywheel on the crankshaft flange. Install and tighten the attaching bolts in sequence, across from each other to 102-115 N·m (75-85 ft·lb).

REMOVAL AND INSTALLATION (Continued)

2. On a vehicle with a manual transmission, install the clutch pressure plate, disc and the transmission and flywheel housing. Refer to Group 08.
3. On a vehicle with an automatic transmission, install the transmission and converter housing. Refer to Group 07.

Crankshaft Rear Oil Seal**Removal**

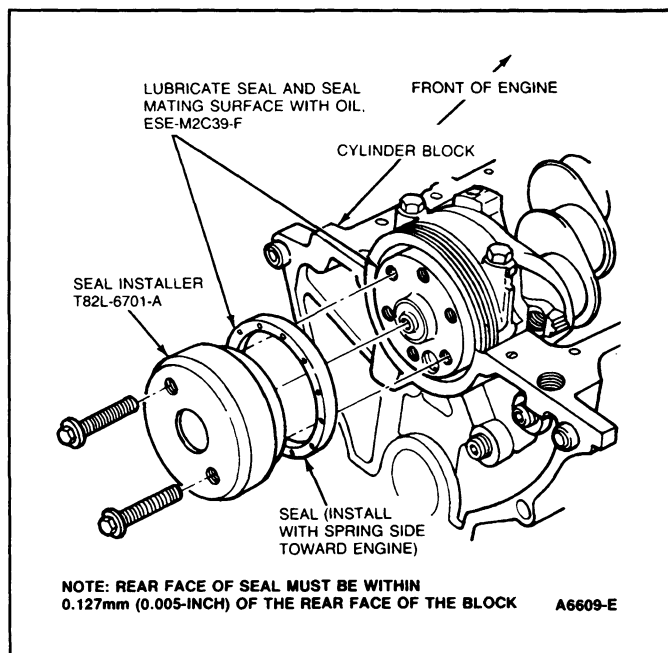
1. Remove transmission. If vehicle is equipped with a manual transmission, remove clutch assembly. Refer to either Group 07 or 08.
2. Remove flywheel from engine.
3. Using a sharp awl, punch one hole in the seal metal surface between the seal lip and the engine block.

CAUTION: Use caution to avoid scratching or damaging the oil sealing surfaces during seal removal.

4. Screw the threaded portion of Jet Plug Remover T77L-9533-B into the hole and remove seal.

Installation

1. Lubricate the seal and seal mating surfaces with clean engine oil.
2. Position the new seal on Rear Oil Seal Installer T82L-6701-A with the spring side toward engine.
3. Position tool with seal over the pilot diameter of the crankshaft and install two bolts.
NOTE: Bolts are supplied with installer tool. Engine flywheel bolts may be substituted.
4. Alternately tighten bolts until seal is properly seated to within 0.127mm (.005 inch) of the rear face of the block.
5. Install flywheel, clutch assembly (if equipped) and transmission assembly. Refer to appropriate sections in Groups 07 and 08.
6. Check engine oil level and correct as required.
7. Start engine and check for leaks.

**Main Bearing**

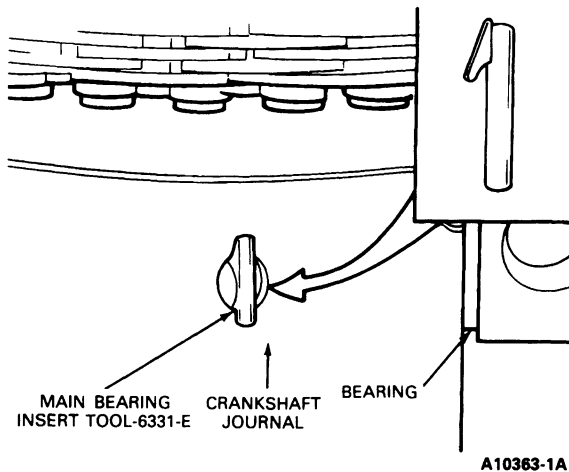
The main bearing inserts are selective fit. Refer to the procedures under Fitting Main and Connecting Rod Bearings in Section 03-00.

Removal

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts following the procedure under Oil Pan Removal.
2. Remove the oil pump inlet tube assembly and the oil pump.
3. Replace one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.
4. Insert Upper Main Bearing Insert Remover and Replacer TOOL-6331-E in the oil hole in the crankshaft.
5. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.
6. Clean each crankshaft journal. Inspect the journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear.

REMOVAL AND INSTALLATION (Continued)

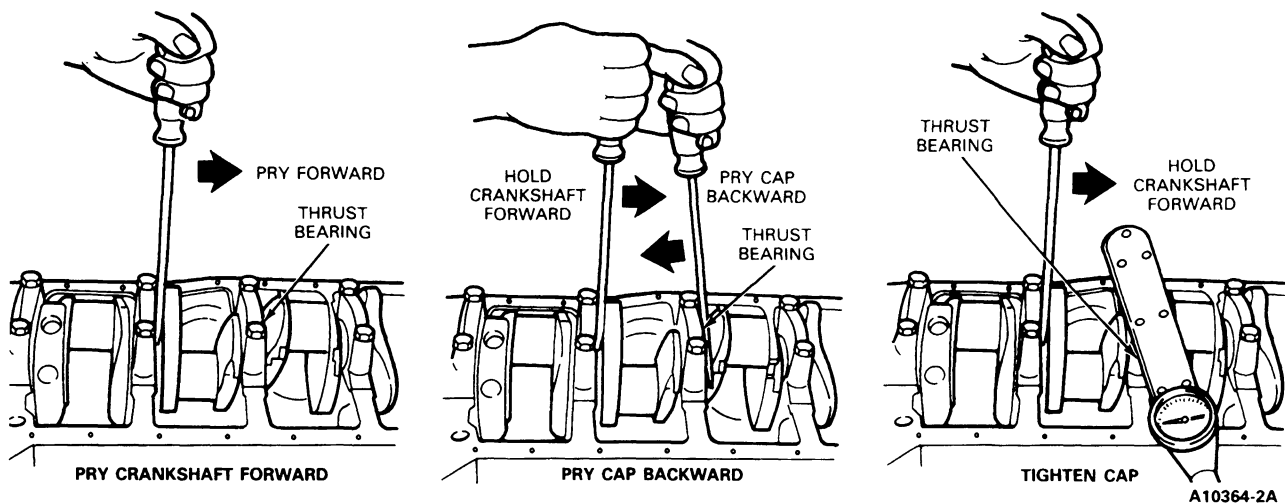
7. If the rear main bearing is being replaced, remove and discard the rear oil seal as described in this section.



Installation

1. To install an upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that Upper Main Bearing Insert Remover and Replacer TOOL-6331-E can be inserted in the oil hole in the crankshaft. With Upper Main Bearing Insert Remover and Replacer TOOL-6331-E in the hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.
2. Install the bearing cap.

Thrust Bearing Cap, Installation



3. Select-fit the bearing for proper clearance following the procedures under Fitting Main and Connecting Rod Bearings in Section 03-00.
4. If the bearing is being replaced on journal number 1, 2 or 4, apply a coat of engine oil of the quality recommended in the Owner Guide to the journal and bearings and install the bearing cap. Tighten the cap bolts. On 5.0L engines, tighten cap bolts to 82-94 N·m (60-70 ft-lb); on 5.8L engines, tighten to 129-142 N·m (95-105 ft-lb).
5. Refer to Section 03-00 for instructions in applying RTV sealer to the rear main bearing cap. Lubricate the journal with engine oil of the quality recommended in the Owner Guide and install the rear main bearing cap. Tighten the cap bolts on 5.0L engines to 81-95 N·m (60-70 ft-lb); on 5.8L engines to 129-142 N·m (95-105 ft-lb).
6. If the thrust bearing cap (No. 3 main bearing) has been removed, install it as follows:

Lubricate the journal with engine oil of the quality recommended in the Owner Guide and install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Tighten the cap bolts on 5.0L engines to 81-95 N·m (60-70 ft-lb); on 5.8L engines to 129-142 N·m (95-105 ft-lb).

7. Install a new rear main seal as described in this section.
8. Force crankshaft toward the rear of the engine.
9. Check crankshaft and play. Refer to Section 03-00.

REMOVAL AND INSTALLATION (Continued)

10. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and inlet tube assembly.
11. Position the oil pan gaskets on the oil pan. Install the oil pan and related parts following the procedure under Oil Pan Installation. Install the oil level dipstick.
12. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

9. Position the oil pan gaskets on the cylinder block. Position the oil pan front seal on the cylinder block front cover and interlock the seal with the gaskets. Position the oil pan rear seal on the rear main bearing cap and interlock the seal with the gaskets. Install the oil pan and related parts following the procedure under Oil Pan Installation. Install the oil level dipstick.
10. Fill the crankcase with engine oil of the quality and quantity recommended in the Owner Guide. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

Connecting Rod Bearings

The connecting rod bearings are selective fit. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00.

Removal

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts, following the procedure under Oil Pan Removal.
2. Remove the oil pump inlet tube assembly and the oil pump.
3. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down.
Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.

Installation

1. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.
2. Clean the crankshaft journal.
3. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.
4. Pull the connecting rod assembly down firmly on the crankshaft journal.
5. Select fit the bearing. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00.
6. Clean and apply a coat of engine oil of the quality recommended in the Owner Guide to the journal and bearings. Install the connecting rod cap. Tighten the nuts on 5.0L engines to 26-32 N·m (19-24 ft·lb); on 5.8L engines to 55-61 N·m (40-45 ft·lb).
7. Repeat the procedure for the remaining connecting rods that require new bearings.
8. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and inlet tube assembly.

Pistons and Connecting Rods**Removal**

1. Drain the cooling system. Refer to Section 03-03. Drain the crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump as outlined.
2. Remove any ridges and/or deposits from the upper end of the cylinder bores as follows.
Turn the crankshaft until the piston to be removed is at the bottom of its travel, then place a cloth on the piston head to collect the cuttings. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturers. Never cut into the ring travel area in excess of 0.794 mm (1/32 inch) when removing ridges.
3. Make sure all connecting rod caps are marked so that they can be installed in their original positions.
4. Turn the crankshaft until the connecting rod being removed is down.
5. Remove the connecting rod nuts and cap.
6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.
7. Remove the bearing inserts from the connecting rod and caps.
8. Install the cap on the connecting rod from which it was removed.

Installation

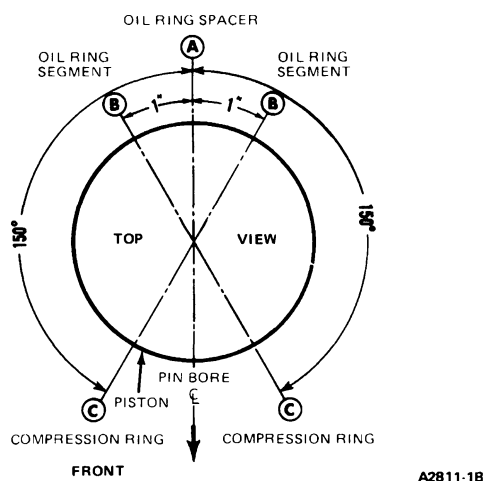
1. If new piston rings are to be installed, remove the cylinder wall glaze. Refer to Section 03-00. The small depression on the ring designates the top.
2. Install rings using a piston ring installation tool of the proper size.

REMOVAL AND INSTALLATION (Continued)

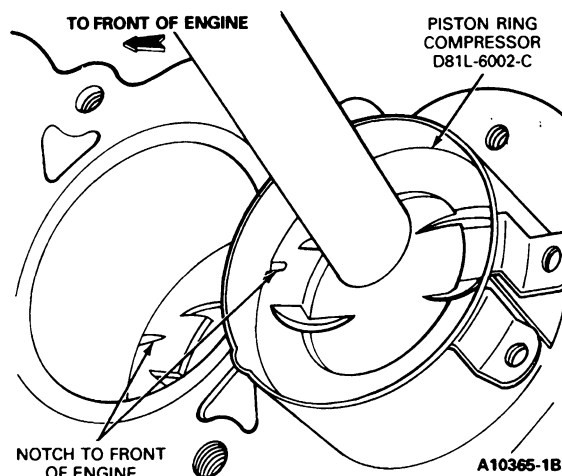
3. Oil the piston rings, pistons and cylinder walls with recommended quality engine oil. **Be sure to install the pistons in the same cylinders from which they were fitted.** The connecting rod and bearing caps are numbered from 1 to 4 in the right bank and from 5 to 8 in the left bank, beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transferred from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

When installing the piston and connecting rod assembly, the largest chamfer at the bearing end of the rod should be positioned toward the crank pin thrust face of the crankshaft.

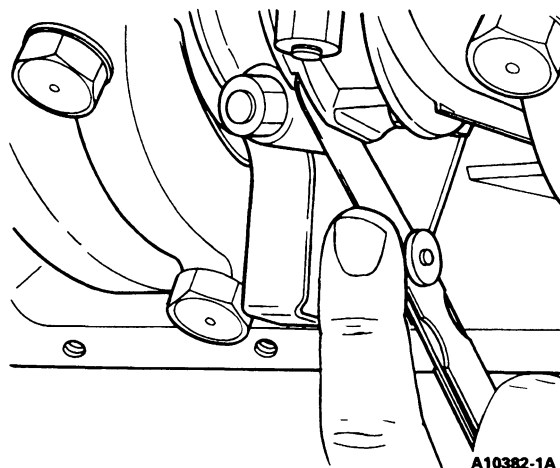
4. Make sure the ring gaps (oil ring spacer-A, oil ring-B, compression ring-C) are properly spaced around the circumference of the piston.



5. Install Piston Ring Compressor D81L-6002-C or equivalent on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder. Be sure to guide the connecting rods to avoid damaging the crankshaft journals. Install the piston with the indentation notch in the piston head toward the front of the engine.



6. Check the clearance of each bearing. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00.
7. After the bearings have been fitted, apply a light coat of recommended engine oil to the journals and bearings.
8. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.
9. Install the connecting rod cap. Tighten the nuts on 5.0L engines to 26-33 N·m (19-24 ft·lb); on 5.8L engines to 54-61 N·m (40-45 ft·lb).
10. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each shaft journal.

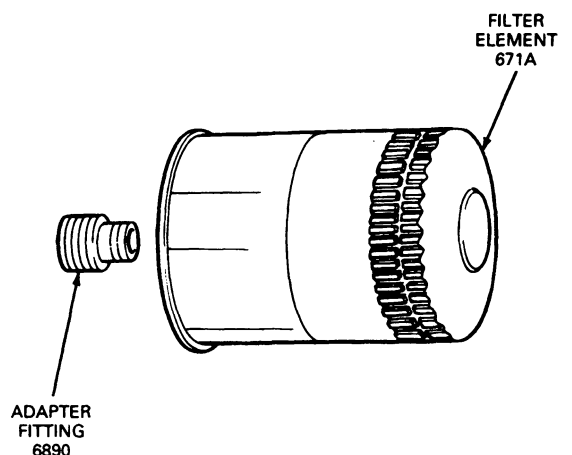


11. Disassemble, clean, and assemble the oil pump. Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.

REMOVAL AND INSTALLATION (Continued)

12. Prime the oil pump by filling the inlet port with engine oil of the quality recommended in the Owner Guide and rotating the pump shaft to distribute the oil within the housing. Install the oil pump and the oil pan following the procedures under Oil Pan Installation.
13. Install the cylinder heads following the steps under Cylinder Head Installation.
14. Install accessory drive brackets with alternator, Secondary Air Injection pump, air conditioning compressor, and power steering pump and connect hoses and electrical connections. Refer to Section 03-05.
15. Install the intake manifold following the steps under Intake Manifold Installation.
16. Fill and bleed the cooling system. Refer to Section 03-03. Fill the crankcase with the proper quality and quantity of engine oil as recommended in the Owner Guide.
17. Start the engine, then check and adjust the ignition timing. Connect the distributor vacuum hoses to the distributor.
18. Operate the engine at fast idle and check for oil and coolant leaks. Operate the engine until engine temperatures have stabilized, then adjust the engine idle speed and idle fuel mixture to specifications on engine decal.
19. Install the air cleaner and intake duct assembly, including the crankcase ventilation hose.

2. Hand-tighten the filter until the gasket makes contact and then advance it one-half turn.
3. Check the oil level and fill the crankcase with engine oil of the quality recommended in the Owner Guide as necessary.
4. Operate the engine at fast idle and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Remove the drip pan.



A10386-1A

Oil Filter**Removal**

1. Position a drip pan under the oil filter.
2. Unscrew the filter from the adapter fitting using an Oil Filter Wrench D79L-6731-A or B or equivalent and clean the adapter fitting.

On E-150-250-350 vehicles equipped with power steering, make sure the wheels are fully to the right before removing the filter. Then, unscrew the filter from the adapter fitting, turn it horizontal and let the excess oil drain off. Slide the oil filter toward the rear of the vehicle and remove. Some effort may be required to slide the oil filter between the engine crossmember and power steering hoses.

Installation

CAUTION: Make sure gasket from removed oil filter has not stuck to the adapter. Wipe adapter clean prior to installing new filter.

1. Coat the gasket on a new filter with recommended quality engine oil. Place the new filter in position on the adapter fitting.

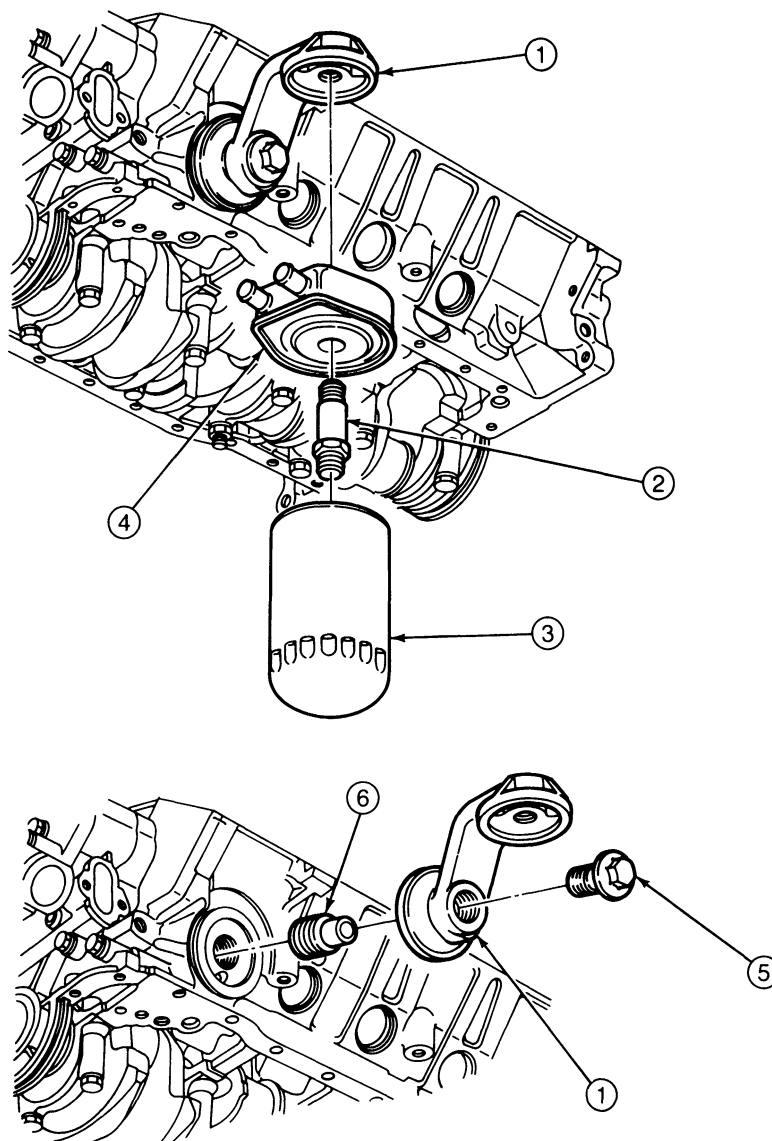
On E-150-250-350 vehicles equipped with power steering, make sure that the wheels are turned fully to the right, then slide the oil filter forward between the crossmember and power steering hoses to position it on the adapter fitting.

Oil Filter Cooler and Adapter**5.8L Lightning Truck Engine**

1. Drain coolant. Refer to Section 03-03.
2. Raise vehicle and position a drain pan under the engine. Drain crankcase.
3. Loosen hose clamps and remove hoses from cooler assembly.
4. Remove oil filter using suitable wrench.
5. Remove adapter from engine and separate cooler from adapter.

For installation, follow removal steps in reverse order. Install a new oil filter. Fill crankcase with proper quantity and grade of oil. Fill cooling system. Refer to Section 03-03. Start engine and check for leaks.

REMOVAL AND INSTALLATION (Continued)



A19034-A

Item	Part Number	Description
1	6884	Oil Filter Adapter
2	6L626	Oil Cooler Insert Mounting Bolt

(Continued)

Item	Part Number	Description
3	67 14	Oil Filter
4	6A642	Oil Cooler Assembly
5	6894	Oil Filter Adapter Mounting Bolt
6	6890	Adapter

Engine Assembly

The engine removal and installation procedures are for the engine only, without the transmission attached.

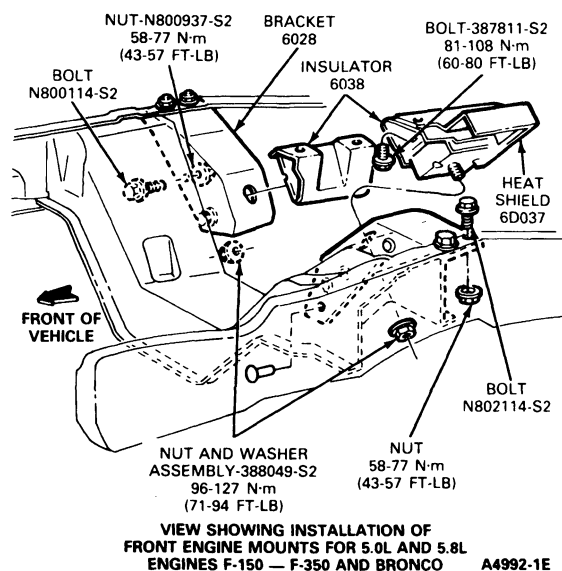
F-150-250-350 and Bronco**Removal**

1. Drain the cooling system and the crankcase. Refer to Section 03-03. Remove hood. Refer to Section 01-02.

REMOVAL AND INSTALLATION (Continued)

2. Disconnect the battery and ground cables from the cylinder block.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM)(12A650) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
3. On 5.8L MFI engine, remove the air intake duct assembly, including the crankcase ventilation hose and carbon canister hose. On 5.0L MFI engine, remove the air intake hoses, PCV tube, and carbon canister hose.
4. Disconnect the radiator lower and upper hose at the radiator. If equipped with an automatic transmission, disconnect the transmission oil cooler lines.
5. Disconnect and cap-off the power steering hoses.
6. Disconnect the Thermactor air pump hoses.
7. If so equipped, discharge the air conditioning system and remove the air conditioning condenser. Refer to Section 12-03A. Disconnect air conditioning lines at the compressor. Disconnect the air conditioning compressor clutch wire.
8. Remove the fan shroud and position it over the fan. Remove the radiator. Refer to Section 03-03. Relieve the belt tension and remove the belt.
9. Disconnect the alternator wires.
10. Remove the brackets for the air pump, alternator, power steering and compressor. Disconnect the power steering pump lines.
11. Disconnect the oil pressure sending unit wire from the sending unit. Disconnect evaporative emission hoses at the evaporative canister.
12. Perform Fuel System Pre-Service Procedures, Section 03-04A or 03-04D. Using Quick Disconnect Tools D87L-9280-A and -B or equivalent, disconnect fuel line and fuel return line.
13. Disconnect accelerator cable, transmission valve cable and, if equipped, speed control cable and remove cable bracket from throttle body. Position bracket with attached cables out of the way. Disconnect power brake booster vacuum hose, if so equipped.
14. Disconnect the heater hoses from the water pump and tee. Disconnect the engine coolant temperature sensor (12A648) wire from the sending unit.
15. Remove the flywheel housing-to-engine upper bolts.

16. Disconnect the engine wire loom and position out of the way. Disconnect the ground strap from the cylinder block.
17. Raise the front of the vehicle. Disconnect the starter cable from the starter. Remove the starter. Refer to Section 03-06A.
18. Disconnect the muffler inlet pipes and exhaust heat control valve, if so equipped, from the exhaust manifolds. Disconnect the engine support insulators from the brackets on the frame underbody.



19. On vehicles with automatic transmission, remove the converter inspection plate. Remove the torque converter-to-flywheel attaching bolts.
20. Remove the remaining flywheel housing-to-engine bolts.
21. Lower the vehicle, and support the transmission. Install Engine Lifting Bracket Tool T70P-6000 on the intake manifold lifting eyes (5.8L). Then, attach the engine lifting sling (attach to engine-mounted lifting eyes for 5.0L).
22. Raise the engine slightly and carefully pull it from the transmission. Carefully lift the engine out of the engine compartment so that the rear cover plate is not bent or other components damaged. Install the engine on a workstand.

Installation

1. Attach the engine lifting brackets and sling. Remove the engine from the workstand.

REMOVAL AND INSTALLATION (Continued)

2. Lower the engine carefully into the engine compartment. Make sure the dowels in the block are through the rear cover plate, then engage the holes in the flywheel housing.

On a vehicle with manual transmission, start the transmission main driveshaft into the clutch disc. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. **If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.**

3. Install the flywheel housing upper bolts.
4. Install the engine support insulator-to-bracket washers and attaching nuts. Disconnect the engine lifting sling and remove the lifting eyes (5.8L). 5.0L lifting eyes remain with engine.
5. Raise the front of the vehicle. Connect both exhaust manifolds and exhaust heat control valve, if so equipped, to the muffler inlet pipes. Tighten the nuts to 33-49 N·m (24-36 ft·lb). Refer to Section 09-00.
6. Position and install the starter and the starter cable. Refer to Section 03-06A.
7. Install the remaining flywheel housing-to-engine bolts.
8. On a vehicle with automatic transmission, install the converter-to-flywheel attaching bolts. Install the converter inspection plate.
9. Remove the support from the transmission and lower the vehicle.
10. Install the air conditioner and power steering bracket and components. Refer to Section 03-05.
11. Install the alternator / air pump bracket. Refer to Section 03-05.
12. Connect the air conditioning compressor magnetic clutch lead wire if so equipped. Refer to Section 12-03A.
13. Connect the engine wire loom.
14. Connect the engine coolant temperature sensor wire.
15. Install bracket with attached cables to throttle body. Connect accelerator, transmission valve, and automatic speed control cables.
16. Connect fuel supply and return lines. Connect evaporative emission hoses. Connect oil pressure sending unit wire.
17. Install the pulley, clutch and fan. Position the fan shroud over the fan.
18. Position the alternator and install the alternator bolts. Connect the battery ground cable. Install alternator, Secondary Air Injection pump, and, if equipped, power steering pump. Install poly-v belt according to instructions on decal. Refer to Section 03-05.

19. Connect two air conditioning lines to the air conditioning compressor if so equipped. Refer to Section 12-03A.
20. Install the radiator. Connect the radiator upper and lower hoses. Connect the transmission oil cooler lines, if so equipped. Install the fan shroud. Refer to Section 03-03.
21. Install the air conditioning condenser to the radiator if so equipped. Refer to Section 12-03A.
22. Connect the heater hoses at the water pump and intake manifold. Fill and bleed the cooling system. Refer to Section 03-03. Fill the crankcase with the proper grade and quantity of oil. Connect the power brake booster vacuum hose, if so equipped.
23. Operate the engine at fast idle and check all gaskets and hose connections for leaks. Purge the power steering system of any air as outlined in Section 11-00.
24. Install the air cleaner and intake duct assembly including the crankcase ventilation hose and carbon canister hose.
25. Evacuate and charge the A / C system, if so equipped. Refer to Section 12-03.
26. Install hood. Refer to Section 01-02.

E-150-250-350**Removal**

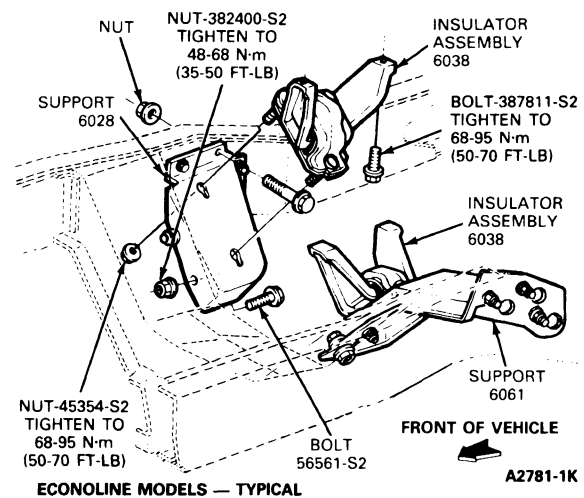
1. Open hood, remove inside engine cover, and disconnect battery ground cable.
2. Drain coolant.
3. Remove air cleaner assembly.
4. Remove radiator air deflector and grille.
5. Remove headlight and side marker light assemblies.
6. Remove fan shroud and radiator, Section 03-03.
7. If equipped, drain air conditioning system. Refer to Section 12-03B. Disconnect condenser using Quick Disconnect Tool Set T84L-19623-B, and remove.
8. Remove hood latch from upper radiator support and set aside without removing cable, and remove upper radiator support and stone deflector.
9. Disconnect electrical connector for air bag and, using trim remover tool, remove wire retainer and position out of the way.
10. Disconnect heater hoses from pipes.
11. Remove oil filler tube.
12. Disconnect alternator and electrical junction box.
13. If equipped, disconnect air conditioner compressor hoses.
14. Remove upper intake manifold as detailed in Section 03-04A.
15. Remove transmission dipstick tube.

REMOVAL AND INSTALLATION (Continued)

16. Perform Fuel System Pre-Service Procedures as outlined in Section 03-04A or 03-04D. Using Quick Disconnect Tool D87L-9280-A and -B or equivalents, disconnect fuel line and fuel return line.
17. Disconnect Thermactor lines.
18. Remove upper distributor cap, rotor, and ignition wires.
19. Remove three top transmission or clutch housing-to-engine bolts.
20. Raise vehicle and remove electrical bracket and hoses from power steering pump.
21. Remove starter motor as detailed in Section 03-06A.
22. Remove exhaust pipe-to-exhaust manifold nuts.
23. Remove flywheel cover and torque converter-to-flex plate nuts.
24. Remove electrical brackets from oil pan, from behind Thermactor pump, and from engine.
25. Remove front engine mount nuts.
26. Lower vehicle, raise front of vehicle just enough to get underneath and support with suitable jack stands. Support transmission with suitable transmission jack.
27. Remove remaining engine-to-transmission bolts.
28. Connect floor crane to engine lifting eyes. Use wood blocks to keep chains from damaging valve covers.
29. Lift out engine and install on work stand.

Installation

1. Connect the floor crane to the engine. Raise the engine and position it into the vehicle aligning the transmission converter to the flex plate and the engine dowels to the transmission. Lower the engine to the chassis brackets, and align the through-bolt holes on the engine supports.
2. Install converter housing-to-cylinder block bolts. Alternately tighten bolts to 55-67 N·m (40-50 ft-lb). Remove the lifting bracket from the intake manifold.
3. Install front engine mount bolts.



4. Remove jack stands and transmission jack and raise vehicle on hoist.
5. Install electrical brackets on oil pan, behind Thermactor pump, and on engine.
6. Install torque converter-to-flex plate nuts and torque to 28-45 N·m (20-34 ft-lb). Install flywheel cover.
7. Install starter motor as detailed in Section 03-06A.
8. Install electrical bracket and hoses to power steering pump.
9. Lower vehicle.
10. From inside vehicle, install upper distributor cap, rotor, and ignition wires.
11. Connect Thermactor lines.
12. Connect fuel line and fuel return line.
13. Install transmission dipstick tube.
14. From front of vehicle, connect alternator and electrical junction box.
15. Connect air conditioning compressor hoses.
16. Install upper intake manifold as detailed in Section 03-04A.
17. Install oil filler tube.
18. Connect heater hoses to pipes.
19. Connect electrical connector for air bag and install wire retainer.
20. Install upper radiator support, stone deflector, and hood latch.
21. If so equipped, install air conditioning condenser.
22. Install fan shroud and radiator. Refer to Section 03-03.
23. Install headlight and side marker light assemblies.
24. Install radiator air deflector and grille.
25. Install air cleaner assembly.
26. Fill and bleed cooling system. Refer to Section 03-03. Fill engine oil if not already done.

REMOVAL AND INSTALLATION (Continued)

27. Evacuate and charge air conditioning system if equipped. Refer to Section 12-03B.
28. Connect battery ground cable.
29. Fill and bleed power steering system if so equipped.
30. Operate engine and check for leaks. Check and adjust timing. Refer to the Powertrain Control / Emissions Diagnosis Manual ².
31. Install engine cover as follows:
 - a. Slide both front seats to the rearmost position.
 - b. Position engine cover in place.
 - c. Before securing cover latches, place your hand under the seal bulb to verify the guide brackets are not on top of the sheet metal. If the guide brackets are on top of the sheet metal sealing surface, tilt cover and push spear bracket in toward engine so it is off the sheet metal. Repeat for other side if required.
 - d. Secure cover with four latches.

NOTE: If there is misalignment, one or both of the following conditions occur:

 - Latches are hard to fasten and secure.
 - Seal bulb will not compress by guide brackets.

Crankshaft**Removal**

1. With the engine removed from the vehicle and placed in a workstand, disconnect the spark plug wires at the spark plugs and remove the wires and bracket assembly from the attaching stud on the valve rocker arm covers using Spark Plug Wire Remover T74P-6666-A. Disconnect the coil-to-distributor high-tension lead at the coil. Remove the distributor cap and spark plug wires as an assembly. Remove the spark plugs to allow easy rotation of the crankshaft.
2. Remove the oil filter. Slide the water pump bypass hose clamp toward the water pump. Remove the alternator and mounting brackets.
3. Remove the crankshaft pulley from the crankshaft vibration damper. Remove the capscrew and washer from the end of the crankshaft. Install the puller using Crankshaft Damper Remover T58P-6316-D on the crankshaft vibration damper and remove the damper.
4. Remove the cylinder front cover and water pump as an assembly.
5. Check the timing chain deflection. Refer to Section 03-00. Then, remove the timing chain and sprockets by following procedure under Cylinder Front Cover and Timing Chain Removal.

6. Invert the engine on the workstand. Remove the clutch pressure plate and disc (manual shift transmission). Remove the flywheel and engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.
 7. **Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations.** Turn the crankshaft until the connecting rod from which the cap is being removed is down, and remove the bearing cap. Push the connecting rod and piston assembly up into the cylinder. Repeat this procedure until all the connecting rod bearing caps are removed.
 8. Remove the main bearing caps.
 9. Carefully lift the crankshaft out of the block so that the thrust bearing surfaces are not damaged. **Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.**
 10. Remove rear journal oil seal from the crankshaft.
 11. Remove the main bearing inserts from the block and bearing caps.
 12. Remove the connecting rod bearing inserts from the connecting rods and caps.
- To refinish journals and dress minor imperfections, refer to Section 03-00.

Installation

1. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings.

CAUTION: Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

2. Place the upper main bearing inserts in position in bores with the tang fitting in the slot provided.
3. Install the lower main bearing inserts in the bearing caps.
4. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**
5. Check the clearance of each main bearing. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00.

NOTE: Apply Silicone Rubber D6AZ-19562-B (ESB-M4G92-A) in a 1.59mm (1/16-inch) bead in each corner of rear main bearing cap saddle, the full length of the saddle.

6. Apply engine oil of the quality recommended in the Owner Guide to the journals and bearings.
7. Install all the bearing caps, except the thrust bearing cap (No. 3 bearing). **Be sure that the main bearing caps are installed in their original locations.** Tighten the bearing cap bolts on 5.0L engines to 82-95 N·m (60-70 ft-lb); on 5.8L MFI engines to 129-142 N·m (95-105 ft-lb).

² Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

8. Install the thrust bearing cap with the bolts finger-tight.
9. Pry the crankshaft forward against the thrust surface on the upper half of the bearing.
10. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.
11. Retain the forward pressure on the crankshaft. Tighten the cap bolts on 5.0L engines to 82-95 N·m (60-70 ft-lb); on 5.8L engines to 129-142 N·m (95-105 ft-lb).
12. Force the crankshaft toward the rear of the engine.
13. Check the crankshaft end play. Refer to Section 03-00.
14. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing. Refer to Fitting Main and Connecting Rod Bearings in Section 03-00.
15. Apply a light coat of recommended quality engine oil to the journals and bearings after the connecting rod bearings have been fitted.
16. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the rod bearing seats on the crankshaft journal.
17. Install the connecting rod cap. Tighten the nuts on 5.0L engines to 26-33 N·m (19-24 ft-lb); on 5.8L to 54-61 N·m (40-45 ft-lb).
18. Check the side clearance between the connecting rods on each connecting rod crankshaft journal after the piston and connecting rod assemblies have been installed. Refer to Specifications at the end of this section.
19. Install a new rear oil seal as described in this section.
20. Install the timing chain, the sprockets, cylinder front cover and crankshaft pulley and adapter as outlined.
21. Coat the threads of the flywheel attaching bolts with oil-resistant Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A-Type II) or equivalent. Position the flywheel on the crankshaft flange. Install and tighten the bolts to 102-115 N·m (75-85 ft-lb).

On a flywheel for manual shift transmission, use Clutch Housing Alignment Tool T75L-6392-A to locate the clutch disc. Install the pressure plate. Tighten the attaching bolts to 102-115 N·m (75-85 ft-lb).

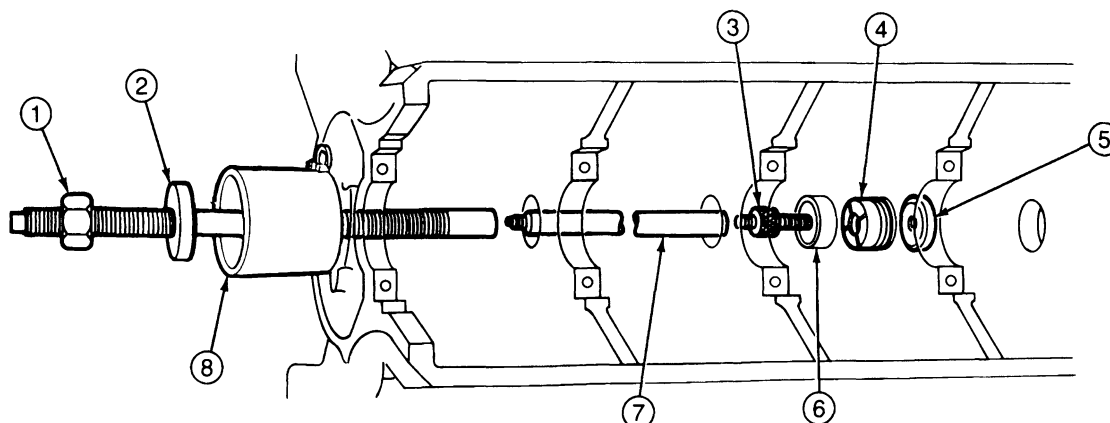
22. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling the inlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and oil pan as described in this section.
23. Install the oil filter.
24. Install the spark plugs, distributor cap and spark plug wires. Connect the spark plug wires and high-tension lead.
25. Install the engine in the vehicle as described in this section.

Camshaft Bearings

Camshaft bearings are available prefinished to size for standard and 0.38mm (0.015 inch) undersize journal diameters. The bearings are not interchangeable from one bore to another.

Removal

1. Remove the camshaft, flywheel and crankshaft as outlined. Push the pistons to the top of the cylinders.
2. Select the proper size expanding collet and backup nut and assemble on the expanding mandrel Camshaft Bearing Set T65L-6250-A.
3. With the expanding collet collapsed, install the collet assembly in the camshaft bearing, and tighten the backup nut on the expanding mandrel until the collet fits the camshaft bearing.
4. Assemble the puller screw and extension (if necessary) and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning.
5. Repeat the procedure for each bearing. To remove the front bearing, install the puller screw from the rear of the cylinder block.

REMOVAL AND INSTALLATION (Continued)**Camshaft Bearings, Removal/Installation**

A9045-D

Item	Part Number	Description
1	—	Pulling Screw
2	—	Pulling Plate
3	—	Expanding Mandrel
4	—	Expanding Collet
5	—	Backup Nut
6	6262	Bearing, Camshaft (Part Number Given is For Reference Only)

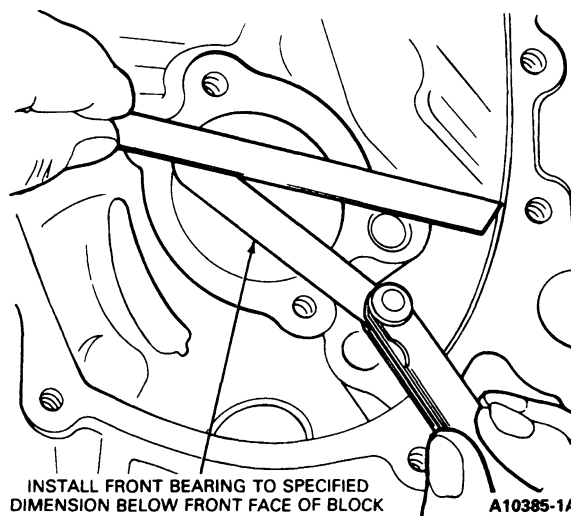
Item	Part Number	Description
7	—	Puller Screw Extension
8	—	Front Spacer
NOTE: All items except #6 (Bearing) are included in Camshaft Bearing Set T65L-6250-A		

TA9045A

(Continued)

Installation

1. Position the new bearing at the bearing bores with the oil holes aligned and press them in place with the Camshaft Bearing Set T65L-6250-A. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. Failure to use the correct expanding collet can cause severe bearing damage. Make sure the front bearing is installed 0.127-0.508mm (0.005-0.020 inches) below the front face of the cylinder block.



A10385-1A

2. Install a new rear bearing bore plug.
3. Install the camshaft, crankshaft, flywheel and related parts as outlined. Do not check connecting rod and main bearing clearances as a part of Camshaft Bearing Replacement. Install the engine in the vehicle.

DISASSEMBLY AND ASSEMBLY

NOTE: Lightly oil attaching bolt and stud threads before installation, except those specifying special sealant.

Refer to Section 03-00 for the cleaning and inspection procedures.

Engine

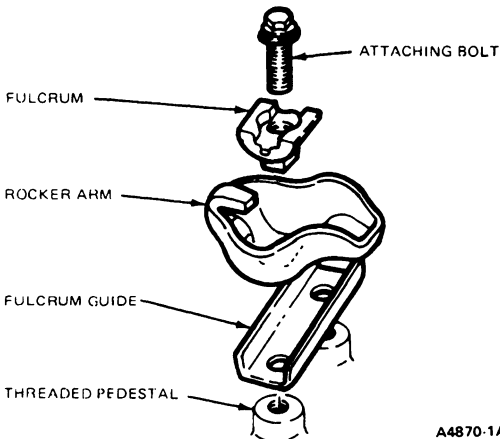
Disassembly

NOTE: Before starting disassembly, remove all wiring harnesses, emission control system, fuel system, ignition system, flywheel, rear cover plate and front end accessory drive components.

For more detailed information on a particular system, refer to the specific section in the appropriate repair group.

With the engine mounted on a workstand:

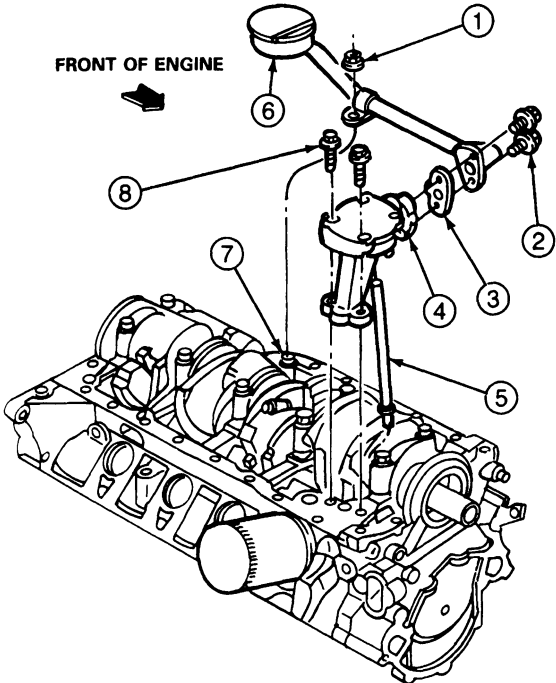
1. Remove the left and right rocker arm covers and discard the gaskets.
2. Remove the upper and lower intake manifold assemblies.
3. Remove the oil dipstick and tube assembly and remove the oil filter.
4. Remove the valve rocker arms, fulcrums, push rods, guides and tappets and remove the cylinder heads as outlined.



A4870-1A

NOTE: All valve train components should be identified to make sure they are installed in their original positions during assembly.

5. Remove the crankshaft pulley and damper as outlined.
6. Remove the water pump and front cover as an assembly. Discard the gasket and seal.
7. Remove the oil pan and discard the gasket.
8. Remove the oil pump, screen and cover assembly and intermediate driveshaft.



FRONT OF ENGINE

5.0L SHOWN, 5.8L SIMILAR

A13397-B

Item	Part Number	Description
1	33771	Nut 3/8-16 30-43 N-m (22-32 Ft-Lb)
2	391378	Screw and Washer 5/16-18 x 1.13 16-24 N-m (12-18 Ft-Lb)
3	6625	Gasket
4	6600	Oil Pump
5	6A618	Intermediate Driveshaft
6	6622	Oil Pump Screen and Cover Assembly (Typical)
7	—	Third Main (Reference)

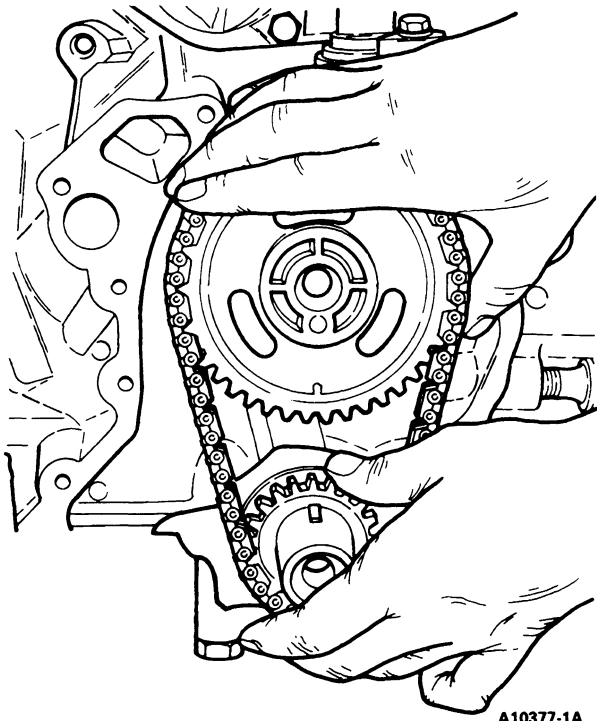
TA13397A

9. Remove the rear crankshaft seal.
10. Remove the camshaft sprocket, capscrew, washer and eccentric or timing flag. Slide the sprocket and timing chain forward and remove the chain and sprocket as an assembly.
11. Remove the camshaft thrust plate and remove the camshaft.

NOTE: Pistons, connecting rods and bearings should be numbered to make sure they are assembled in their original positions.

DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: Before removing pistons, inspect the top of the cylinder bores. If necessary, remove the ridge and / or carbon deposits from each cylinder using Cylinder Ridge Reamer T64L-6011-EA as outlined in Section 03-00.



A10377-1A

12. Remove the connecting rod caps and remove the pistons.
13. Remove the crankshaft main bearing caps, bearings and crankshaft.

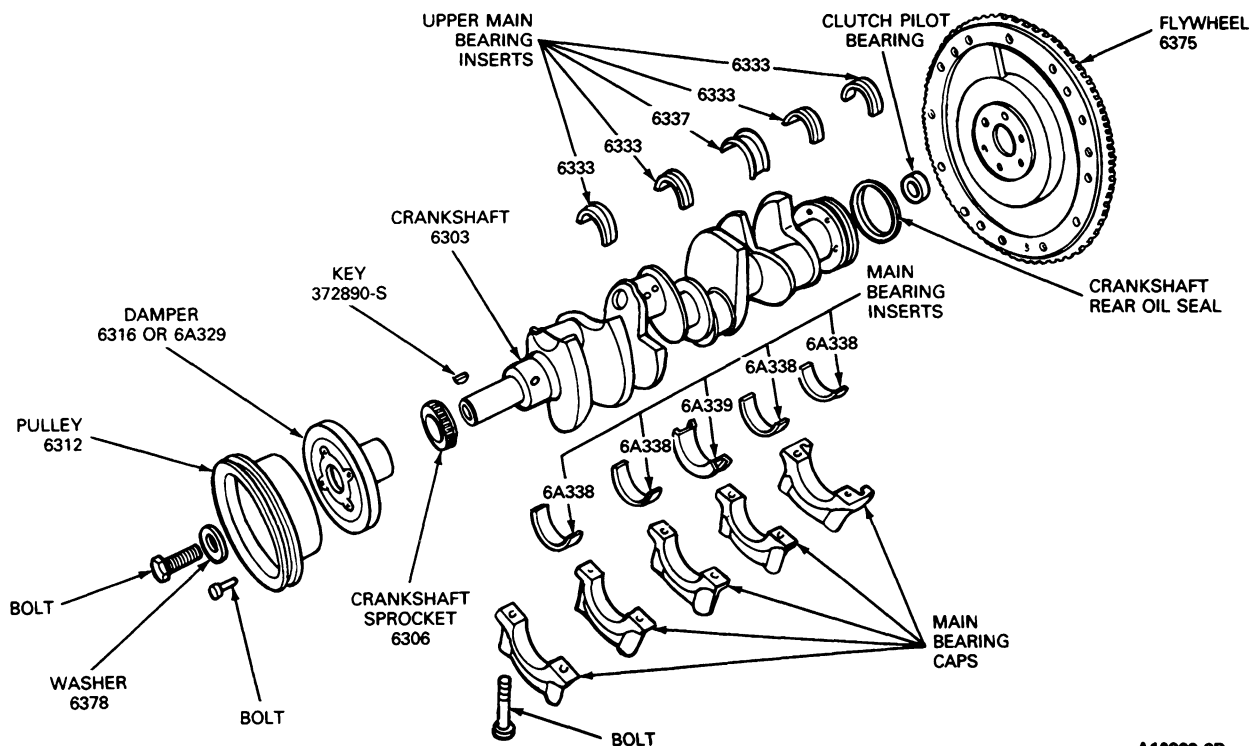
CAUTION: When removing the crankshaft, take care not to damage any of the bearing surfaces on the crankshaft.

NOTE: The location of the main bearing caps and the main bearing inserts should be identified. When the engine is assembled, bearings which are to be reused should be installed in their original positions.

14. For cleaning purposes, the oil gallery and coolant drain plugs can be removed.

DISASSEMBLY AND ASSEMBLY (Continued)

Crankshaft, Disassembled View



A10383-2B

Assembly

Before assembling cylinder block, all sealing surfaces must be clean and free of chips, dirt, paint, and foreign material. Also make sure coolant and oil passages are clear.

If new piston rings are to be installed and no visible cross hatch marks remain on the cylinder wall, remove cylinder wall glaze using a spring-type tool. Follow instructions of tool manufacturer.

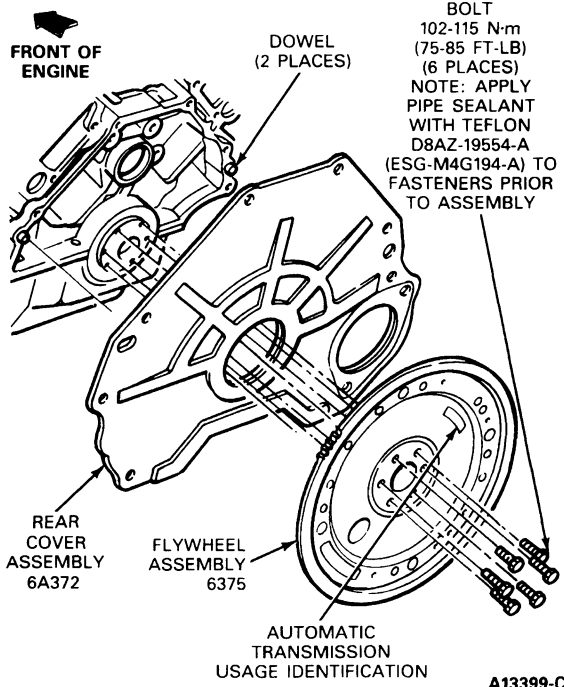
NOTE: Lightly oil all attaching bolt and stud threads before installation, except those specifying special sealant.

1. Place crankshaft upper main bearings in position in the bores with the tang fitting in the slot provided. Lubricate bearings with SAE 50 weight, ESE-M2C39-F or equivalent oil.
2. Install the lower main bearings in the bearing caps.

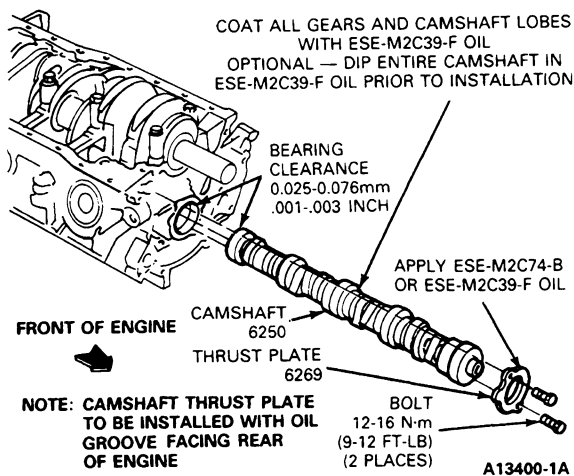
3. Carefully lower crankshaft into place. Use care to prevent damage to bearing surfaces.
4. Check clearance of each main bearing, following the procedure under Fitting Main and Connecting Rod Bearings in Section 03-00.
5. Apply a light coat of engine oil to the journals and bearings after bearings have been fitted.
6. Install all bearings and caps except thrust bearing cap (No. 3 bearing). **MAKE SURE MAIN BEARING CAPS ARE INSTALLED IN THEIR ORIGINAL POSITIONS.** Refer to Main Bearings, Installation in this section for installation of thrust bearing cap. Tighten bearing caps to specification.

DISASSEMBLY AND ASSEMBLY (Continued)

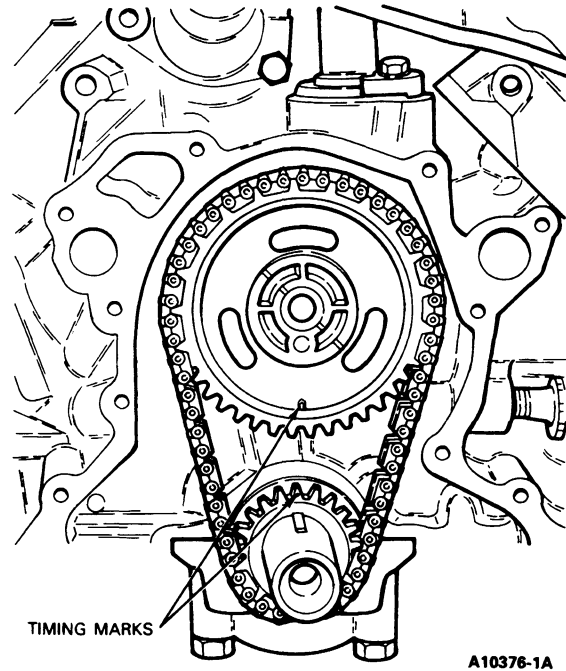
7. Install crankshaft rear oil seal as described in this section. Install rear cover plate and flywheel and tighten bolts to specification.



8. Coat all camshaft bearings, camshaft lobes and gear with engine oil.
9. Carefully slide camshaft through camshaft bearings. Install camshaft thrust plate with groove toward cylinder block. Tighten thrust plate retaining bolts.



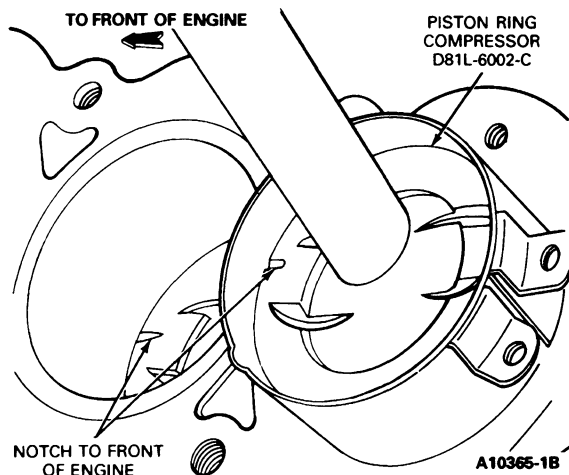
10. Check camshaft end play. Refer to Section 03-00. If not within specification, replace thrust plate.
11. Install camshaft sprocket and timing chain. Position sprocket and timing chain on camshaft and crankshaft sprocket simultaneously. Make sure timing marks on the sprockets are aligned.



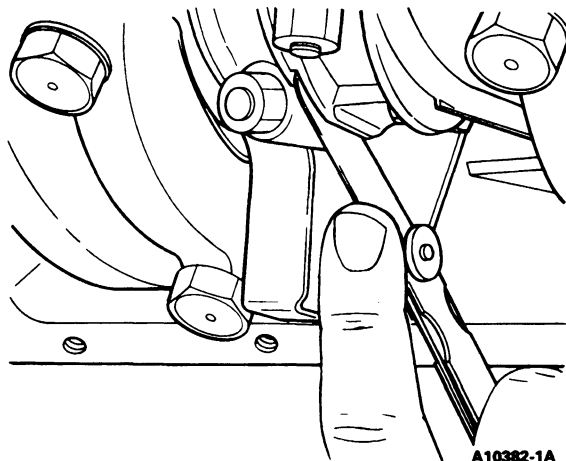
12. Install eccentric or timing flag, washers, and camshaft capscrew. Tighten camshaft capscrew to 55-61 N-m (40-45 ft-lb).
13. Oil the piston rings, pistons and cylinder walls. Be sure to install the pistons in the same cylinders from which they were removed.
14. Make sure the ring gaps are properly spaced around the circumference of the piston. (Refer to Piston and Connecting Rod Installation in this section.)

DISASSEMBLY AND ASSEMBLY (Continued)

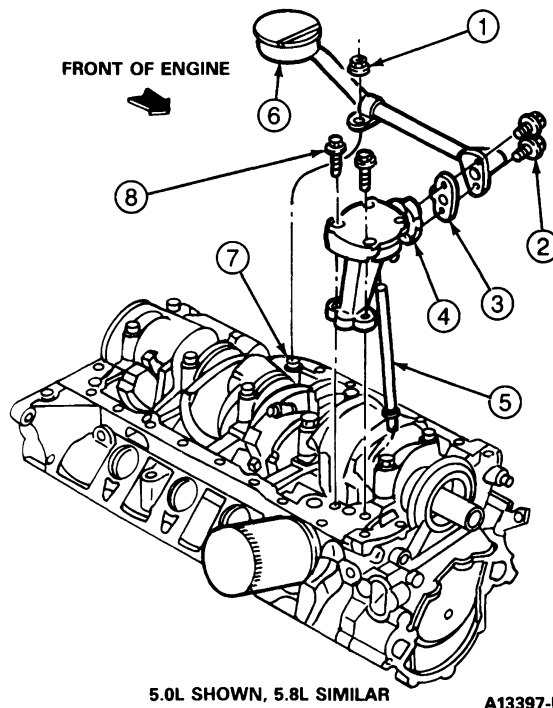
15. Install a piston ring compressor on the piston and push piston in with a hammer handle or an appropriate piston hammer until it is slightly below top of cylinder. Be sure to guide connecting rods to avoid damaging crankshaft journals (cover studs). **INSTALL PISTON WITH INDENTATION NOTCH IN THE PISTON HEAD TOWARD FRONT OF ENGINE.**



16. Check clearance of each connecting rod bearing. Refer to procedure in Section 03-00.
17. After bearings have been fitted, apply a light coat of engine oil to the journals and bearings.
18. Turn the crankshaft throw to the bottom of its stroke. Push piston all the way down until connecting rod bearing seats on the crankshaft journal.
19. Install connecting rod cap. Install nuts and tighten to 26-32 N·m (19-24 ft-lb) for 5.0L engines, or to 55-61 N·m (40-45 ft-lb) for 5.8L engines.
20. After piston and connecting rod assemblies have been installed, check side clearance between connecting rods on each crankshaft journal.



21. Prime the oil pump and install oil pump, intermediate shaft, and screen and cover assembly. Tighten oil pump bolts to 30-43 N·m (22-32 ft-lb).

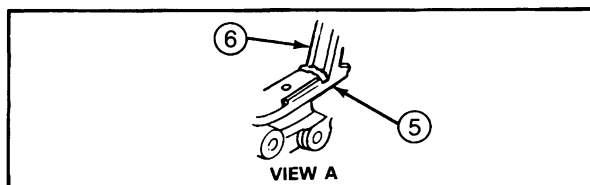
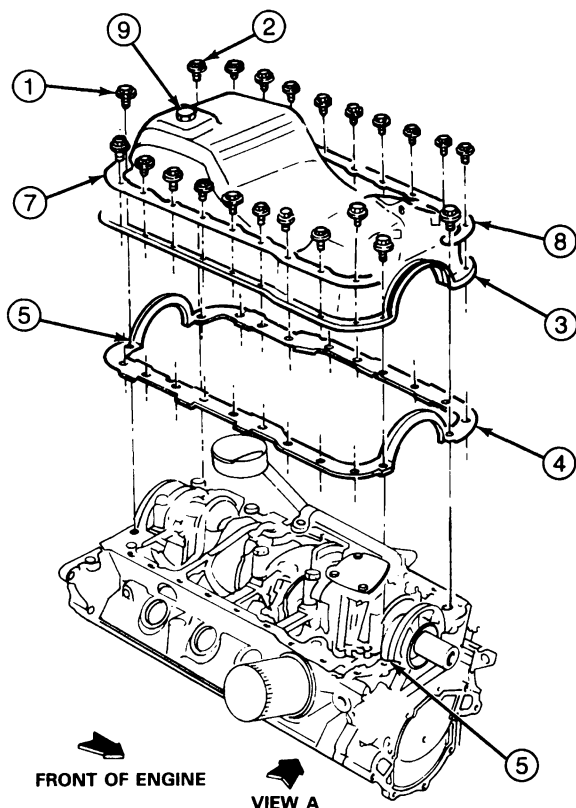


Item	Part Number	Description
1	33771	Nut 3/8-16 30-43 N·m (22-32 Ft-Lb)
2	391378	Screw and Washer 5/16-18 x 1.13 16-24 N·m (12-18 Ft-Lb)
3	6625	Gasket
4	6600	Oil Pump
5	6A618	Intermediate Driveshaft
6	6622	Oil Pump Screen and Cover Assembly (Typical)
7	—	Third Main (Reference)

TA13397A

22. Install crankshaft oil seal in front cover. (Refer to the procedure in this section.)
23. Install front cover seal, gasket, timing pointer and front cover. Tighten cover bolts to specification. Refer to Procedure in this section. Also, install crankshaft damper and pulley and torque bolt to specification.
24. Install new oil filter.
25. Install oil pan gasket and seal assembly. Install oil pan. Tighten oil pan bolts to specification.

DISASSEMBLY AND ASSEMBLY (Continued)



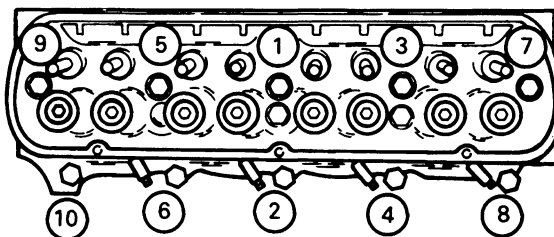
A13396-D

Item	Part Number	Description
1	390657	Bolt 5/16-18 x 1.12 16-24 N-m (12-18 Ft-Lb)
2	390658	Bolt 1/4-20 x .94 9-14 N-m (80-124 In-Lb)
3	6675	Oil Pan Assembly
4	6710	Gasket, Oil Pan
5	—	Apply Silicone Rubber D6AZ-19562-BA (ESE-M4G195-A) Sealer (2 Places)
6	6B041	Front Cover
7	6694	Reinforcement, Left Side
8	6A674	Reinforcement, Right Side
9	6730	Drain Plug, 20-33 N-m (15-25 Ft-Lb)

TA 13396A

26. Install tappets in their original bores.
27. Install tappet guide plate (roller tappet engines only) and tighten screws and washers to specification.

28. Position cylinder head gaskets on cylinder block. Install cylinder head locating dowels. Install cylinder heads.
29. Tighten cylinder head bolts to specification, in the sequence shown.

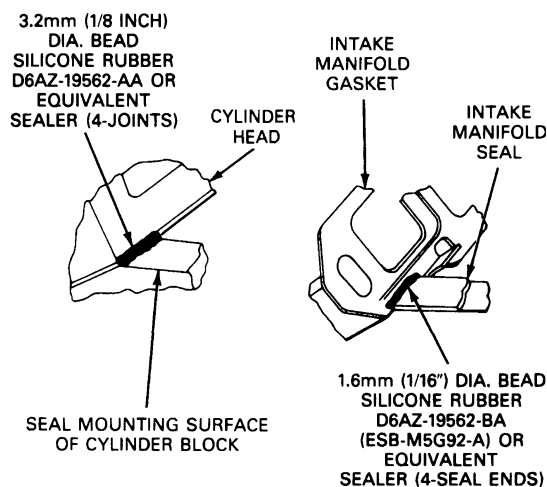


A10374-1A

30. Install valve push rods, rocker arms, fulcrums, fulcrum guides, and tighten fulcrum bolts to specification.

NOTE: If cylinder heads were completely disassembled, refer to Cylinder Head Disassembly and Assembly procedures in this section.

31. Apply sealer at points shown and install intake manifold gaskets and seals.



NOTE: THIS SEALER SETS UP WITHIN 15 MINUTES AFTER APPLICATION. TO ASSURE EFFECTIVE SEALING, ASSEMBLY SHOULD PROCEED PROMPTLY.

A3715-J

32. Install lower and upper intake manifold. Use guide pins to ease installation of intake manifold onto cylinder head.

NOTE: Sealer sets up in 15 minutes, so it is important that the assembly be completed promptly.

NOTE: On E-150-250-350 vehicles, do not install upper intake manifold until engine is installed in vehicle. There is not enough room to install engine with upper intake manifold installed.

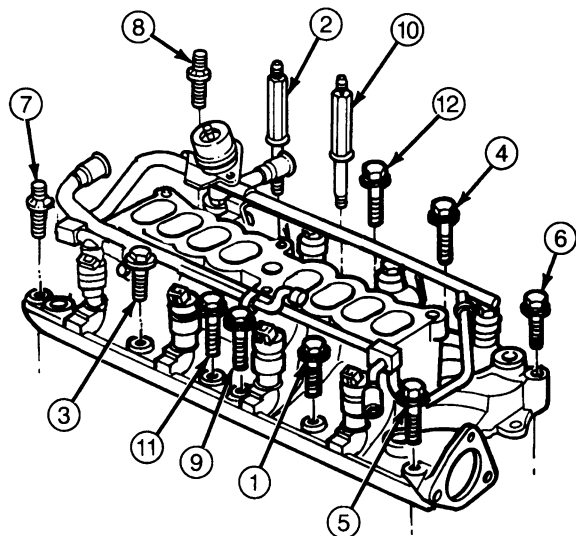
DISASSEMBLY AND ASSEMBLY (Continued)

33. Tighten intake manifold bolts in two steps using the sequence shown.

Step 1 — 16 N·m (12 ft-lb)

Step 2 — 32-33 N·m (23-25 ft-lb)

5.0L and 5.8L Shown, 5.8L Lightning Similar



A10698-C

34. Install oil dipstick tube and indicator assembly.
35. Position valve rocker arm cover gasket in each cover and install valve rocker arm covers. Refer to Valve Rocker Arm Cover and Rocker Arm, Installation in this section.
36. Install wiring harnesses, emission control system, fuel system, ignition system and front end accessory drive components, by referring to procedure in appropriate section.

Tappet

The internal parts of each hydraulic tappet assembly are matched sets. Do not mix the parts. Keep the assemblies intact until they are to be cleaned.

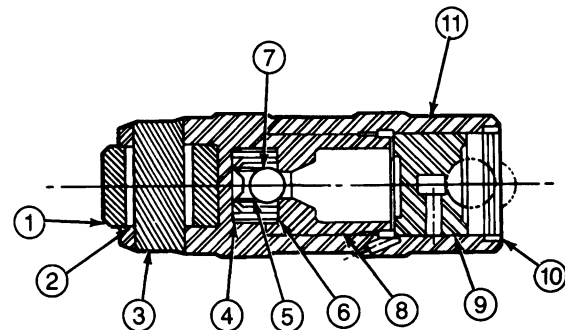
Tappets should always be tested after assembly. Refer to Section 03-00.

Disassembly

Disassemble and assemble each tappet separately. Keep the tappet assemblies in proper sequence so that they can be installed in their original bores.

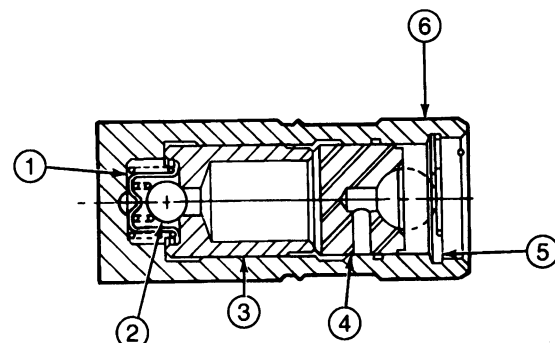
1. Grasp the plunger retainer with needlenose pliers to release it from the groove. It may be necessary to depress the leakdown plunger to fully release the plunger retainer.
2. Remove the push rod socket, metering valve (disc), plunger and spring.

3. Carefully remove the plunger spring, the check valve retainer socket, the check valve spring and valve from the plunger.

Roller Tappet, 5.0L Engine

A16238-A

Item	Description
1	Cam Roller
2	Needles
3	Axle
4	Plunger Spring
5	Check Ball Spring
6	Ball Retainer
7	Check Ball
8	Leakdown Plunger
9	Plunger Retainer
10	Plunger Retainer
11	Body

Non-Roller Tappets, 5.8L and 5.8L Lightning Engine

A17900-A

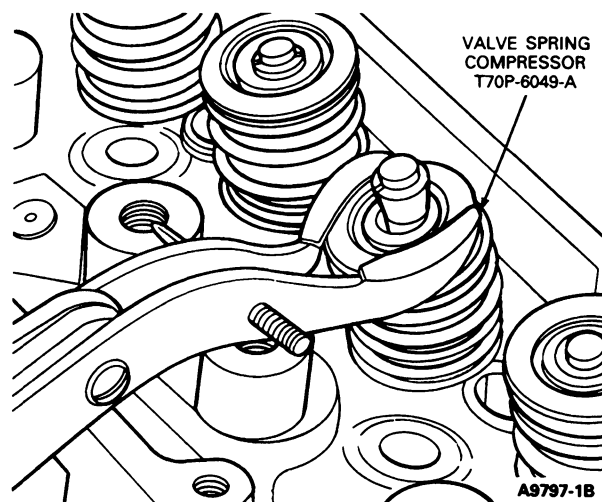
Item	Description
1	Check Ball Spring
2	Check Ball
3	Leakdown Plunger
4	Push Rod Socket
5	Plunger Retainer
6	Body

DISASSEMBLY AND ASSEMBLY (Continued)**Assembly**

1. Place the plunger upside down on a clean workbench.
2. Place the check valve (disc or check ball) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or check ball).
3. Position the check valve retainer over the check valve and spring and push the retainer down into place on the plunger.
4. Place the plunger spring, and then the plunger (open end up) into the tappet body.
5. Position the metering valve (disc) in the plunger and then place the push rod socket in the plunger.
6. Depress the plunger, and position the closed end of the plunger retainer in the groove of the tappet body. With the plunger still depressed, position the open ends of the plunger retainer in the groove. Release the plunger, and then depress it again to fully seat the plunger retainer.
7. Use the Tappet Leakdown Tester Tool-6500-E to fill the tappets with test fluid. Refer to Section 03-00.

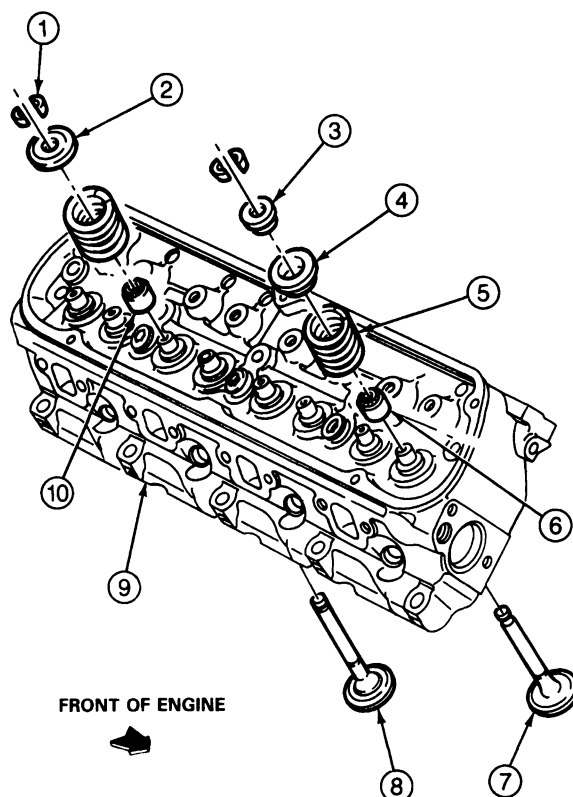
Cylinder Heads**Disassembly**

1. Remove the exhaust manifolds and the spark plugs.
2. Clean the carbon out of the cylinder head combustion chambers before removing the valves.
3. Carefully compress the valve spring using Valve Spring Compressor T70P-6049-A. Remove the spring retainer keys and release the spring.



4. Remove the sleeve, spring retainer or retainer/rotator, spring, guide mounted stem seal and valve. Discard the valve stem seals. Identify all valve parts.

5. Clean, inspect and repair the cylinder head as required, or transfer all usable parts to a new cylinder head.



A17841-A

Item	Part Number	Description
1	6518	Key
2	6A516	Retainer/Rotator (Exhaust Only)
3	6517	Sleeve (Intake Only)
4	6514	Retainer (Intake Only)
5	6513	Spring, Valve
6	6A517	Seal, Valve (White, Intake Only)
7	6507	Valve, Intake
8	6505	Valve, Exhaust
9	6049	Cylinder Head
10	6A517	Seal, Valve (Exhaust Only)

TA17841A

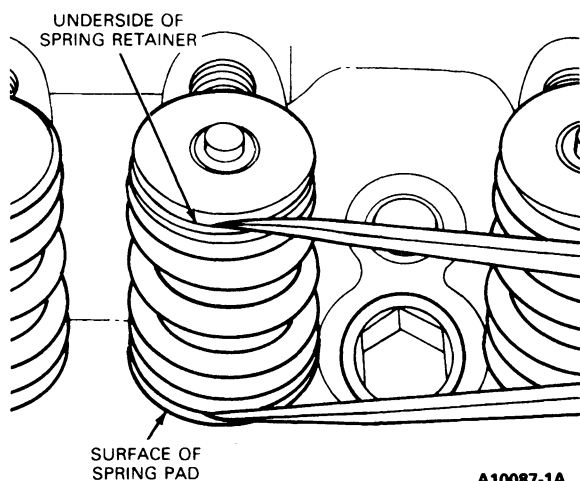
Assembly

1. Install each valve in the port from which it was removed or to which it was fitted. Install a new stem seal on the intake valve guide and exhaust valve guide.

DISASSEMBLY AND ASSEMBLY (Continued)

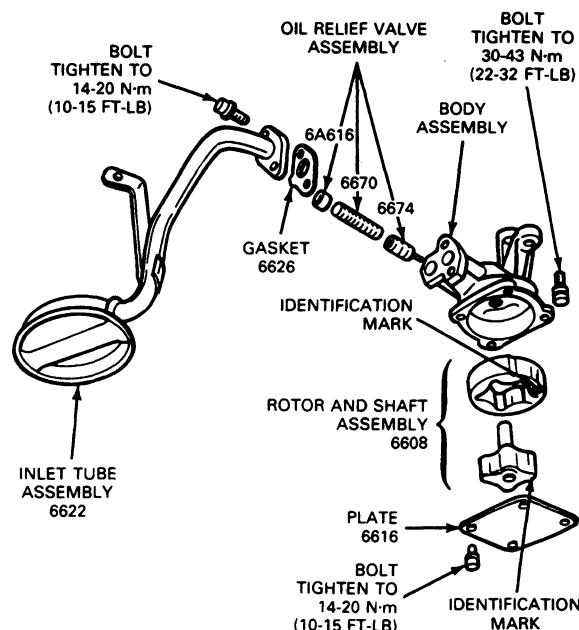
2. Install the valve spring over the valve, and then install the spring retainer and sleeve. Compress the spring using Valve Spring Compressor T70P-6049-A and install the retainer locks.
3. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers. Check the dividers against a scale. If the assembled height is greater than specifications, install the necessary 0.762mm (0.030-inch) thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended height.

Do not install the spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.



A10087-1A

4. Install the exhaust manifolds and the spark plugs.



A2535-1E

Assembly

The oil pump assembly is shown.

1. Clean, inspect and oil all parts thoroughly.
2. Install the oil pressure relief valve plunger, spring and a new cap.
3. Install the outer race and the inner rotor and shaft assembly. **Be sure the dimple (identification mark) on the outer race is facing the same side as the identification mark on the rotor.**
4. Install the cover and tighten the cover attaching bolts to 30-43 N·m (22-32 ft-lb).

Oil Pump**Disassembly**

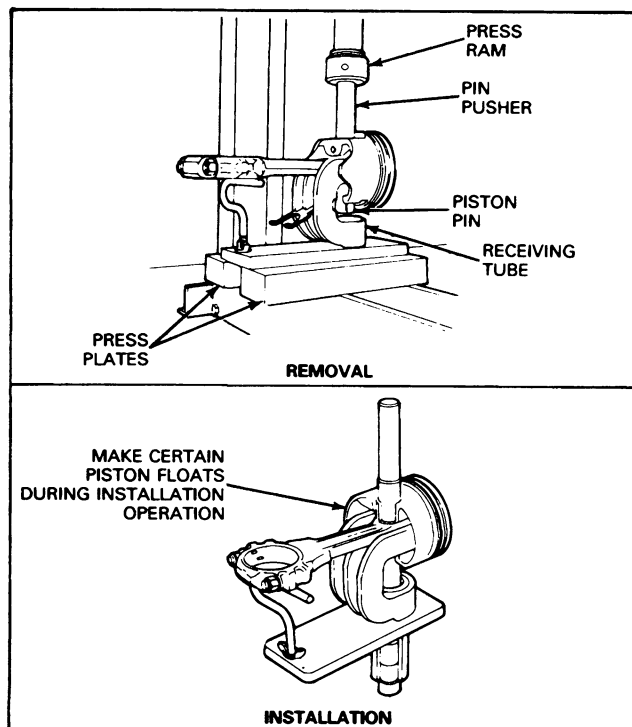
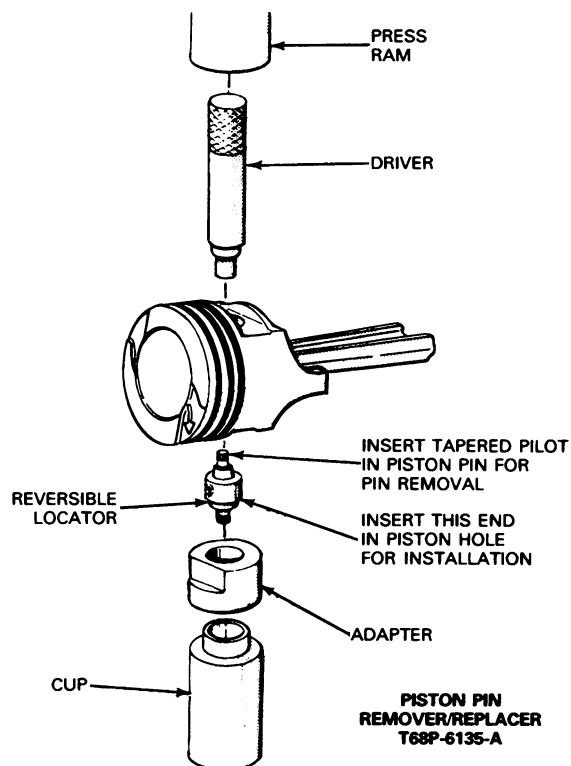
1. Remove the oil inlet tube from the oil pump and remove the gaskets.
2. Remove the cover attaching bolts, then remove the cover. Remove the inner rotor and shaft assembly. Then remove the outer race.
3. Drill a small hole and insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.

Pistons and Connecting Rods**Disassembly**

1. Remove the bearing inserts from the connecting rod and cap.
2. Mark the pistons to make sure they are assembled with the same rod and installed in the same cylinders from which they were removed.
3. Using an arbor press and the Piston Pin Remover / Replacer T68P-6135-A, press the piston pin from the piston and connecting rod. Remove the piston rings if they are to be replaced.

DISASSEMBLY AND ASSEMBLY (Continued)

Piston Pin, Removal and Installation



A4871-2D

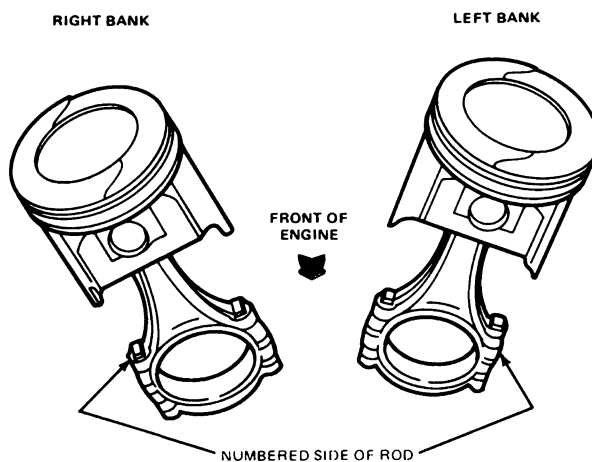
Assembly

The piston, connecting rod and related parts are shown. Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications.

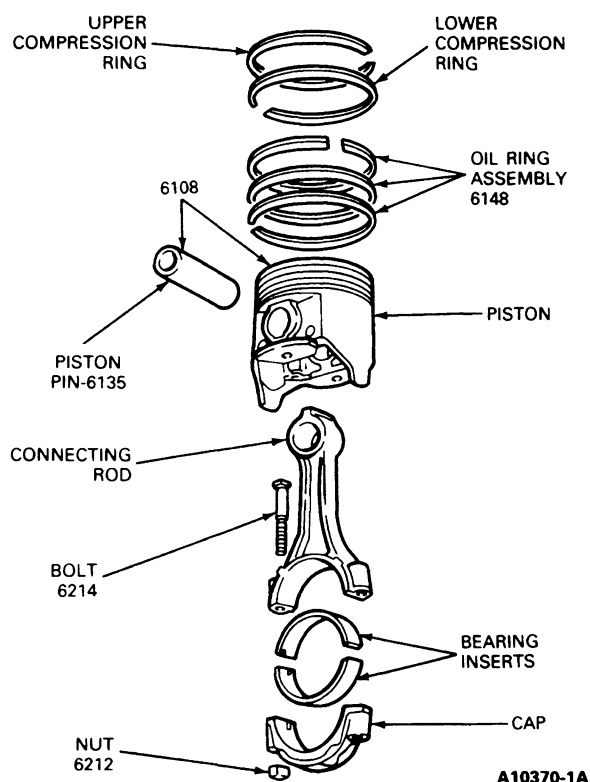
1. Apply a light coat of recommended quality engine oil SG to all parts. **Assemble the piston to the connecting rod with the indentation in the piston positioned as shown.**

On replacement connecting rods, install the large-chamfered side of the connecting rod bearing bore toward the crankshaft cheek; facing toward front of engine on the right bank rods, and facing toward rear of engine on left bank rods.



A6572-1B

DISASSEMBLY AND ASSEMBLY (Continued)



2. Start the piston pin in the piston and connecting rod (this may require a very light tap with a mallet). Using an arbor press and Piston Pin Remover / Replacer T68P-6135-A, press the piston pin through the piston and connecting rod until the pin is centered in the piston.
3. Check the end gap of all piston rings. Refer to Section 03-00. It must be within specifications. Follow the instructions contained on the piston ring package and install the piston rings using a piston ring installation tool of the proper size.
4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land. Refer to Section 03-00. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. **If the lower lands have high steps, the piston should be replaced.**
5. Make sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

Cylinder Block Assembly (6009)

Disassembly

1. Mount the old engine in a workstand and remove all parts not furnished with the new cylinder block assembly following Engine Components Removal and Installation procedures in this section.
2. Remove the old cylinder block assembly from the workstand.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder block assembly in a workstand.
3. Transfer all serviceable parts removed from the old cylinder block assembly following Engine Components Removal and Installation procedures in this section.
4. Check all assembly clearances following Specifications listed at the end of this section, and correct as necessary.

Cylinder Block (6010)

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs. Refer to Section 03-00.

Disassembly

1. Completely disassemble the old engine following appropriate removal and installation procedures in this section.
2. Ridge-ream the cylinder bores before removing piston assemblies.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder block in a workstand.
3. Transfer all serviceable parts removed from the old cylinder block following appropriate removal and installation procedures in this section.
4. Check all assembly clearances. Refer to Specifications and correct as necessary.

ADJUSTMENTS

Valve Clearance

The valve arrangement of the left bank is E-I-E-I-E-I-E-I and on the right bank is I-E-I-E-I-E-I-E.

A 1.52mm (0.060 inch) shorter push rod or a 1.52mm (0.060 inch) longer push rod is available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List for the appropriate color code.

ADJUSTMENTS (Continued)

Valve stem-to-valve rocker arm clearance should be within specifications with the hydraulic tappet completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if it is not compensated for, the hydraulic valve tappet will cease to function and the valve will be held open.

The positive stop rocker arm bolts eliminate the necessity to adjust the valve clearance. However, to obtain the specified valve clearance, it is important that all valve components be in a serviceable condition and installed and tightened properly.

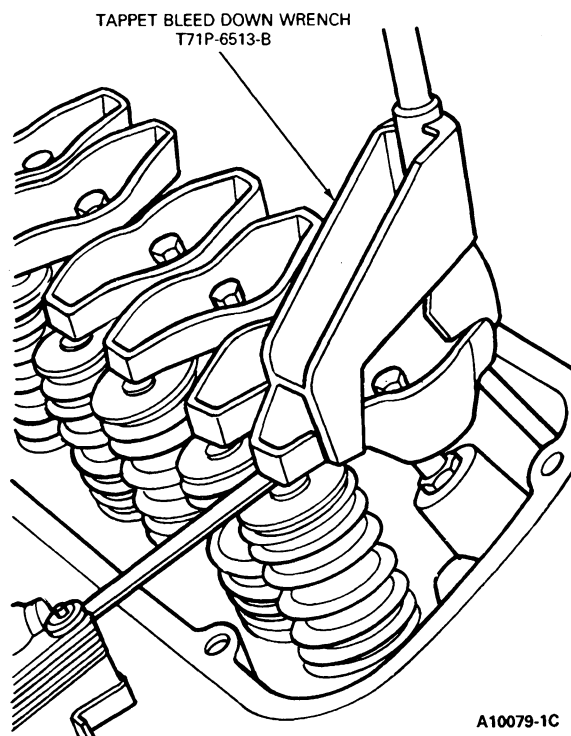
To determine whether a shorter or a longer push rod is necessary, make the following check.

5.0L (302 CID) MFI V-8 Engine

1. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay.
2. Install an auxiliary starter switch between the battery and S terminal of the starter relay. Crank the engine with the ignition switch in off position until the No. 1 piston is on TDC after the compression stroke.
3. Position the tappet compressor tool, Tappet Bleed Down Wrench T71P-6513-B, on the rocker arm with the crankshaft in the positions designated in Steps 4, 5 and 6.

Slowly apply pressure to bleed down the tappet until the plunger is completely bottomed. Hold the tappet in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

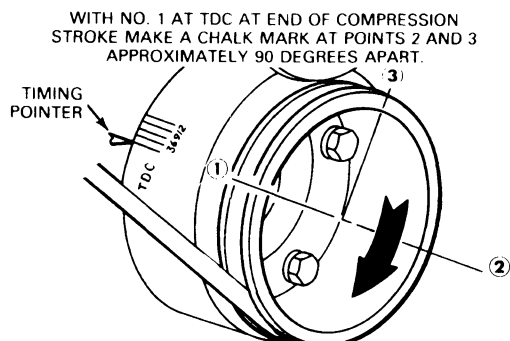
If the clearance is less than specifications, install a shorter push rod. If the clearance is greater than specifications, install a longer push rod.



4. With the No. 1 piston on TDC at the end of the compression stroke, POSITION 1, check the following valves:
No. 1 Intake No. 1 Exhaust
No. 7 Intake No. 5 Exhaust
No. 8 Intake No. 4 Exhaust
5. Rotate the crankshaft to POSITION 2 and check the following valves:
No. 5 Intake No. 2 Exhaust
No. 4 Intake No. 6 Exhaust
6. Rotate the crankshaft to POSITION 3 and check the following valves:
No. 2 Intake No. 7 Exhaust
No. 3 Intake No. 3 Exhaust

ADJUSTMENTS (Continued)

No. 6 Intake No. 8 Exhaust



POSITION 1 — NO. 1 AT TDC AT END OF COMPRESSION STROKE.

POSITION 2 — ROTATE THE CRANKSHAFT 180 DEGREES (1/2 REVOLUTION) CLOCKWISE FROM POSITION 1.

POSITION 3 — ROTATE THE CRANKSHAFT 270 DEGREES (3/4 REVOLUTION) CLOCKWISE FROM POSITION 2.

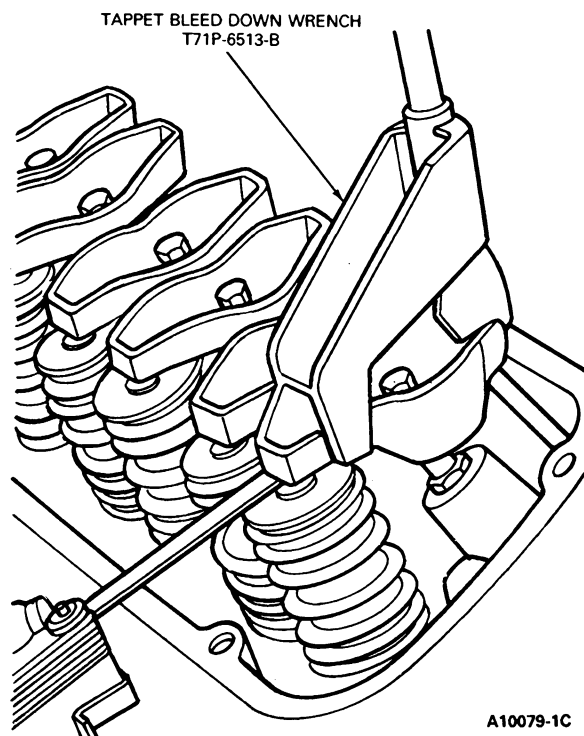
A3234-H

5.8L (351 CID) MFI W-V-8 and 5.8L MFI Lightning W-V-8 Engines

1. Disconnect the red and blue leads (S terminal) at the starter relay.
2. Install an auxiliary starter switch between the battery and S terminals of the starter relay. Crank the engine with the ignition switch in off position until the No. 1 piston is on TDC on the compression stroke.
3. With the crankshaft in the positions designated in steps 4, 5 and 6, position the tappet compressor tool on the rocker arm.

Slowly apply pressure to bleed down the tappet until the plunger is completely bottomed. Hold the tappet in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

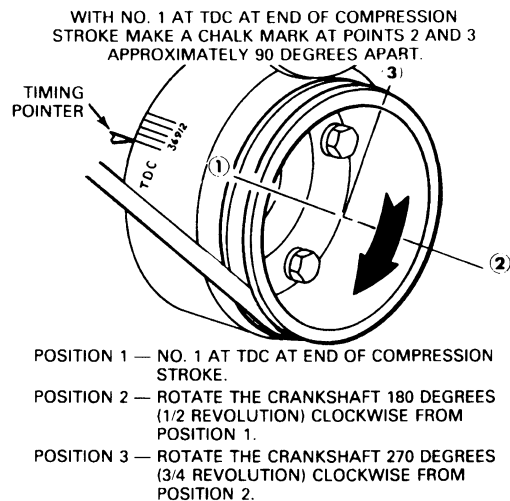
If the clearance is less than specifications, install a shorter push rod. If the clearance is greater than specifications, install a longer push rod.



4. With the No. 1 piston on TDC at the end of the compression stroke, POSITION 1, check the following valves:
No. 1 Intake No. 1 Exhaust
No. 4 Intake No. 3 Exhaust
No. 8 Intake No. 7 Exhaust
5. Rotate the crankshaft to POSITION 2 and check the following valves:
No. 3 Intake No. 2 Exhaust
No. 7 Intake No. 6 Exhaust
6. Rotate the crankshaft to POSITION 3 and check the following valves:
No. 2 Intake No. 4 Exhaust
No. 5 Intake No. 5 Exhaust

ADJUSTMENTS (Continued)

No. 6 Intake No. 8 Exhaust



A3234-H

SPECIFICATIONS

GENERAL SPECIFICATIONS

Engine	Bore and Stroke	Firing Order	Oil Pressure Hot @ 2000 RPM		Engine Type and Number of Cylinders
			kPa	(PSI)	
5.0L (302 CID) MFI V-8	4.00 x 3.00	15426378	275-413	(40-60)	O.H.V. V-8
5.8L (351 CID) MFI W-V-8	4.00 x 3.50	13726548	275-448	(40-65)	O.H.V. V-8
5.8L (351 CID) MFI Lightning W-V-8	4.00 x 3.50	13726548	275-448	(40-65)	O.H.V. V-8

CYLINDER HEAD

Engine	Combustion Chamber Volume C.C. ^b	Valve Guide Bore Diameter		Valve Seat Width ^a		Valve Seat Runout TIR Maximum	Valve Arrangement Front to Rear	Gasket Surface Flatness ^c
		Intake	Exhaust	Intake	Exhaust			
5.0L (302 CID) MFI V-8	60.6-63.6	.3433-.3443	.3433-.3443	.060-.080	.060-.080	.002	RT I-E-I-E-I-E-I-E LT E-I-E-I-E-I-E-I	.003 in any 6 inch .006 overall
5.8L (351 CID) MFI W-V-8	60.6-63.6	.3433-.3443	.3433-.3443	.060-.080	.060-.080	.002	RT I-E-I-E-I-E-I-E LT E-I-E-I-E-I-E-I	.003 in any 6 inch .006 overall
5.8L (351 CID) Lightning MFI W-V-8	60.6-63.6	.3433-.3443	.3433-.3443	.060-.080	.060-.080	.002	RT I-E-I-E-I-E-I-E LT E-I-E-I-E-I-E-I	.003 in any 6 inch .006 overall

a Valve seat angle — 45°.

b Compression pressure (PSI) of the lowest cylinder must be at least 75% of the highest to be within specification.

c Gasket surface finish — RMS 60-150.

SPECIFICATIONS (Continued)

VALVE ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

Engine	Rocker Arm Lift Ratio to 1	Push Rod Runout TIR Maximum	Valve Tappet or Lifter			Collapsed Tapped Gap (Clearance)	
			Standard Diameter	Clearance to Bore ^a	Hydraulic Lifter Leakdown Rate ^b	Allowable	Desired
5.0L (302 CID) MFI V-8	1.59	.015	.8740-.8745	.0007-.0027	10 to 50 seconds for 1/16 travel	.071-.171	.091-.151
5.8L (351 CID) MFI W-V-8	1.59	.015	.8740-.8745	.0007-.0027	10 to 50 seconds for 1/16 travel	.092-.192	.112-.172
5.8L (351 CID) MFI Lightning W-V-8	1.59	.015	.8740-.8745	.0007-.0027	10 to 50 seconds for 1/16 travel	.092-.192	.112-.172

a Service limit .005.

b Time required for plunger to leakdown .0625 inch under load of 50 lbs. using leakdown fluid in tappet.

VALVE SPRINGS

Engine	Valve Spring Compression Pressure (lbs) @ Specified Height		Valve Spring Free Length (Approximate)		Valve Spring Assembled Height		Valve Spring Out of Square
	Intake ^a	Exhaust	Intake	Exhaust	Intake	Exhaust	
5.0L (302 CID) MFI V-8	74-82 @ 1.78 196-212 @ 1.36	76-84 @ 1.60 190-210 @ 1.20	2.06	1.88	1.75-1.81	1.58-1.64	5/64 (.078)
5.8L (351 CID) MFI W-V-8	74-82 @ 1.78 190-210 @ 1.20	76-84 @ 1.60 190-210 @ 1.20	2.06	1.88	1.75-1.81	1.58-1.64	5/64 (.078)
5.8L (351 CID) MFI W-V-8 Lightning	74-82 @ 1.78 190-210 @ 1.20	76-84 @ 1.60 190-210 @ 1.20	2.06	1.88	1.75-1.81	1.58-1.64	5/64 (.078)

a Service limit — 10% loss pressure.

VALVES

Engine	Valve Stem to Guide Clearance ^a		Valve Head Diameter ^b		Valve Face Runout Maximum
	Intake	Exhaust	Intake	Exhaust	
5.0L (302 CID) MFI V-8	.0010-.0027	.0015-.0032	1.690-1.694	1.439-1.463	.002
5.8L (351 CID) MFI W-V-8	.0010-.0027	.0015-.0032	1.770-1.794	1.453-1.468	.002
5.8L (351 CID) MFI Lightning W-V-8	.0010-.0027	.0015-.0032	1.837-1.847	1.536-1.546	.002

a Service clearance — .0055.

b Valve face angle — 44°.

VALVE STEM DIAMETER

Engine	Standard		.015 Oversize		.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
5.0L (302 CID) MFI V-8	.3415-.3423	.3410-.3418	.3565-.3573	.3561-.3568	.3715-.3723	.3711-.3718
5.8L (351 CID) MFI W-V-8	.3415-.3423	.3410-.3418	.3565-.3573	.3561-.3568	.3715-.3723	.3711-.3718
5.8L (351 CID) MFI V-8	.3415-.3423	.3410-.3418	.3565-.3573	.3561-.3568	.3715-.3723	.3711-.3718

SPECIFICATIONS (Continued)

CAMSHAFT

Engine	Lobe Lift ^a		Camshaft End Play		Camshaft Journal to Bearing Clearance ^b
	Intake	Exhaust	End Play	Wear Limit	
5.0L (302 CID) MFI V-8	.2375	.2474	.001-.007	.009	.001-.003
5.8L (351 CID) MFI W-V-8	.2780	.2830	.001-.007	.009	.001-.003
5.8L (351 CID) MFI Lightning W-V-8	.2600	.2780	.001-.007	.009	.001-.003

a Maximum allowable lift loss — .005.

b Service limit — .006 maximum.

CAMSHAFT DRIVE

Engine	Camshaft Journal Diameter — Standard ^a					Camshaft Bearing Inside Diameter					Camshaft Front Bearing Location ^b
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 1	No. 2	No. 3	No. 4	No. 5	
5.0L (302 CID) MFI V-8	2.0805	2.0655	2.0505	2.0355	2.0205	2.0825	2.0675	2.0525	2.0375	2.0225	.005-.020
5.8L (351 CID) MFI W-V-8	2.0815	2.0665	2.0515	2.0365	2.0215	2.0835	2.0685	2.0535	2.0385	2.0235	.005-.020
5.8L (351 CID) MFI Lightning W-V-8	2.0815	2.0665	2.0515	2.0365	2.0215	2.0835	2.0685	2.0535	2.0385	2.0235	.005-.020

a Camshaft journal runout — .005 TIR maximum.

b Distance in inches that front edge of bearing is installed below the front face of the cylinder block.

NOTE: Timing chain deflection — .500 inches maximum.

CYLINDER BLOCK

Engine	Cylinder Bore Diameter ^a	Main Bearing Bore Diameter ^b	Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness	Head Gasket Surface Finish	Tappet Bore Diameter
5.0L (302 CID) MFI V-8	4.0004-4.0052	2.4412-2.4420	.4525-.4541	.003 in any 6 in. .006 overall	RMS 60-150	.8752-.8767
5.8L (351 CID) MFI W-V-8	4.0000-4.0048	3.1922-3.1930	.5155-.5170	.003 in any 6 in. .006 overall	RMS 60-150	.8752-.8767
5.8L (351 CID) MFI Lightning W-V-8	4.0000-4.0048	3.1922-3.1930	.5155-.5170	.003 in any 6 in. .006 overall	RMS 60-150	.8752-.8767

a Maximum out-of-round — .0015, Service limit — .005, Maximum taper service limit — .010, Cylinder bore surface finish — RMS 18-38, Bore tapes service limit — .010.

b Crankshaft to rear face of block runout. TIR maximum .005.

CRANKSHAFT AND FLYWHEEL

Engine	Main Bearing Journal Diameter ^a	Main Bearing Journal Runout TIR Maximum ^b	Main Bearing Thrust Face Runout TIR Maximum	Main Bearing Journal Taper Maximum Per Inch	Thrust Bearing Journal Length	Main and Rod Bearing Journal Finish RMS Maximum	Main Bearing Thrust Face Finish RMS Maximum
5.0L (302 CID) MFI V-8	2.2482-2.2490	.002	.001	.0005	1.137-1.139	12	25 Front — 20 Rear
5.0L (351 CID) MFI W-V-8	2.9994-3.0002	.002	.001	.0005	1.137-1.139	12	25 Front — 20 Rear
5.8L (351 CID) MFI Lightning W-V-8	2.9994-3.0002	.002	.001	.0005	1.137-1.139	12	25 Front — 20 Rear

a Maximum out-of-round — .0006.

b Service limit — .005.

SPECIFICATIONS (Continued)

CRANKSHAFT AND FLYWHEEL (Continued)

Engine Assembled	Connecting Rod Journal Diameter ^a	Connecting Rod Journal Taper Per Inch Maximum	Crankshaft Free End Play ^b	Flywheel Clutch Face Run-Out
5.0L (302 CID) MFI V-8	2.1228-2.1236	.0006	.004-.008	0.010
5.8L (351 CID) MFI W-V-8	2.3103-2.3111	.0006	.004-.008	0.010
5.8L (351 CID) MFI Lightning W-V-8	2.3103-2.3111	.0006	.004-.008	0.010

a Maximum out-of-round — .0006.

b Service limit — .012.

CRANKSHAFT BEARINGS

Engine	Connecting Rod Bearing To Crankshaft Clearance Selective Fit			Main Bearing to Crankshaft Clearance Selective Fit ^a		
	Desired	Allowable	Bearing Wall Thickness Std. ^a	Desired	Allowable	Bearing Wall Thickness Std. ^a
5.0L (302 CID) MFI V-8	.0008-.0015	.0007-.0024	.0572-.0577	.0008-.0015 ^b	.0008-.0026 ^c	.0957-.0960 ^d
5.8L (351 CID) MFI W-V-8	.0008-.0015	.0008-.0025	.0572-.0577	.0008-.0015 ^b	.0008-.0026 ^c	.0957-.0960 ^d
5.8L (351 CID) MFI Lightning W-V-8	.0008-.0015	.0008-.0025	.0572-.0577	.0008-.0015 ^b	.0008-.0026 ^c	.0957-.0960 ^d

a For .002 undersize add .001 to standard wall thickness.

b #1 Bearing — .0001-.0015; all others — .0005-.0015.

c #1 Bearing — .0001-.0020; all others — .0005-.0024.

d #1 Upper only .0961 — .0966; all others — .0957-.0962.

CONNECTING ROD

Engine	Piston Pin Bore or Bushing I.D.	Rod Bearing Bore I.D. ^a	Rod Length Center to Center	Connecting Rod Alignment Maximum Total Difference		Rod to Crankshaft Assembled Side Clearance ^b
				Twist ^b	Bend ^c	
5.0L (302 CID) MFI V-8	.9096-.9112	2.2390-2.2398	5.0885-5.0915	.015	.012	.010-.020
5.8L (351 CID) MFI W-V-8	.9097-.9112	2.4265-2.4273	5.9545-5.9575	.024	.012	.010-.020
5.8L (351 CID) MFI Lightning W-V-8	.9097-.9112	2.4265-2.4273	5.9545-5.9575	.024	.012	.010-.020

a Connecting rod bearing bore maximum out-of-round — .0004

b Service limit — .023

c Pin bushing and crankshaft bore must be parallel and in same vertical plane with specified total difference when measured at the ends of an 8-inch long bar, 4 inches on each side of rod centerline.

PISTON

	DIAMETER ^a			Piston to Bore Clearance Selective Fit	Piston Pin Bore Diameter	Ring Groove Width Compression		
	Coded Red	Coded Blue	.003 Oversize Coded Yellow			Top	Bottom	Oil
5.0L (302 CID) MFI V-8	3.9989-3.9995	4.0001-4.0007	4.0013-4.0019	.0014-.0022	.9123-.9126	.060-.061	.060-.061	.1587-.1597
5.8L (351 CID) MFI W-V-8	3.9978-3.9984	3.9990-3.9996	4.0002-4.0008	.0018-.0026	.9123-.9126	.080-.081	.080-.081	.188-.189
5.8L (351 CID) MFI Lightning W-V-8	3.9984-3.9990	3.9996-4.0002	4.0008-4.0018	.0015-.0023	.9123-.9126	.080-.081	.080-.081	.188-.189

a Measured at the piston pin bore centerline at 90° to the pin.

SPECIFICATIONS (Continued)

PISTON PIN

Engine	Length	Diameter			To Piston Pin Bore Clearance ^a	To Connecting Rod Bushing Clearance
		Standard	.001 Oversize	.002 Oversize		
5.0L (302 CID) MFI V-8	3.010-3.040	.9119-.9124	.9130-.9133	.9140-.9143	.0002-.0004	Interference Fit
5.8L (351 CID) MFI W-V-8	3.010-3.040	.9119-.9124	.9130-.9133	.9140-.9143	.0003-.0005	Interference Fit
5.8L (351 CID) MFI Lightning W-V-8	3.010-3.040	.9119-.9124	.9130-.9133	.9140-.9143	.0003-.0005	Interference Fit

a Selective fit.

PISTON RINGS

Engine	Ring Width		Side Clearance ^a			Ring Gap		
	Top Compression	Bottom Compression	Top Compression	Bottom Compression	Oil	Top Compression	Bottom Compression	Oil ^b
5.0L (302 CID) MFI V-8	.0577-.0587	.0577-.0587	.0013-.0033	.0013-.0033	Snug	.010-.020	.018-.028	.010-.040
5.8L (351 CID) MFI W-V-8	.077-.078	.077-.078	.002-.004	.002-.004	Snug	.010-.020	.010-.020	.015-.055
5.8L (351 CID) MFI Lightning W-V-8	.0577-.0587	.0577-.0587	.0013-.0033	.0013-.0033	Snug	.010-.020	.018-.028	.010-.040

a Service limit — .002 maximum increase in clearance.

b Steel rail.

OIL PUMP AND OIL CAPACITY

Engine	Relief Valve Spring Pressure Lbs. @ Specified Length	Driveshaft to Housing Clearance	Relief Valve to Housing Clearance	Rotor Assembly End Clearance	Outer Race to Housing Clearance	Engine Oil Capacity ^a		
						U.S. Quarts	Imperial Quarts	Litres
5.0L (302 CID) MFI V-8	10.6-12.2 @ 1.74	.0015-.0030	.0015-.0030	.004 Maximum	.001-.013	5	4.2	4.7
5.8L (351 CID) MFI W-V-8	18.2-20.2 @ 2.49	.0015-.0030	.0015-.0030	.004 Maximum	.001-.003	5	4.2	4.7
5.8L (351 CID) MFI W-V-8	18.2-20.2 @ 2.49	.0015-.0030	.0015-.0030	.004 Maximum	.001-.003	5	4.2	4.7

a Add 1 U.S. quart (or equivalent in imperial quarts or liters) when replacing filter.

TORQUE LIMITS — 5.0L (302 CID) MFI V-8 W-V-8 — 5.8L (351 CID) MFI LIGHTNING W-V-8

1/4-20	5/16-18	5/16-24	3/8-16	3/8-24	7/16-14	7/16-20	1/2-13	9/16-18
8-12 (6-9)	17-24 (12-18)	19-27 (14-20)	30-43 (22-32)	37-51 (27-38)	61-77 (45-57)	55-81 (40-60)	75-81 (55-60)	116-162 (85-120)

NOTE: All values in N-m (ft-lbs), unless otherwise noted. Oil threads with engine oil unless the threads require oil or water-resistant sealer. The standard torque limits listed below are applicable for all functions not listed in the special torque chart.

PIPE THREADS

1/8-27	1/4-18	3/8-18	1/2-14
7-11 (5-8)	17-24 (12-18)	30-44 (22-33)	34-47 (25-35)

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

Item	N·m	Ft-Lb (In-Lb)
Camshaft Sprocket — Gear to Camshaft	55-61	40-45
Camshaft Thrust Plate to Cylinder Block	13-16	9-12
Connecting Rod Nut — 5.0L	26-32	19-24
Connecting Rod Nut — 5.8L	55-61	40-45
Cylinder Front Cover	17-24	12-18
Cylinder Head Bolts	SEE NOTE	
Damper to Crankshaft	95-122	70-90
EGR Valve to Carburetor Spacer or Intake Manifold	17-24	12-18
Flywheel to Crankshaft	102-115	75-85
Main Bearing Cap Bolts — 5.0L (302 CID) V-8	82-94	60-70
Main Bearing Cap Bolts — 5.8L (351 CID) W-V-8	129-142	95-105
Manifold to Cylinder Head — Intake	32-33	23-25
Upper to Lower Intake Manifold	17-24	12-18
Manifold to Cylinder Head — Exhaust	24-32	18-24
Intake Manifold Vacuum Fittings — Aluminum	8-13	6-10
Intake Manifold Pipe Fittings — Aluminum	17-24	12-18
Oil Inlet Tube to Main Bearing Cap	30-43	22-32
Thermactor Pump Bracket to Cylinder Block	44-67	30-45
Distributor Clamp Down	24-32	17-25
Oil Filter Insert to Cylinder Block / Adaptor	28-40	20-30
Oil Filter to Adaptor or Cylinder Block	1/2 turn after gasket contacts sealing surface — oiled gasket	
Oil Inlet Tube Pump	14-20	10-15
Oil Pan Drain Plug	21-33	15-25
Oil Pan to Cylinder Block (18 Places)	9-14	(84-120)
Oil Pan to Cylinder Block (4 Places)	16-24	12-18
Oil Pump to Cylinder Block	30-43	22-32
Pulley to Damper Bolt	54-68	40-50
Rocker Arm Stud / Bolt to Cylinder Head	24-33	18-24
Spark Plug to Cylinder Head	14-20	10-15
Valve Rocker Arm Cover	16-20	11-14
Water Outlet Housing	13-16	9-12
Water Pump to Block / Front Cover	17-24	12-18
Thermactor Pump and Alternator Bracket to Cylinder Head — Bolt 3/8-16	41-54	30-40
Air Conditioning Compressor to Bracket	24-31	18-22
Power Steering Pump to Bracket	41-54	30-40
Thermactor Pump Holding Bolt	41-54	30-40
Alternator Attaching Bolt	41-54	30-40
Thermactor Pump and Alternator Bracket to Cylinder Head 7/16-14 Bolt	54-68	40-50
Air Conditioning Compressor and Power Steering Pump Bracket to Water Pump	53-72	39-53
Air Conditioning Compressor and Power Steering Pump Bracket to Head	54-68	40-50
Thermactor Pump Pivot Bolt	41-54	30-40
Alternator Pivot Bolt	54-68	40-50
Thermactor Pump Pulley to Pump Hub	12-15	(8.5-11)
Exhaust Pipe to Manifold	33-49	24-36
Heat Shield, Spark Plug	16-23	12-17

(Continued)

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS (Cont'd)

Item	N·m	Ft-Lb (In-Lb)
Clutch-to-Fan Bolts	16-24	12-18
Fan and Clutch Assembly-to-Pulley	16-24	12-18
Dipstick Tube Bracket	16-24	12-18

NOTE: 5.0L MFI V-8 — Tighten in steps: first to 75-88 N·m (55-65 Ft-Lbs) then to 88-97 N·m (65-72 Ft-Lbs).
 5.8L MFI W-V-8 — Tighten in steps: first to 115 N·m (85 Ft-Lbs.) then to 129 N·m (95 Ft-Lbs.), final to 143-151 N·m (105-112 Ft-Lbs).

TA4961A

FORD MOTOR COMPANY
IMPORTANT VEHICLE INFORMATION

THIS VEHICLE IS EQUIPPED WITH EEC IV/EFI SYSTEMS. IDLE SPEEDS AND IDLE MIXTURES ARE NOT ADJUSTABLE. SEE SHOP MANUAL FOR ADDITIONAL INFORMATION.

ADJUST IGNITION TIMING WITH THE TRANSMISSION IN NEUTRAL, PARKING BRAKE SET AND THE WHEELS BLOCKED. ENGINE MUST BE AT NORMAL OPERATING TEMPERATURE.

(1) TURN OFF ENGINE.
 (2) DISCONNECT THE IN-LINE SPOUT CONNECTOR (- □ □ - OR - □ □ -).
 (3) RE-START PREVIOUSLY WARMED-UP ENGINE.
 (4) ADJUST IGNITION TIMING TO 10° BTDC.
 (5) TURN OFF ENGINE AND RESTORE ELECTRICAL CONNECTION.

FIRING ORDER - 1-5-4-2-6-3-7-8

THIS VEHICLE CONFORMS TO U.S. EPA REGULATIONS APPLICABLE TO 1990 MODEL YEAR NEW LIGHT-DUTY TRUCKS

EBAE-9C485-ADL **CATALYST** SPARK PLUG: ASF 42C GAP: .042-.046
 5.0L 89HW FM5.8T5H2B7-A1P3E GR/E05/TWC/F1

VACUUM HOSE ROUTING

FRONT OF VEHICLE

IGNITION TIMING PROCEDURE

ENGINE DISPLACEMENT

SPARK PLUG TYPE

SPARK PLUG GAP SPECIFICATIONS

ENGINE VACUUM HOSE ROUTING (TYPICAL)

V7458-2B

SPECIAL SERVICE TOOLS/EQUIPMENT

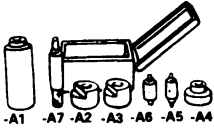
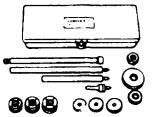


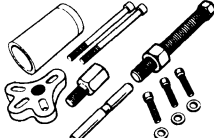


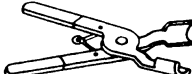

Tool Number/ Description	Illustration
T59L-100-B Impact Slide Hammer	 T59L-100-B
T58L-101-B Puller Attachment	 T58L-101-B
TOOL-4201-C Dial Indicator with Bracketry	 TOOL-4201-C
T70P-6000 Engine Lifting Brackets	 T70P-6000

(Continued)

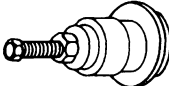

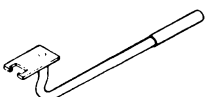
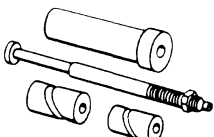
Tool Number/ Description	Illustration
T64L-6011-EA Cylinder Ridge Reamer	 T64L-6011-EA
T61P-6019-B Front Cover Aligner	 T61P-6019-B
T70P-6049-A Valve Spring Compressor	 T70P-6049-A

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

Tool Number / Description	Illustration
T68P-6135-A Piston Pin Remover / Replacer	 T68P-6135-A
T65L-6250-A Camshaft Bearing Set	 T65L-6250-A
T52L-6306-AEE Crankshaft Damper & Sprocket Replacer	 T52L-6306-AEE
T58P-6316-D Crankshaft Damper Remover	 T58P-6316-D
T79T-6316-A Damper Remover / Replacer Tool	 T79T-6316-A
TOOL-6331-E — or TOOL-6331 (351 CID) Upper Main Bearing Insert Remover & Replacer	 TOOL-6331
TOOL-6500-E Hydraulic Tappet Leakdown Tester	 TOOL-6500-E
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A
T70P-6B070-B Front Cover Seal Remover	 T70P-6B070-B

(Continued)

Tool Number / Description	Illustration
T88T-6701-A Front Cover Seal Installer	 T88T-6701-A
T84L-19623-B A / C Spring Lock Coupling Disconnect Tool Set	 T84L-19623-B
T71P-6513-B Tappet Bleed Down Wrench	 T71P-6513-B
T75L-6392-A Clutch Housing Alignment Tool	 T75L-6392-A

ROTUNDA EQUIPMENT

Tool Number	Description
066-00017	Transmission Jack
D80L-522-A	Damper Remover
D81L-6002-C	Piston Ring Compressor
D79L-6731-A	Oil Filter Wrench
D79L-6731-B	Oil Filter Wrench
D87L-9280-A	Disconnect tool
D87L-9280-B	Disconnect Tool

SECTION 03-01C Engine, 7.5L MFI V-8

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION (Cont'd.)	
Valve Clearance	03-01C-46	E-350	03-01C-32
DESCRIPTION AND OPERATION		F-250-350, F-Super Duty Chassis Cab and	
Cooling System	03-01C-3	Motorhome Chassis	03-01C-35
Crankcase Ventilation System	03-01C-2	Engine Components	03-01C-6
Emission Calibration Label	03-01C-2	Engine Front Supports, E-350	03-01C-4
Engine	03-01C-2	Engine Front Supports, F-250-350, F-Super	
Exhaust Emission Control System	03-01C-2	Duty, F-Super Duty Motorhome	
Lubrication System	03-01C-2	Chassis	03-01C-5
DIAGNOSIS AND TESTING	03-01C-3	Engine Rear Support	03-01C-6
DISASSEMBLY AND ASSEMBLY		Exhaust Manifolds	03-01C-17
Cylinder Assembly	03-01C-46	Flywheel	03-01C-25
Cylinder Block	03-01C-46	Front Cover and Timing Chain	03-01C-19
Cylinder Head	03-01C-44	Front Oil Seal	03-01C-22
Piston and Connecting Rod	03-01C-44	Intake Manifold	03-01C-13
Valve Tappet	03-01C-43	Main Bearing	03-01C-28
REMOVAL AND INSTALLATION		Oil Filter	03-01C-32
Camshaft	03-01C-23	Oil Pan	03-01C-25
Camshaft Bearings	03-01C-42	Oil Pump	03-01C-27
Camshaft Rear Bearing Bore Plug	03-01C-25	Pistons and Connecting Rods	03-01C-30
Clutch Pilot Bearing	03-01C-31	Valve Rocker Arm and Tappets	03-01C-11
Connecting Rod Bearing	03-01C-29	Valve Rocker Arm Cover and Rocker Arm,	
Crankcase Ventilation System	03-01C-10	F-Series and E-Series	03-01C-10
Crankshaft	03-01C-39	Valve Spring, Retainer and Stem Seal	03-01C-11
Crankshaft Rear Oil Seal	03-01C-27	Valve Tappet	03-01C-13
Cylinder Heads	03-01C-13	Water Pump	03-01C-19
Electronic Fuel Injection	03-01C-3	SPECIAL SERVICE TOOLS/EQUIPMENT	03-01C-52
Engine	03-01C-32	SPECIFICATIONS	03-01C-48
		VEHICLE APPLICATION	03-01C-1

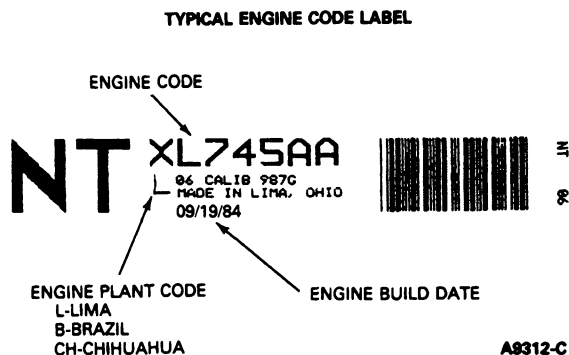
VEHICLE APPLICATION

F-250-350, F-Super Duty Chassis Cab and
Motorhome Chassis, E-350 Vehicles

DESCRIPTION AND OPERATION

Engine Code Information Label

An engine code information label located on the rocker arm cover contains an engine build date, an engine plant code and an engine code.



DESCRIPTION AND OPERATION (Continued)

Engine

The 7.5L (460 CID) MFI V-8 engine has a cast iron cylinder block. The crankshaft is precision-cast, nodular iron alloy and has five main bearings. The pistons are hyper-eutectic cast aluminum alloy, tin plated. Valve rocker arms are pedestal-mounted and the tappets are hydraulic. Large intake and exhaust valves with wear-resistant hard chrome-plated stems provide optimum breathing. A low restriction air cleaner is utilized for maximum clean air intake. Refer to the chart under Specifications for complete specifications.

The 7.5L (460 CID) MFI engine is optional for E-350, F-250 -350 and F-Super Duty.

Emission Calibration Label

The emission calibration number label is located on the left side door or left door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.

NOTE: It is critical that the engine codes and the calibration number be used when ordering parts or making inquiries about the engine.

**CALIBRATION
ÉTALONNAGE
CALIBRACIÓN**



2-54E-R00 E8AE-6E061-ABY

A10693-B

Exhaust Emission Control System

Operation, removal, installation and required maintenance of the exhaust emission control devices used on the 7.5L (460 CID) MFI engine are covered in the Powertrain Control / Emissions Diagnosis Manual.¹

Crankcase Ventilation System

The 7.5L (460 CID) MFI V-8 engine is equipped with a positive closed-type crankcase ventilation system to purge the crankcase vapors.

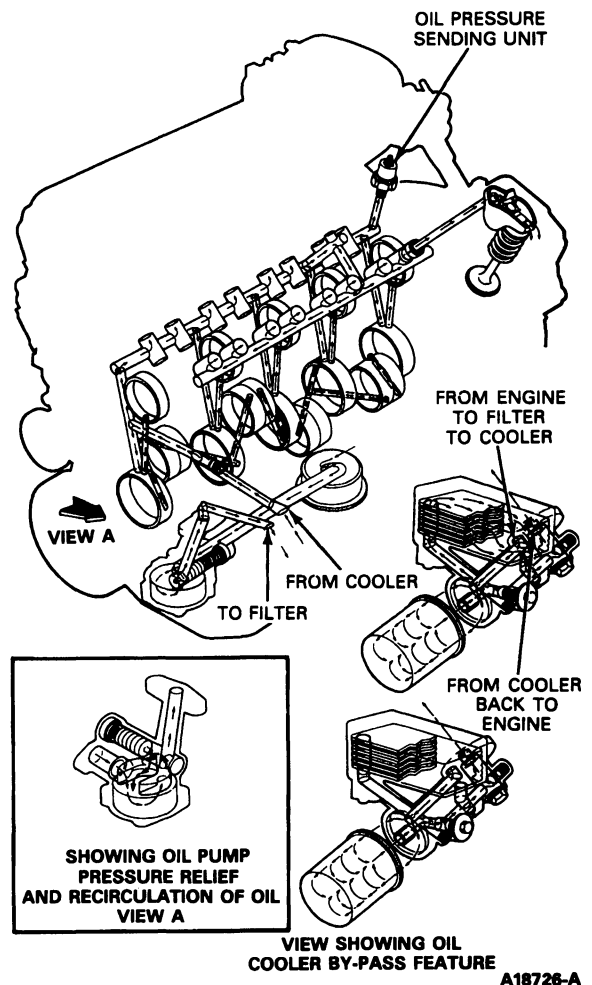
Lubrication System

The heart of the lubrication system is a full-pressure cast-iron pump. The high capacity "G-rotor" pump is driven by a hex shaft from the distributor. The pressure is relief-valve controlled.

Oil is directed through a drilled oil passage to the full-flow oil filter and from the filter to main oil galleries intersecting the valve tappet guide bores. A drilled gallery (crossover) at the rear of the tappet chamber routes oil to the left bank. The main, connecting rod, and camshaft bearings are supplied with oil from the right oil gallery.

Oil flow to the camshaft sprocket and timing chain is through an annulus and drilled passage at the front of the No. 1 camshaft bearing. Oil flow to the rocker arms is through the tappets and up the push rods to the arms.

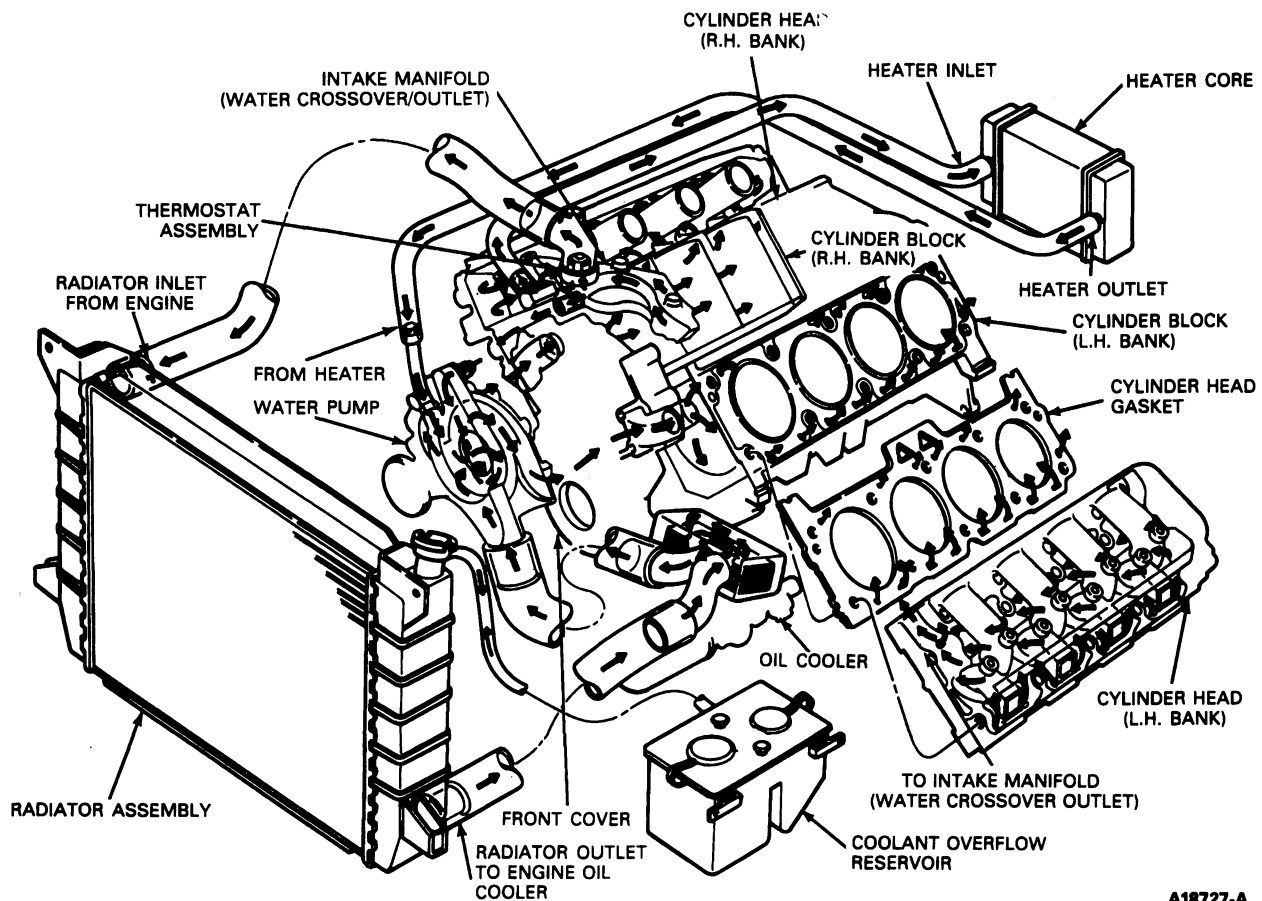
All 7.5L engines are equipped with an oil cooler. The cooler is block-mounted. The compact oil-to-water heat exchanger mounts directly to the left side of the engine, at the oil filter mounting pad.



¹ Can be purchased as a separate item.

DESCRIPTION AND OPERATION (Continued)**Cooling System**

The cooling system is a series-parallel flow design. Coolant flow is from the water pump through passages in the front cover (both sides) to the cylinder block. Flow continues through the block toward the rear of the engine and into the cylinder head at various transfer passages along the length of the cylinder block deck. It then travels from the cylinder heads to the water crossover at the front of the intake manifold, through the water outlet (thermostat housing) and to the top of the radiator.



A18727-A

DIAGNOSIS AND TESTING

Refer to Diagnosis and Testing in Section 03-00.

Refer to Section 03-00 for cleaning, inspection and testing procedures.

REMOVAL AND INSTALLATION

The following procedures can be performed with the engine in the vehicle.

When installing nuts or bolts (refer to Torque Specifications listed at the end of this section), oil the threads with lightweight engine oil. **Do not oil threads requiring oil-resistant or water-resistant sealer.**

Electronic Fuel Injection

Refer to Section 03-04C for service of MFI components.

REMOVAL AND INSTALLATION (Continued)

Engine Front Supports, E-350

Front supports are located on each side of the cylinder block. The following procedures apply to either support.

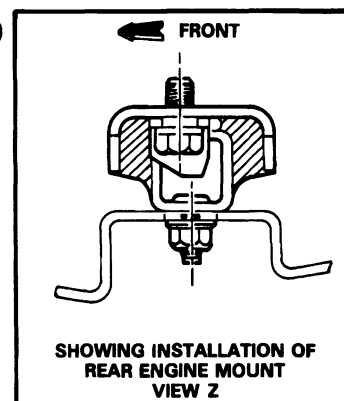
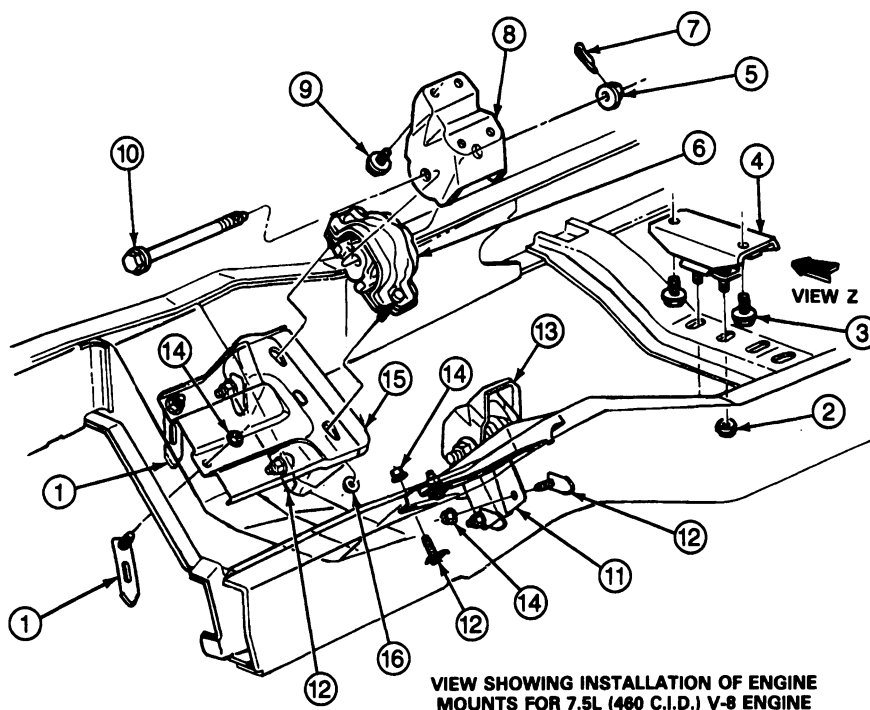
Removal

1. Support the engine with a jack and a wood block placed under the oil pan. Be sure to position wood block so as not to cause any damage to oil pan.
2. Remove the locknuts from the bolts attaching the support bracket to the frame crossmember and frame side rail.
3. Remove the through-bolt attaching the engine support bracket to the insulator.
4. Raise the engine with the jack, until the insulator is clear of the cup-shaped engine bracket.
5. Remove the insulator and frame bracket as an assembly.
6. Remove the nuts attaching the insulator to the frame bracket.

Installation

1. Assemble the insulator to the frame bracket and install the attaching nuts. **The insulator should be installed so that the word TOP is visible on either side of the engine.** Tighten the attaching nuts to 68-94 N·m (50-70 ft·lb).
2. Position the insulator and frame bracket assembly to the engine insulator bracket and the frame crossmember. Install the through-bolt attaching the insulator to the engine bracket. The through-bolt for the right insulator must be installed from the front of the engine. The through bolt for the left insulator must be installed from the rear of the engine. Tighten the nut to 55-78 N·m (40-58 ft·lb) and install the cotter pin. Lower the engine.
3. Install the locknuts on the bolts attaching the frame bracket to the crossmember. Tighten the frame bracket attaching bolt locknuts to 48-67 N·m (35-50 ft·lb). **Tighten the crossmember bolts and locknuts on the left support bracket to 98-142 N·m (72-105 ft·lb).** Remove the jack and wood block.

Engine Supports, E-350



A6538-E

Item	Part Number	Description
1	N807251-S2	Bolt and Retainer M12-1.75 x 32 Hex Flange
2	N621945-S2	Nut and Washer Assembly 81-108 N·m (60-80 Ft·Lb)

(Continued)

Item	Part Number	Description
3	390066-S2	Screw and Washer Assembly 81-108 N·m (60-80 Ft·Lb)
4	6D091	Insulator and Retainer Assembly
5	379696-S2	Nut 54-78 N·m (40-58 Ft·Lb)

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
6	6038	Insulator Assembly
7	N642569-S36	Cotter Pin
8	6046	Bracket
9	387811-S100	Bolt 68-94 N·m (50-70 Ft-Lb)
10	385734-S2	Bolt
11	6029	Bracket

(Continued)

Item	Part Number	Description
12	N807250-S2	Bolt and Retainer M12-1.75 x 32
13	6046	Bracket
14	N802074-S2	Nut M12-1.75 76-104 N·m (56-77 Ft-Lb)
15	6028	Bracket
16	45354-S2	Nut and Washer 7 / 16-14 68-92 N·m (50-68 Ft-Lb)

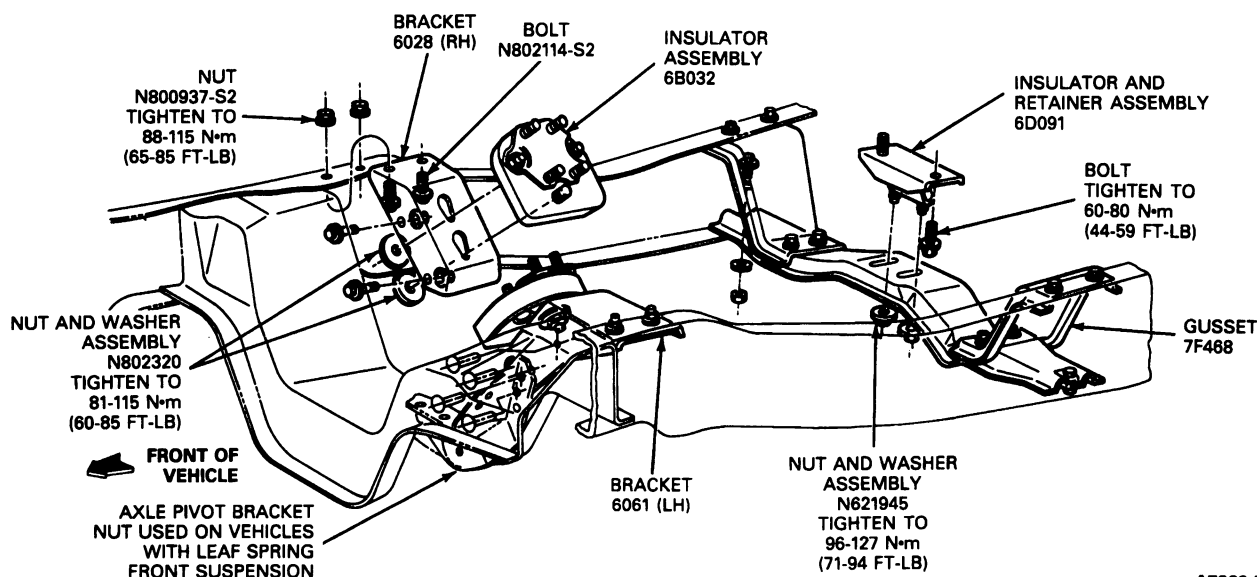
TA6538A

Engine Front Supports, F-250-350, F-Super Duty, F-Super Duty Motorhome Chassis**Removal and Installation**

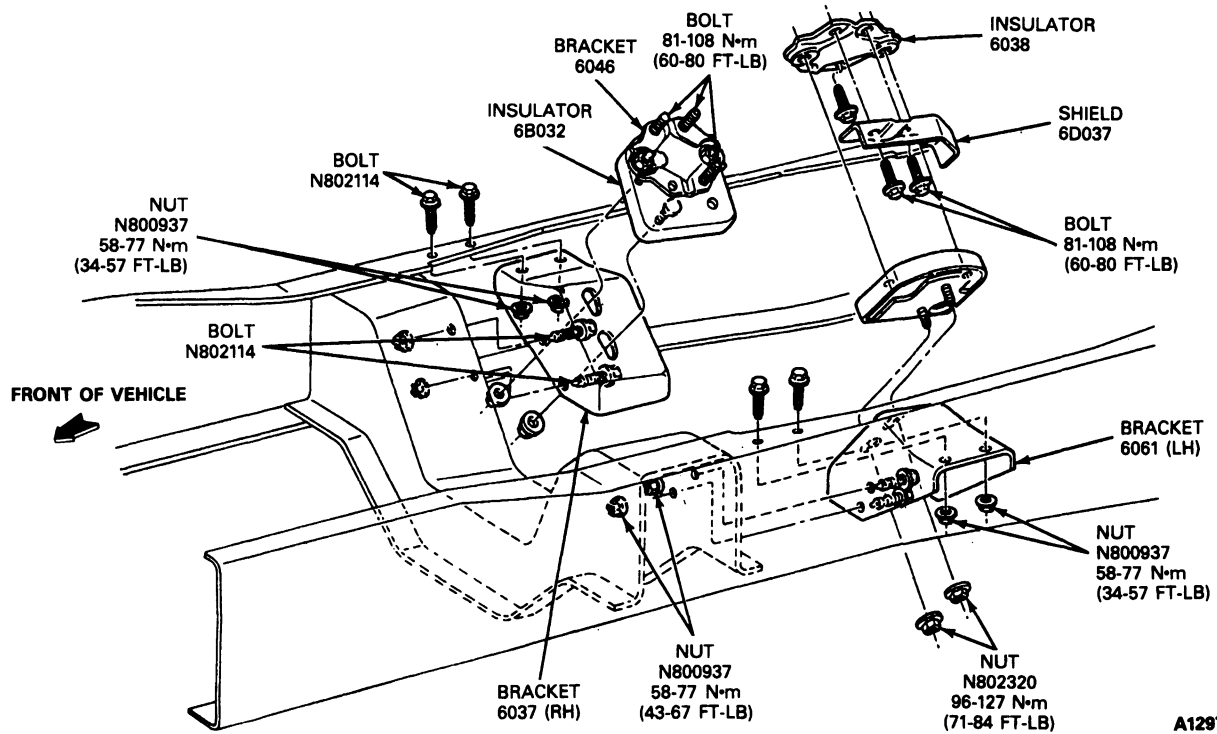
1. Support engine with a jack and wood block placed under the oil pan. Be sure to position wood block so as not to cause any damage to oil pan.
2. Remove insulator-to-lower bracket nuts for both front engine mounts.

3. Raise engine until insulator-to-engine block bolts are accessible.
4. Remove insulator-to-engine block bolts and insulator.

For installation, follow removal procedure in reverse order. Tighten insulator-to-engine bolts to 81-108 N·m (60-80 ft-lb). Tighten insulator-to-lower bracket nuts to 96-127 N·m (71-94 ft-lb).

Engine Supports, F-250-350, F-Super Duty

A7329-E

REMOVAL AND INSTALLATION (Continued)**Engine Front Supports, F-Super Duty Motorhome Chassis**

A12973-B

Engine Rear Support**Removal**

1. Remove the attaching bolts, nut and washer as previously outlined.
2. Raise the transmission slightly to provide clearance; then, remove the insulator and insulator retainer.

Installation

1. Position the insulator and retainer as previously outlined. Install the insulator-to-extension housing bolts and lockwashers. Tighten to 68-94 N·m (50-70 ft-lb) on E-250-350; 60-80 N·m (44-59 ft-lb) on F-250-350 and F-Super Duty.

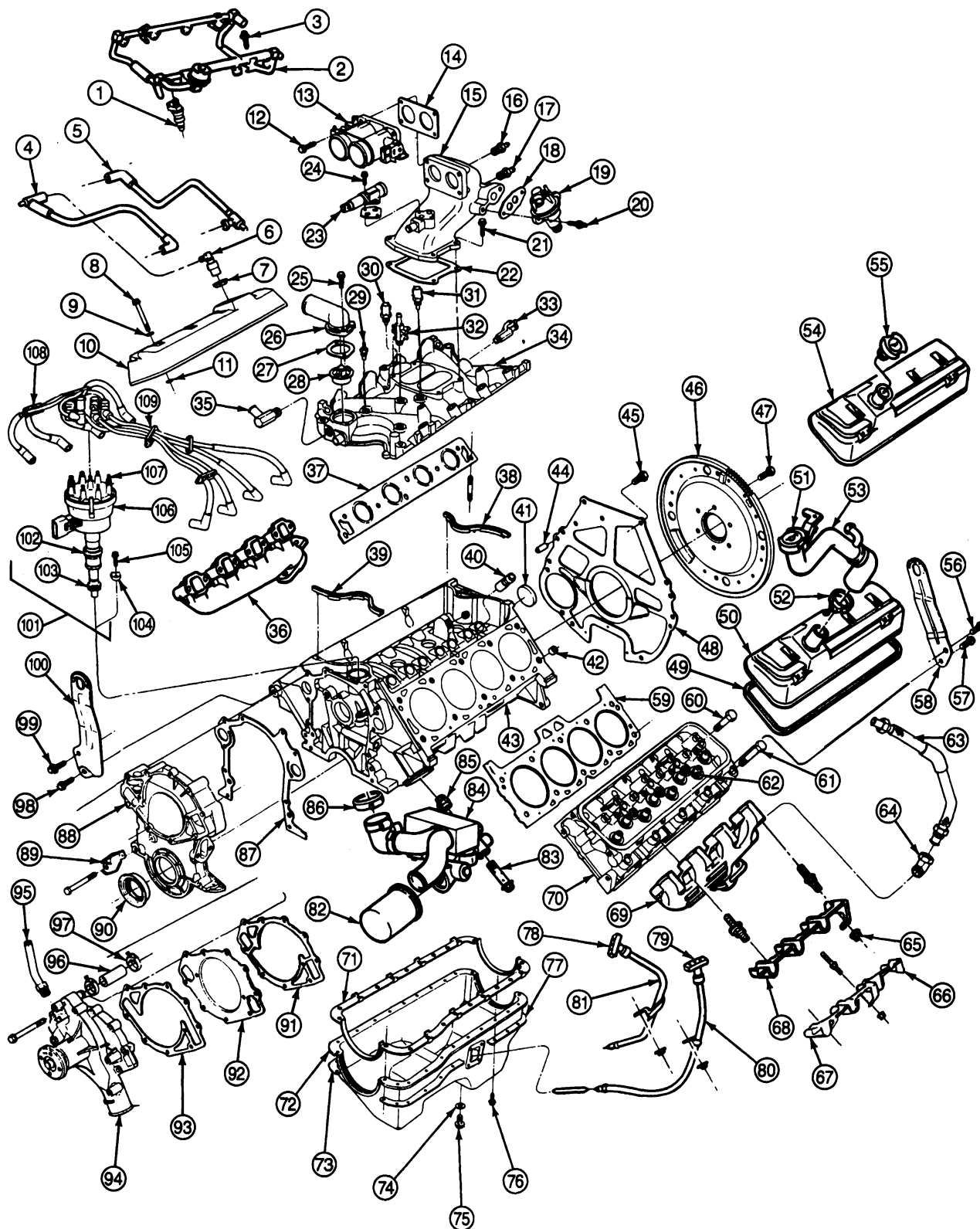
2. Lower the transmission and install the insulator-to-frame crossmember nuts. Tighten the nuts to 68-94 N·m (50-70 ft-lb) on E- and F-Series.

Engine Components

The following exploded views of the 7.5L MFI engine are typical and are references for procedures outlined. The parts descriptions and basic numbers in the illustration keys correspond with the Ford Master Parts Catalog.

REMOVAL AND INSTALLATION (Continued)

7.5L MFI (460 CID) V-8 Engine, External Exploded View



A10741-C

REMOVAL AND INSTALLATION (Continued)

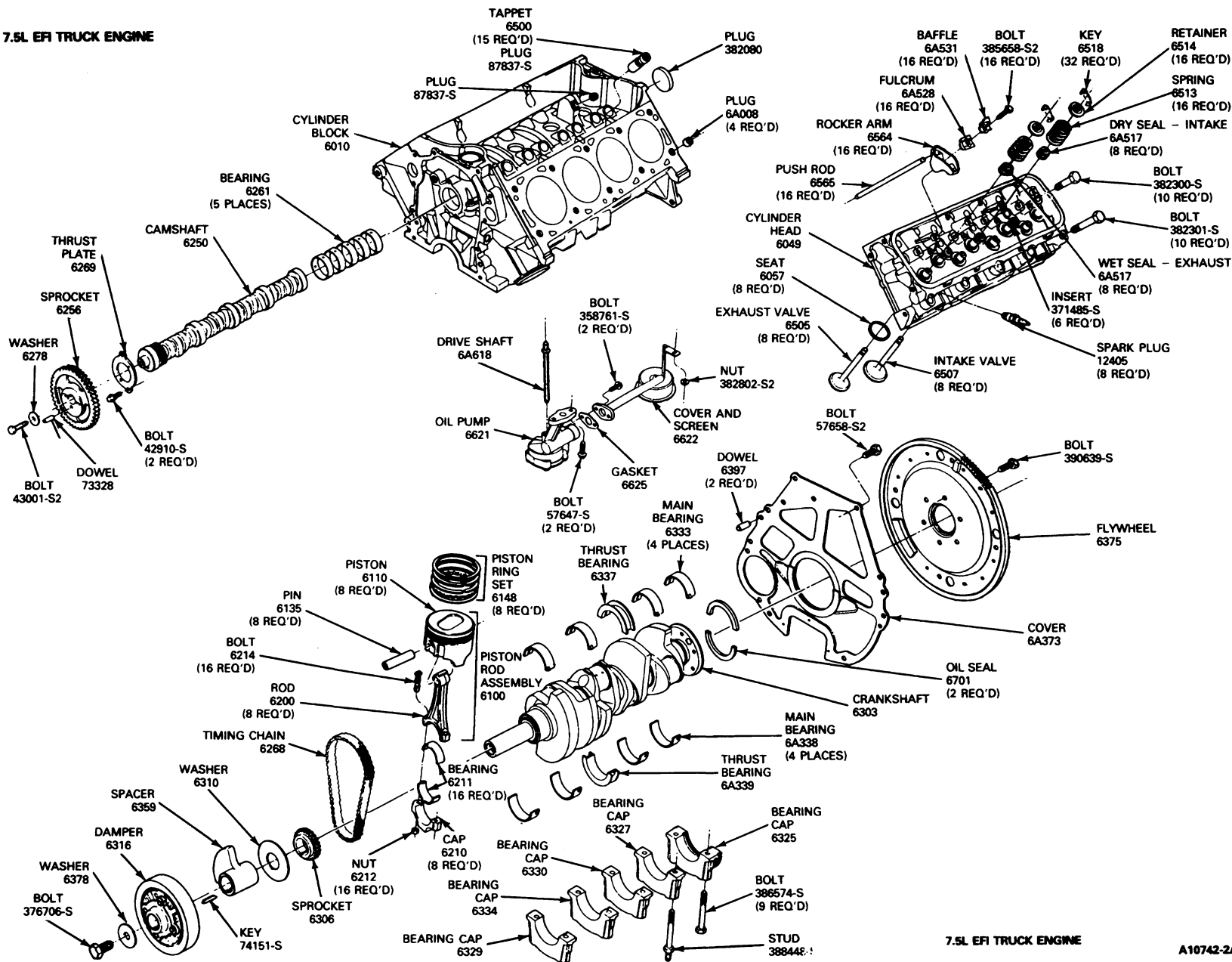
Item	Part Number	Description
1	9F593	Fuel Injector (8)
2	9F792	Fuel Rail Assembly
3	N802626	Bolt (4)
4	6C324	Tube (F-Series)
5	6C342	Tube (E-Series)
6	6B890	PCV Valve
7	6K780	Grommet
8	390768	Bolt (8)
9	6A532	Washer (8)
10	6582	Cover (RH)
11	W623842	Washer (8)
12	390774	Bolt (4)
13	9E926	Throttle Body
14	9E936	Gasket
15	9424	Upper Intake Manifold
16	386153	Nipple
17	389642	Nipple
18	9D476	Gasket
19	9F483	EGR Valve
20	390715	Stud (2)
21	390712	Bolt (4)
22	9H486	Gasket
23	9F715	Air Bypass Valve
24	N605893	Bolt (2)
25	358720	Bolt (2)
26	8594	Connector
27	8255	Gasket
28	8575	Thermostat
29	10884	Sensor — Coolant Temperature
30	12648	Sensor
31	12A697	Air Charge Temperature Sensor
32	9D446	Valve — EGR
33	9D446	Valve — EGR
34	9J447	Intake Manifold
35	38768	Fitting
36	9430	Exhaust Manifold (RH)
37	9439	Gasket (2)
38	9A425	Seal
39	9A425	Seal
40	6500	Tappet (16)
41	382080	Plug
42	6A008	Plug (4)
43	6010	Block
44	6397	Dowel (2)
45	57658	Bolt
46	6375	Flywheel
47	390639	Bolt
48	6A373	Adapter Plate
49	6584	Gasket (2)
50	6A505	Cover (E-Series) (LH)
51	6766	Cap (E-Series)
52	389885	Clamp
53	6763	Filler Pipe (E-Series)

(Continued)

Item	Part Number	Description
54	6A505	Cover (F-Series) (LH)
55	6766	Cap
56	56559	Bolt
57	42997	Bolt
58	17K056	Bracket (LH Rear)
59	6051	Gasket
60	382330	Bolt (10)
61	382301	Bolt (10)
62	371485	Insert (6)
63	9D477	Hose and Valve
64	N801906	Elbow
65	33771	Nut (4)
66	12A087	Shield (E-Series) (RH and LH)
67	12A087	Shield (F-Series) (RH Only)
68	12A087	Shield (F-Series) (LH Only)
69	9429	Manifold (LH)
70	6049	Cylinder Head (2)
71	6710	Gasket
72	6675	Oil Pan
73	6A674	Reinforcement (RH)
74	6734	Washer
75	6730	Plug
76	388221	Bolt (23)
77	6694	Reinforcement (LH)
78	6750	Dipstick (E-Series)
79	6750	Dipstick (F-Series)
80	6754	Tube (F-Series)
81	6754	Tube (E-Series)
82	6714	Oil Filter
83	6895	Bolt
84	6B856	Oil Cooler Assembly
85	6890	Insert
86	391001	Clamp
87	6020	Gasket
88	6059	Front Cover
89	6023	Pointer
90	6700	Seal
91	8507	Gasket
92	8508	Cover
93	8513	Gasket
94	8501	Coolant Pump
95	18K396	Tube
96	8597	Hose
97	97355	Clamp (2)
98	56559	Bolt
99	42997	Bolt
100	17A084	Bracket (RH Front)
101	12A332	Distributor Assembly
102	12127	Distributor
103	12390	Gear
104	12270	Clamp
105	42955	Bolt
106	12A217	Adapter
107	12106	Cap
108	12280	Spark Plug Wires (RH)
109	12281	Spark Plug Wires (LH)

REMOVAL AND INSTALLATION (Continued)

7.5L MFI (460 CID) V-8 Engine, Internal Exploded View



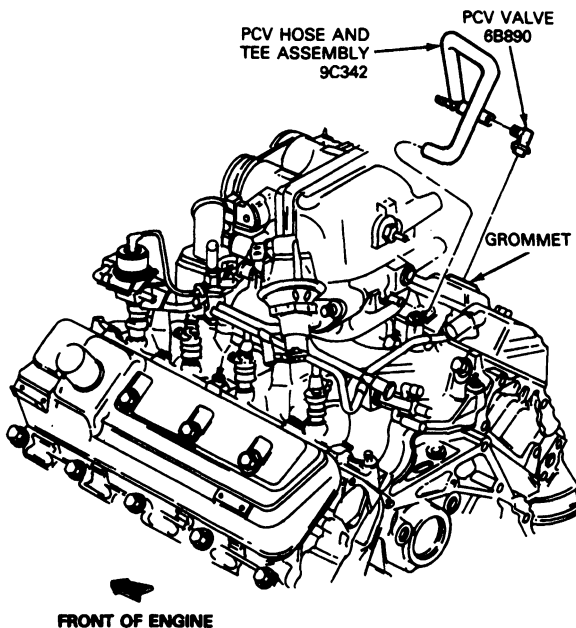
7.5L EFI TRUCK ENGINE

A10742-2A

REMOVAL AND INSTALLATION (Continued)**Crankcase Ventilation System****E-350, F-250-350 and F-Super Duty****Removal and Installation**

1. Remove ventilation intake hose from the air cleaner and the oil fill tube on left rocker cover.
2. Disconnect and remove ventilation filter pack from dirty side of air cleaner assembly.
3. Remove the PCV valve from the grommet on the right rocker cover.
4. Disconnect the crankcase ventilation hose at the upper intake manifold and at the evaporative emission harness.

For installation, follow removal procedures in reverse order.

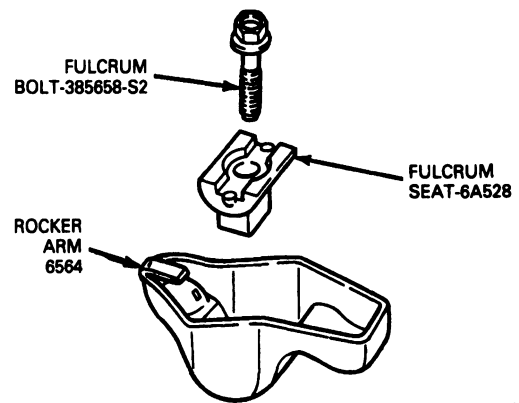


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Valve Rocker Arm Cover and Rocker Arm, F-Series and E-Series**Removal**

1. Disconnect battery(s).
2. On Econoline, remove air cleaner and intake duct assembly.
3. On the right side of the engine, disconnect the secondary air injection (Thermactor) system, including brackets, and position out of the way. On the left side of the engine, remove the ignition coil mounting bracket and position out of the way.
4. Disconnect spark plug wires from spark plugs using Spark Plug Wire Remover T74P-6666-A and position wires out of the way.

5. Remove crankcase ventilation (PCV) valve from the valve rocker arm cover (for right cover).
6. On Econoline, remove oil fill tube from left rocker arm cover.
7. On F-Series, remove crankcase ventilation hose from left rocker arm cover.
8. Position wiring and vacuum harnesses to gain access in order to remove right valve rocker arm cover.
9. Remove attaching bolts and remove the valve rocker arm cover(s).
10. Remove fulcrum bolt, oil deflector, fulcrum seat and rocker arm.



A3236-D

Installation

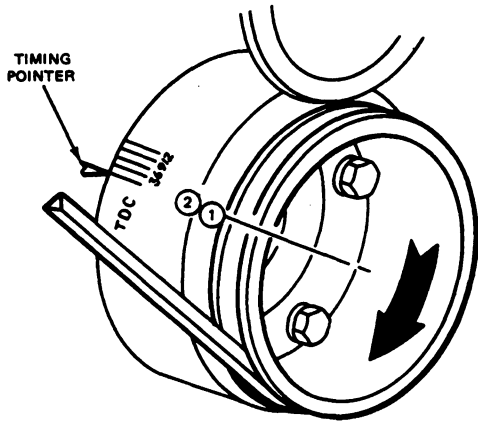
1. Apply Ford Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to the top of the valve stems, the rocker arm and fulcrum seats.
2. Position the No. 1 piston at TDC at the end of the compression stroke (Position No. 1). Install the rocker arm, fulcrum seat, oil deflector and fulcrum bolt on the following valves:
No. 1 Intake No. 1 Exhaust
No. 3 Intake No. 8 Exhaust
No. 7 Intake No. 5 Exhaust
No. 8 Intake No. 4 Exhaust

Make sure the fulcrum seat base is inserted into its slot on the cylinder head before tightening the fulcrum bolts. Tighten the fulcrum bolt to 25-33 N-m (18-25 ft-lb).

3. Position the crankshaft in Position No. 1 and install the rocker arm, fulcrum seat, oil deflector and a bolt on the following valves:
No. 2 Intake No. 2 Exhaust
No. 4 Intake No. 3 Exhaust
No. 5 Intake No. 6 Exhaust

REMOVAL AND INSTALLATION (Continued)

No. 6 Intake No. 7 Exhaust



POSITION 1—NO. 1 AT TDC AT END OF COMPRESSION STROKE.
 POSITION 2—ROTATE THE CRANKSHAFT 360 DEGREES
 (ONE REVOLUTION) CLOCKWISE FROM POSITION 1.

A7908-1A

Make sure the fulcrum seat base is inserted into its slot on the cylinder head before tightening the fulcrum bolts. Tighten the fulcrum bolt to 25-33 N·m (18-25 ft·lb). Adjust the valve clearance as outlined under Adjustments.

4. Clean valve rocker arm cover(s) and cylinder head sealing surface(s). Position seal in cover seal groove, making sure that the seal tang is aligned with notch in the cover.
5. Position cover(s) on the cylinder head(s). Starting with rearmost bolt and working forward, tighten the four rocker arm cover bolt and washer assemblies to 12-15 N·m (9-11 ft·lb).
6. Install PCV valve into right side valve cover.
7. Install ignition coil mounting bracket. Connect spark plug wires to spark plugs.
8. Connect secondary air injection (Thermactor) valve and bracket assembly.
9. Install Thermactor air supply tube and hose at Thermactor valve.
10. Install air cleaner and intake duct assembly.
11. Connect battery(s).
12. Start engine and check for leaks.

Valve Rocker Arm and Tappets**Removal**

1. Remove the valve rocker arm cover, lower intake manifold, rocker arm fulcrum assembly, push rod, and associated parts as described in this section.
2. Lift out tappet(s).

Installation

1. Place tappet(s) in position in the bore.
2. Install lower intake manifold gaskets and seals. Install lower intake manifold, rocker arm fulcrum assembly, push rod, and associated parts as described in this section.
3. Clean the sealing surfaces of the valve cover and cylinder head.
4. Position seal in cover seal groove, making sure that the seal tang is aligned with notch in the cover.
5. Position cover(s) on the cylinder head(s). Starting with the rearmost bolt and working forward, tighten the rocker arm cover bolt and washer assemblies to 8-12 N·m (6-9 ft·lb).
6. Install the air cleaner and all other hardware removed.
7. Run the engine at fast idle and check for oil leaks.

Valve Spring, Retainer and Stem Seal

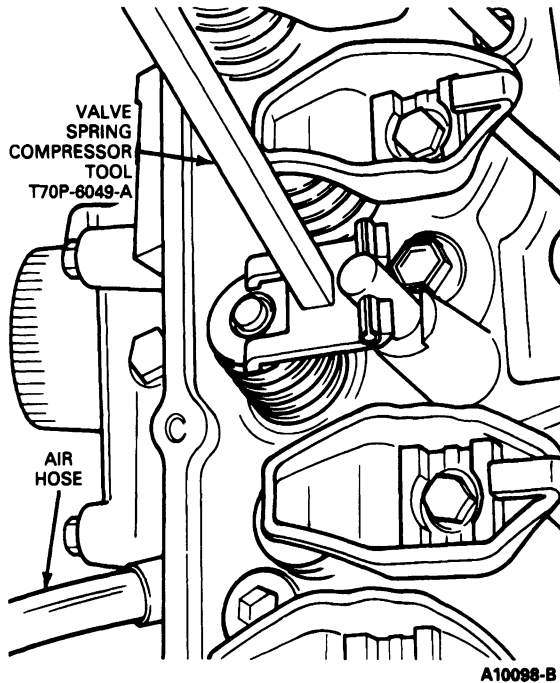
If the valve or valve seat has not been damaged, the valve spring damper assembly, seals and retainers may be replaced by holding the affected valve against its seat using compressed air. Use an appropriate air line tool installed in the spark plug hole. A minimum of 965 kPa (140 psi) line pressure is required. If air pressure does not hold the valve shut, the valve or valve seat is damaged and the cylinder head must be removed and serviced. Refer to Section 03-00.

Removal

1. Remove the valve rocker arm cover and associated parts as described in this section.
2. Remove the rocker arm and fulcrum assembly.

REMOVAL AND INSTALLATION (Continued)

3. Using Valve Spring Compressor T70P-6049-A compress the valve spring and remove the retainer locks, spring retainer, and spring. Remove and discard the stem seal.



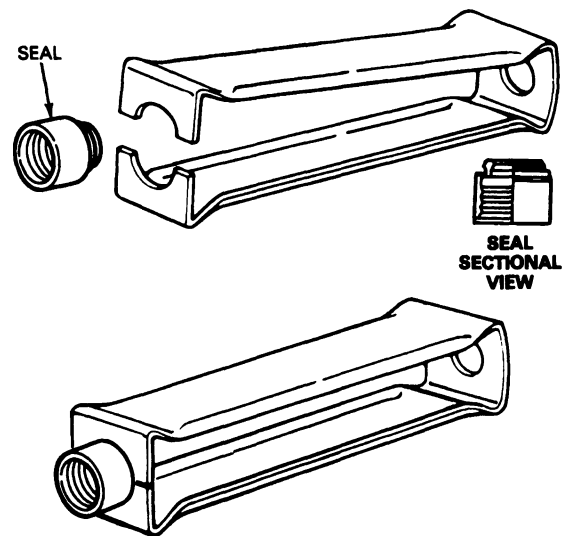
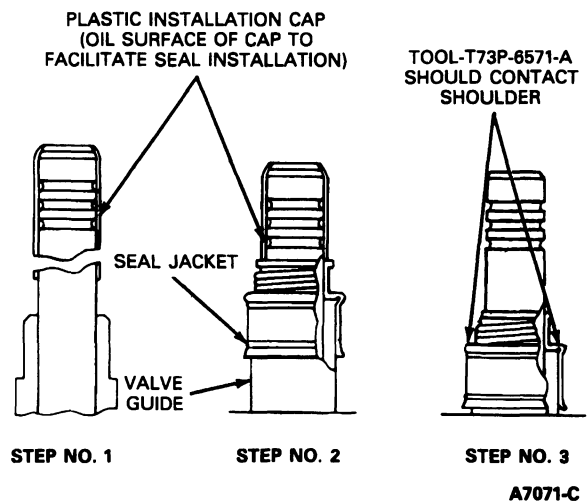
4. If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to fall into the cylinder. A rubber band, tape or string wrapped around the end of adjacent valve stems will prevent this condition and will still allow enough travel to check the valve for binds.
5. Inspect the valve stem for damage. Rotate the valve and check the stem tip for eccentric movement. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head and service. Refer to Section 03-00 for cylinder head repair procedures.

Installation

NOTE: Unique exhaust and intake guide-mounted valve stem seals are required and care should be used to install the correct seal in the appropriate location. The seals are identified on one end with IN for intake and EX for exhaust.

1. Install new valve stem seals as follows:
 - a. With valves in head, place plastic installation cap over end of valve stem. Lubricate the surface of the plastic cap to aid seal installation.
 - b. Slide valve stem seal carefully over cap and push seal down until jacket touches top of valve guide.

- c. Remove plastic installation cap. Using Valve Seal Installer T73P-6571-A push the seal down until it bottoms on the valve guide.
2. Apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to all contact surfaces of the rocker arm. Install push rod, rocker arm and fulcrum assembly and the spark plug as described in this section.
3. Install the rocker arm cover as outlined.

VALVE SEAL INSTALLER — T73P-6571-A**VALVE STEM SEAL INSTALLATION**

REMOVAL AND INSTALLATION (Continued)**Intake Manifold****Removal and Installation**

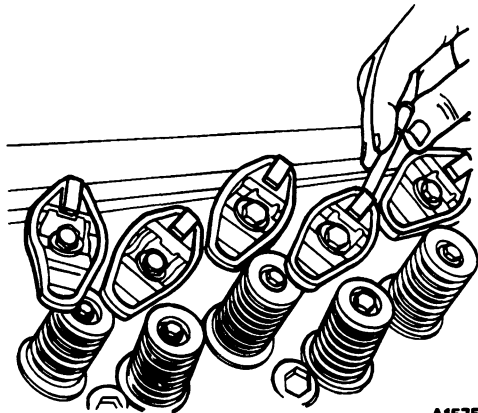
NOTE: On F-350 vehicles, it is possible to remove upper and lower manifolds as an assembly. On E-350 vehicles it is necessary to remove the upper intake manifold first, then the lower intake manifold. Refer to Section 03-04C for upper and lower intake manifold removal.

Valve Tappet

The following procedure is applicable for removing one or all of the valve tappets. Before replacing a hydraulic valve tappet for noisy operation, make sure the noise is not caused by improper valve clearance or by worn rocker arms and /or push rods.

Removal

1. Remove intake manifold. Refer to Section 03-04C.
2. Remove the valve rocker arm covers as described in this section. Loosen the rocker arm fulcrum bolts and turn rocker arms to one side.



A15758-A

3. Remove the push rods. Keep push rods in sequence so they can be installed in their original locations.
4. Remove the valve tappets with a magnet. Place them in a rack in sequence. Rotate tappets back and forth to loosen them from gum or varnish deposits.

Refer to Section 03-00 for cleaning, inspection and testing procedures. If necessary to disassemble tappet(s), refer to Valve Tappet Disassembly and Assembly.

Installation

1. Clean the outside of valve tappets. Tappets and bores are to be lubricated with recommended engine oil before installation. Install the tappets into their original bores. Check any new tappet for free fit in bore to which it is to be installed. Prior to installation of a new lifter, make sure lifter is full of oil by working the valve tappet plunger up and down until the tappet fills with fluid and all traces of air bubbles has disappeared.
2. Install push rods in original positions. Apply Ford Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips and push rod ends.
3. Position the rocker arms over the push rods. Tighten the bolts following the procedure under Valve Rocker Arm Installation. Adjust valve clearance as outlined.
4. Install rocker arm covers as described in this section.
5. Install intake manifold and throttle body (9E926). Refer to Section 03-04C.

Cylinder Heads**Removal**

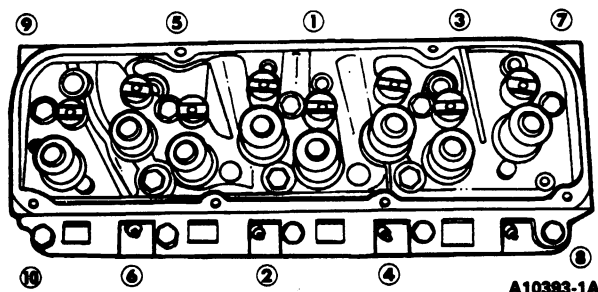
1. Disconnect battery negative cable(s). Drain cooling system.
2. On F-250-350 vehicles, remove upper and lower intake manifold as an assembly. On E-350 vehicles, remove upper intake manifold, then lower intake manifold. Refer to Section 03-04C.
3. Disconnect muffler inlet pipe at exhaust manifold.
4. Remove power steering and alternator drive belts.
5. Remove secondary air injector (Thermactor) pump and alternator.
6. Remove the secondary air injector (Thermactor) pump bracket from the right head.
7. If equipped, discharge the air conditioning system into an approved refrigerant recovery system. Refer to Section 12-03 in the Body / Chassis Volume. Follow all safety precautions. Remove hose assembly from rear of air conditioning compressor. Remove bolts attaching air conditioning compressor to air conditioning / power steering support bracket.
8. Remove nut attaching air conditioning / power steering support bracket to water pump. Remove bolts attaching air conditioning / power steering support bracket to front of head. Swing bracket out of the way with power steering pump still attached.
9. Disconnect the oil filler tube (E-Series and Motorhome Chassis).

REMOVAL AND INSTALLATION (Continued)

10. Remove valve rocker arm covers. Remove rocker arm fulcrum bolts, rocker arms, fulcrums and push rods in sequence so they can be installed in their original positions.
11. Remove cylinder head attaching bolts. Lift cylinder heads and exhaust manifolds as assemblies from cylinder block with a hoist or other suitable lifting device. **If necessary to loosen cylinder head gasket seal, pry at forward corners of cylinder heads against casting bosses provided on cylinder block. Do not damage machined surfaces of head or block. Discard cylinder head gasket.**
12. If disassembly or machining of cylinder head is required, remove exhaust manifold.

Installation

1. Clean cylinder head, intake manifold, valve rocker arm cover, and cylinder block sealing surfaces. If cylinder head was removed for cylinder head gasket replacement, check flatness of cylinder head and block gasket surfaces for flatness. Refer to Section 03-00. If exhaust manifold was removed, coat cylinder head and manifold port areas with film of Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) and install manifold to cylinder head.
2. Place two long cylinder head attaching bolts in two rear lower bolt holes of left cylinder head. Place a long cylinder head attaching bolt in rear lower bolt hole of right cylinder head. Use rubber bands to retain bolts in position, above head-to-block mating surface, until cylinder heads are installed.
3. Position new cylinder head gaskets on block over dowels. Do not apply sealer to head gasket surfaces. Place cylinder heads on block, guiding exhaust manifold studs into muffler inlet pipe connections. Install remaining attaching bolts (longer bolts in lower row of bolt holes). Tighten all cylinder head attaching bolts in sequence shown in three steps: first to 95-108 N·m (70-80 ft·lb), then to 136-149 N·m (100-110 ft·lb), and finally to 177-189 N·m (130-140 ft·lb). **When this procedure is used, it is not necessary to tighten bolts after extended operation.**

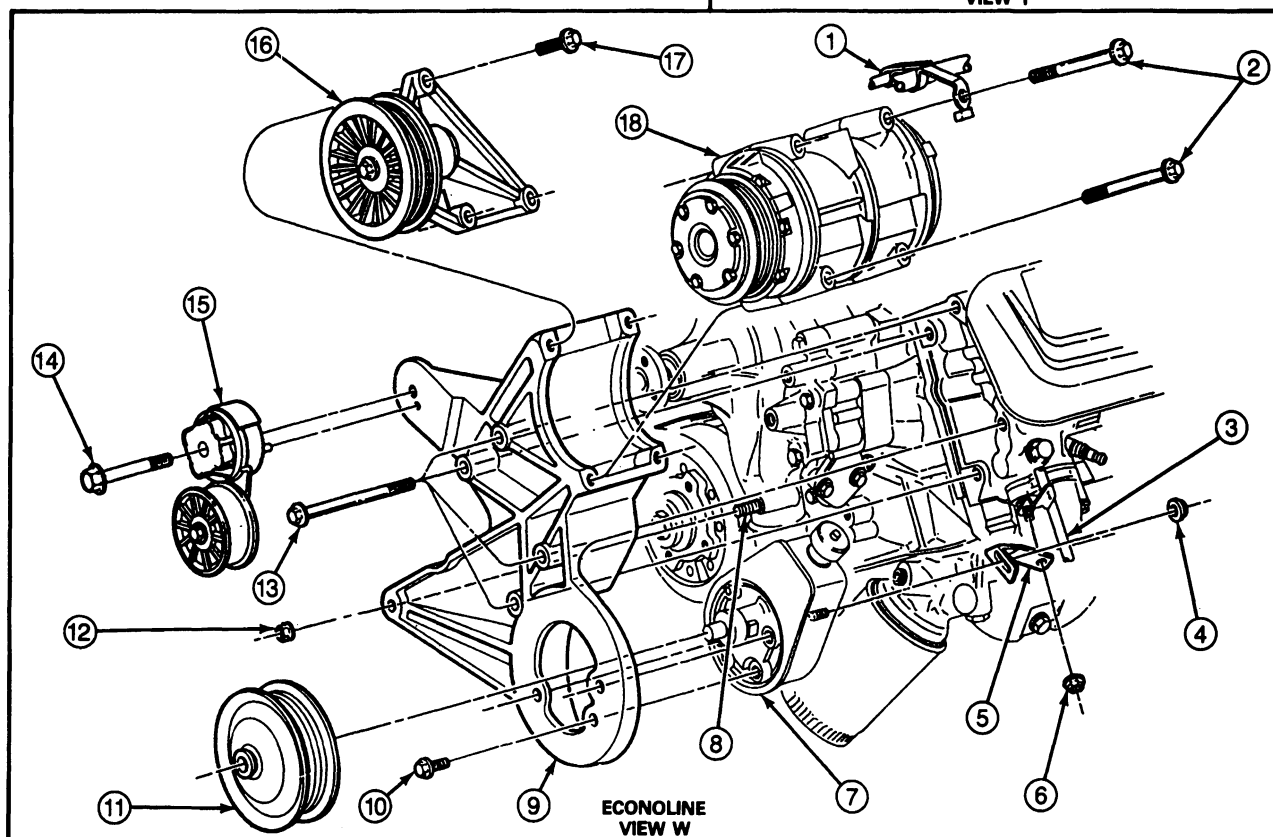
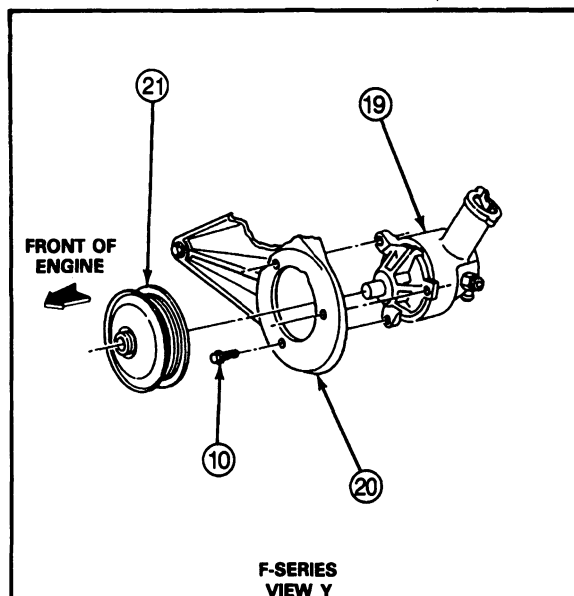
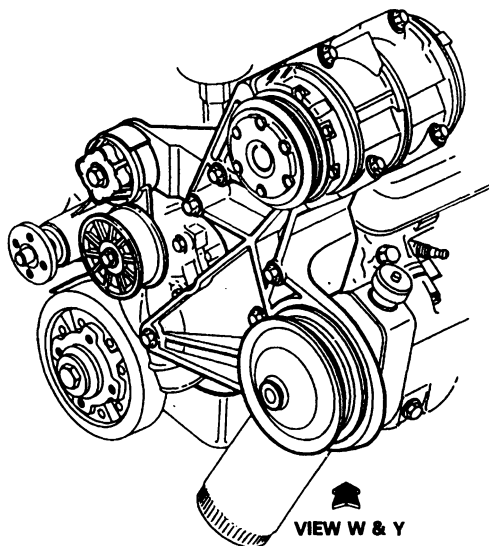


A10393-1A

4. Clean and inspect push rods, one at a time. Clean the oil passage in the push rods with a suitable solvent, and blow out with compressed air.
5. Install push rods in original positions. Apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips and push rod ends.
6. Lubricate and install the rocker arms as described in this section. **Make sure lower ends of push rods remain seated in valve tappets.**
7. Tighten muffler inlet pipe stud nuts to 34-52 N·m (25-38 ft·lb).
8. Install intake manifold and throttle body assembly. Refer to Section 03-04C.
9. Perform Valve Clearance Check as outlined.
10. Install air conditioning / power steering mounting bracket, with power steering pump in place, to left cylinder head and water pump. Tighten bolts to 54-71 N·m (40-53 ft·lb) and nut to 41-54 N·m (30-40 ft·lb). If equipped with air conditioning, attach compressor to mounting bracket. Tighten compressor mounting bolts to 24-31 N·m (18-23 ft·lb). Connect service valves and hoses to compressor.
11. Install alternator bracket to right cylinder head.
12. Install alternator and air pump to bracket. Refer to Specifications at the end of this section for bolt torques.
13. Install air conditioning and power steering pump drive belt. Install alternator and secondary air injection (Thermactor) pump belt. Refer to Section 03-05.
14. Fill and bleed cooling system. Refer to Section 03-03. Fill and bleed power steering reservoir, as necessary. Refer to the Body / Chassis Manual, Section 11-00.
15. Connect battery(s).
16. Start engine and check for leaks.
17. If equipped with air conditioning, evacuate compressor and partially charge system with refrigerant. Refer to the Body / Chassis Manual, Section 12-03.

REMOVAL AND INSTALLATION (Continued)

7.5L Accessory Bracket, Left



A16399-A

Item	Part Number	Description
1	19B980	Air Conditioning Hose Assembly — F-Series
2	N806020-S2	Bolt M8-1.25 x 123 24-31 N-m(18-23 Ft-Lb)

(Continued)

Item	Part Number	Description
3	6750	Oil Indicator Tube
4	N801206-S2	Nut M10-1.5 41-54 N-m (30-40 Ft-Lb)

(Continued)

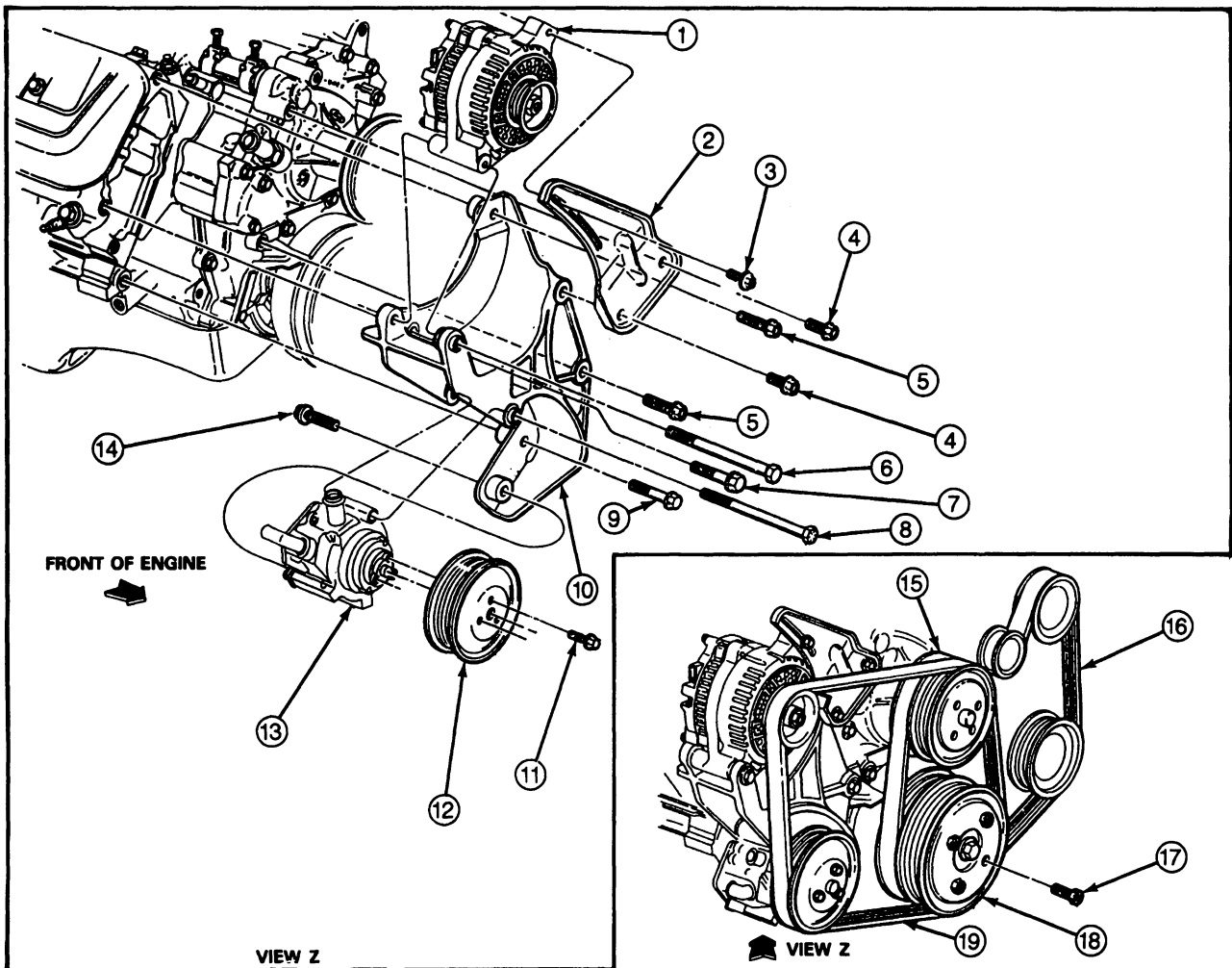
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
5	3C718	Bracket — Power Steering Pump
6	—	Nut 3/8-16 41-54 N-m (30-40 Ft-Lb)
7	3A674	Power Steering Pump — Econoline
8	388112	Stud
9	19E708	Bracket, Air Conditioning Compressor and Power Steering — Econoline
10	N300199-S8	Screw M10-1.5 x 33 41-54 N-m (30-40 Ft-Lb)
11	3D673	Pulley Assembly, Power Steering — Econoline Press Flush $\pm 0.25\text{mm}$ (0.010 Inch)
12	382802-S2	Nut 3/8-16 41-54 N-m (30-40 Ft-Lb)

(Continued)

Item	Part Number	Description
13	391319-S2	Bolt 7/16-14 x 5.5 54-71 N-m (40-53 Ft-Lb)
14	56192-S2	Bolt 1/2-13 x 3.75 68-92 N-m (51-67 Ft-Lb)
15	6B209	Belt Tensioner Assembly
16	19A216	Idler Assembly — Accessory Drive Belt
17	N605790-S2	Bolt M8-1.25 x 40 24-31 N-m (18-23)
18	19D629	Air Conditioning Compressor
19	3A674	Power Steering Pump — F-Series
20	19E708	Bracket, Air Conditioning Compressor and Power Steering Pump — F-Series
21	3D673	Pulley Assembly, Power Steering — F-Series Press Flush $\pm 0.25\text{mm}$ (0.010 Inch)

7.5L Accessory Bracket, Right



A16401-A

REMOVAL AND INSTALLATION (Continued)

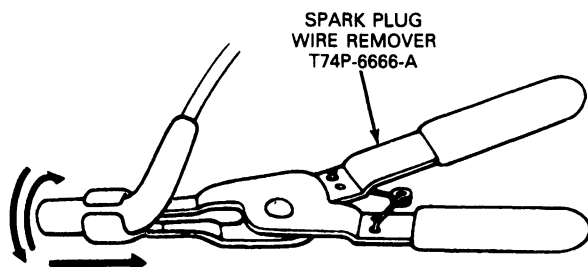
Item	Part Number	Description
1	10300	Alternator
2	10159	Bracket — Alternator Adjusting Arm
3	N806413-S36	Bolt M8-1.25 x 33 — Used with Medium and Large Frame Alternator 30-40 N·m (22-29 Ft-Lb)
	390785-S36	Screw 3/8-16 x 1.25 — Used with Small Frame Alternator 41-54 N·m (30-40 Ft-Lb)
4	56540-S36	Bolt 3/8-16 x 1.0 41-54 N·m (30-40 Ft-Lb)
5	56542-S2	Bolt 3/8-16 x 1.5 40-55 N·m (30-41 Ft-Lb)
6	391319-S2	Bolt 7/16-14 x 5.50 54-71 N·m (40-53 Ft-Lb)
7	56564-52	Bolt 7/16-14 x 2.0 54-71 N·m (40-53 Ft-Lb)
8	391314-S2	Bolt 3/8-16 x 5.25 41-54 N·m (30-40 Ft-Lb)

(Continued)

Item	Part Number	Description
9	56544-S36	Bolt 3/8-16 x 2.0 41-54 N·m (30-40 Ft-Lb)
10	10239	Bracket — Alternator Mounting
11	N802493-S2	Screw M6-1.0 x 16 12-15 N·m (9-11 Ft-Lb)
12	9C480	Pulley Assembly — Thermactor Pump
13	9A486	Thermactor Pump
14	56543-S36	Bolt 3/8-16 x 1.75 41-54 N·m (30-40 Ft-Lb)
15	8509	Pulley Assembly — Water Pump
16	8620	Belt — Drive 6K x 67.5 W/O A/C and All Econoline 6k x 68.6 F-Series with A/C
17	42988-S36	Bolt 3/8-16 x 1.0 54-71 N·m (40-53 Ft-Lb)
18	6312	Pulley — Crankshaft
19	8620	Belt — Drive 6k x 49.5 — Small and Medium Frame Alternator 6k x 50.5 — Large Frame Alternator

Exhaust Manifolds**Removal**

1. If removing right exhaust manifold, remove spark plug heat shield.
2. Remove spark plug wires using Spark Plug Wire Remover T74P-6666-A.



TWIST AND PULL

B3496-E

3. Disconnect external EGR tube on left exhaust manifold.
4. Disconnect exhaust manifold(s) at muffler inlet pipe(s).
5. On Econoline, remove power steering pump support brace from back of power steering pump. Remove oil dipstick tube from left exhaust manifold.

6. Remove attaching bolts. Remove exhaust manifold(s).

Inspect the cylinder head joining flanges of the exhaust manifold(s) for evidence of exhaust gas leaks.

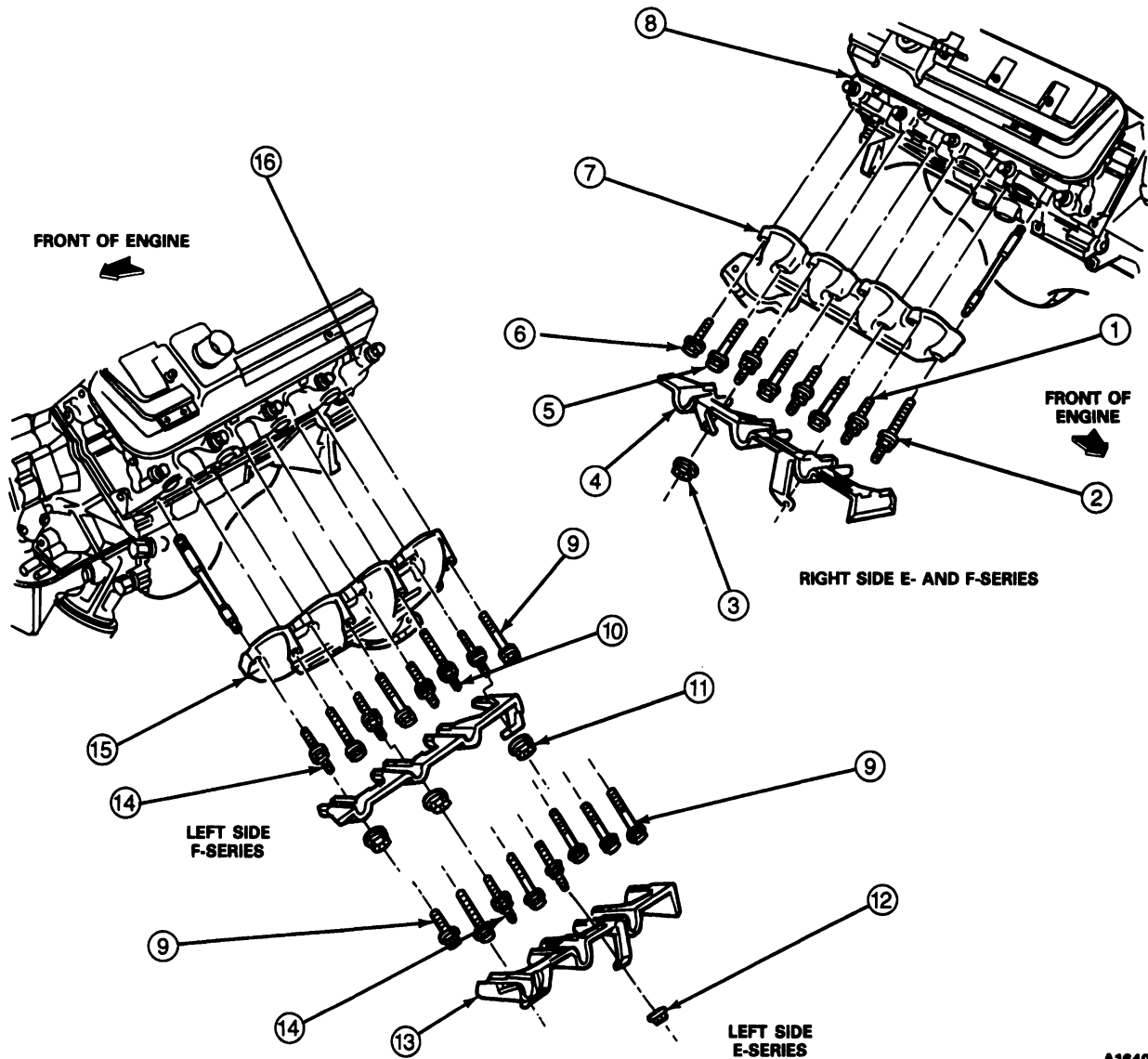
Inspect the manifold(s) for cracks, damaged sealing surfaces, or other wear or damage that would make them unfit for further service.

Installation

1. Clean mating surfaces of exhaust manifold(s) and cylinder head(s). Clean mounting flange of manifold(s) and inlet pipe(s). Apply light film of Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) to exhaust manifold(s).
2. Position exhaust manifold(s) on cylinder head(s). Install attaching bolts and washers, starting at fourth bolt hole from front of each manifold. Tighten bolts to 30-41 N·m (22-30 ft-lb), working from center of manifold to both ends.
3. Position inlet pipes to manifolds. Install attaching nuts and tighten to 39-49 N·m (25-36 ft-lb).
4. Install heat shield and spark plug wires.
5. On Econoline, install power steering pump support brace.
6. Install air cleaner and intake duct assembly, if removed.
7. Start engine and check for exhaust leaks.

REMOVAL AND INSTALLATION (Continued)

7.5L Exhaust Manifold Installation



A16403-A

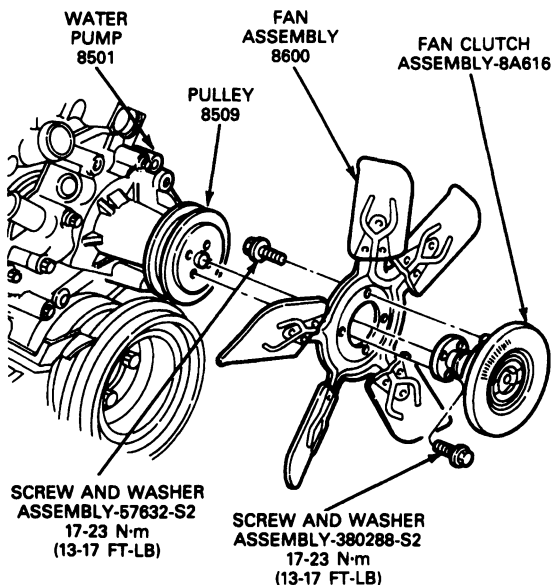
Item	Part Number	Description
1	390613	3/8-16 x 2.82 Hex Shoulder Stud 30-41 N-m (22-30 Ft-Lb)
2	—	3/8-16-16 x 3.79 Hex Shoulder Stud 30-41 N-m (22-30 Ft-Lb)
3	—	3/8-16 Nut 13-24 N-m (10-18 Ft-Lb) This Location Only
4	12A087	Spark Plug Heat Shield
5	390849	3/8-16 x 2.75 Bolt 30-41 N-m (22-30 Ft-Lb)
6	—	3/8-16 x 1.62 Bolt 30-41 N-m (22-30 Ft-Lb)
7	9430	Exhaust Manifold — Right

(Continued)

Item	Part Number	Description
8	6050	Cylinder Head — Right
9	390849	3/8-16 x 2.75 Bolt 30-41 N-m (22-30 Ft-Lb)
10	—	3/8-16 x 3.79 Hex Shoulder Stud 30-41 N-m (22-30 Ft-Lb)
11	—	3/8-16 Nut 22-37 N-m (11-27 Ft-Lb)
12	—	3/8-16 Nut 13-24 N-m (10-18 Ft-Lb)
13	12A087	Heat Shield — E-Series
14	—	3/8-16-16 x 2.82 Hex Shoulder Stud 30-41 N-m (22-30 Ft-Lb)
15	9431	Exhaust Manifold — Left
16	6049	Cylinder Head — Left

REMOVAL AND INSTALLATION (Continued)**Water Pump****Removal**

1. Drain cooling system. Refer to Section 03-03.
2. Remove power steering and alternator drive belts.
3. Remove bolts attaching fan shroud to radiator.
4. Remove fan assembly from fan clutch assembly and remove fan shroud.
5. Remove fan clutch and water pump pulley from water pump.
6. Remove four bolts and one nut attaching air conditioning compressor and power steering pump bracket to cylinder head and water pump. Do not remove air conditioning compressor or power steering pump from bracket. On Econoline it is necessary to remove the brace which connects the power steering pump to the exhaust manifold.
7. Pull bracket forward to remove from stud on water pump.
8. Remove bolt attaching alternator adjusting bracket to water pump. Remove four bolts attaching alternator and air pump bracket to cylinder head, block and water pump.
9. Remove remaining water pump attaching bolts and remove water pump from cylinder front cover. Remove separator plate from water pump. Discard gaskets.



A10711-C

Installation

1. Remove any gasket material from water pump, cylinder front cover and separator plate mating surfaces.

2. Position new gaskets coated on both sides with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent water-resistance sealer.
3. Position water pump and cover onto cylinder front cover. Install bolts and tighten to 16-24 N-m (12-18 ft-lb).
4. Install alternator and air pump bracket to cylinder head, block and water pump with four attaching bolts. Install alternator adjusting bracket to water pump with one attaching bolt. Tighten 7/16-inch bolts to 54-71 N-m (40-53 ft-lb) and 3/8-inch bolts to 40-45 N-m (30-33 ft-lb).
5. Position air conditioning compressor and power steering pump bracket over water pump stud and secure to head with four bolts tightened to 54-71 N-m (40-53 ft-lbs) and secure nut to water pump to 41-54 N-m (30-40 ft-lbs). On Econoline, tighten power steering pump bracket nuts to 41-54 N-m (30-40 ft-lb).
6. Install water pump pulley and fan clutch to water pump hub with four bolts. Install fan assembly to fan clutch with four bolts. Tighten water pump pulley, fan clutch hub bolts, and fan-to-fan clutch hub bolts to 17-23 N-m (13-17 ft-lb). Install fan shroud.
7. Install power steering and alternator drive belts. Refer to Section 03-05.
8. Fill and bleed the cooling system. Refer to Section 03-03.
9. Start the engine and check for leaks.

Front Cover and Timing Chain**Removal**

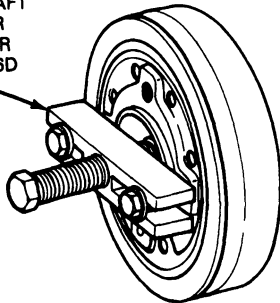
Cylinder front cover oil seal replacement is recommended whenever the cover has been removed.

1. Disconnect battery(s).
2. Drain cooling system and crankcase. Refer to Section 03-03.
3. Remove power steering and alternator drive belts.
4. Remove bolts attaching fan shroud to radiator.
5. Remove fan assembly from fan clutch assembly and remove fan shroud.
6. Remove fan clutch and water pump pulley from water pump.
7. Disconnect radiator upper and lower hoses at engine. Disconnect transmission and engine oil cooler lines at radiator. Disconnect engine oil cooler fan radiator support and position out of the way.
8. Remove radiator upper support and remove radiator. Refer to Section 03-03.
9. On Econoline, position alternator splash shield out of the way.

REMOVAL AND INSTALLATION (Continued)

10. Remove alternator pivot and attaching bolts. Remove alternator from bracket.
11. Remove two bolts attaching alternator adjusting bracket to water pump and alternator bracket and remove bracket.
12. Remove air pump pivot and attaching bolts. Remove air pump from bracket.
13. Remove four bolts attaching alternator and secondary air injection (Thermactor) pump bracket to cylinder head, block and water pump, and remove bracket.
14. Remove power steering pulley from power steering pump. On Econoline remove two nuts attaching power steering pump brace to power steering pump and exhaust manifold.
15. Remove power steering lines from pump. Remove four bolts attaching power steering pump to bracket and remove pump from bracket.
16. Remove four bolts attaching air conditioning compressor to bracket. Remove four bolts and one nut attaching air conditioning compressor and power steering pump bracket to cylinder head and water pump. Remove bracket from engine.
17. Remove the crankshaft pulley from the vibration damper.
18. Remove bolt and washer attaching crankshaft damper. Remove crankshaft damper using Crankshaft Damper Remover T58P-6316-D or Rotunda Gear Puller 014-00293 or equivalent. Remove Woodruff key and crankshaft damper spacer from crankshaft.

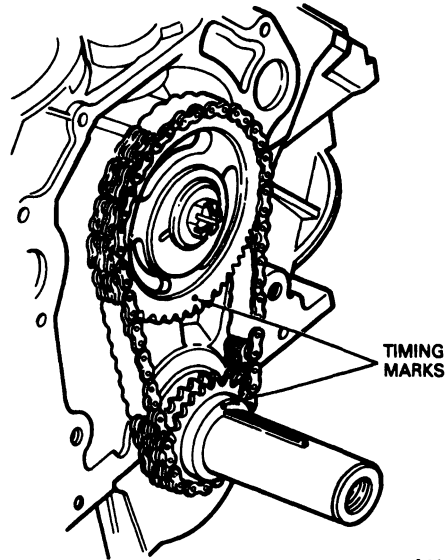
CRANKSHAFT
DAMPER
REMOVER
T58P-6316D



A17843-A

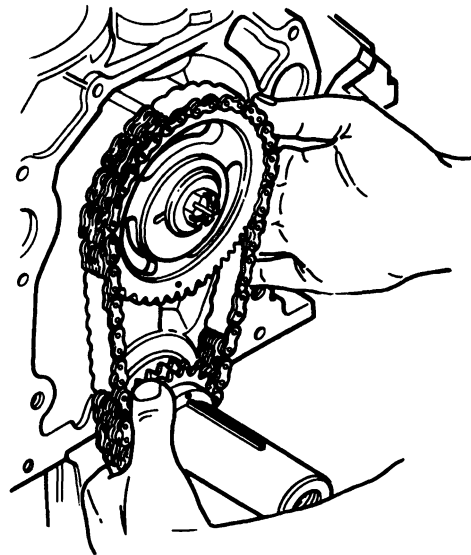
19. Loosen bypass hose at water pump. Disconnect heater return tube at water pump.
20. Remove bolts attaching front cover to cylinder block. Remove front cover and water pump as an assembly. Discard front cover gasket and oil pan seal. Using a thin-blade knife, cut the oil pan seal flush with cylinder block face separating the cover from the cylinder block.
21. If new front cover is to be installed, remove water pump and install it and a new gasket on the new front cover.

22. Check timing chain deflection. Refer to Section 03-00.
23. If the timing chain and sprocket are to be removed, crank the engine until timing marks on sprockets are as shown.



A10737-1A

24. Remove camshaft sprocket capscrew, washer and slinger. Slide timing chain and sprockets forward, and remove as an assembly.
25. Refer to Section 03-00, for cleaning and inspection procedures.



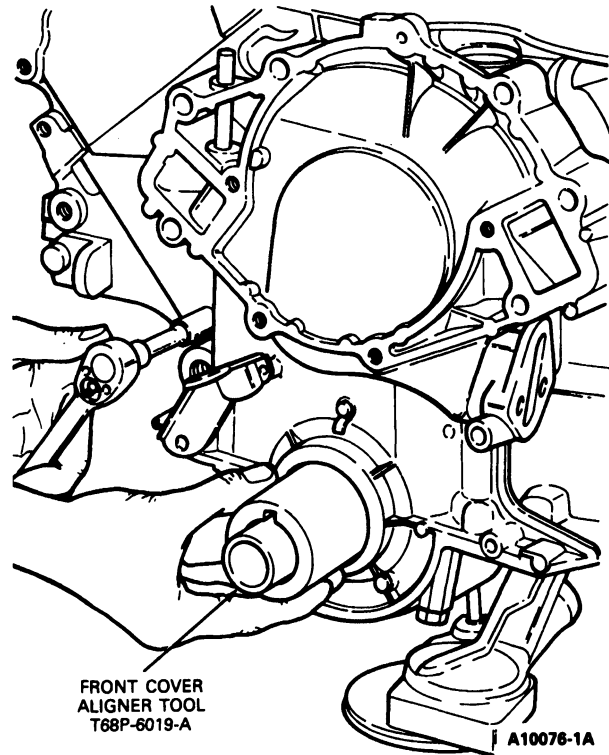
A10738-1A

REMOVAL AND INSTALLATION (Continued)**Installation**

1. Assemble the timing chain and sprockets so sprocket timing marks align with each other as shown under Removal. Install the chain and sprockets as an assembly to crankshaft and camshaft. If a new chain is to be installed, submerge chain in a container of recommended quality engine oil. Verify proper alignment of timing marks after installation. Install front oil slinger.
2. Install the camshaft sprocket capscrew and washer. Tighten capscrew to 55-68 N·m (40-50 ft·lb). Lubricate timing chain with recommended quality engine oil.
3. Replace front oil seal as described in this section.
4. Clean front cover and cylinder block sealing surfaces. Also, clean oil pan gasket sealing surfaces of any oil or debris.
5. Coat the gasket surfaces of the block and cover with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent oil resistant sealer and position a new gasket on the block.
6. Apply Silicone Rubber D6AZ-19562-AA or -BA (ESB-M4G92-A) or equivalent sealer along the cylinder block pan gasket junction where the front cover contacts the pan gasket.

NOTE: The use of RTV sealer requires joining components within 15 minutes to ensure sealing effectiveness.

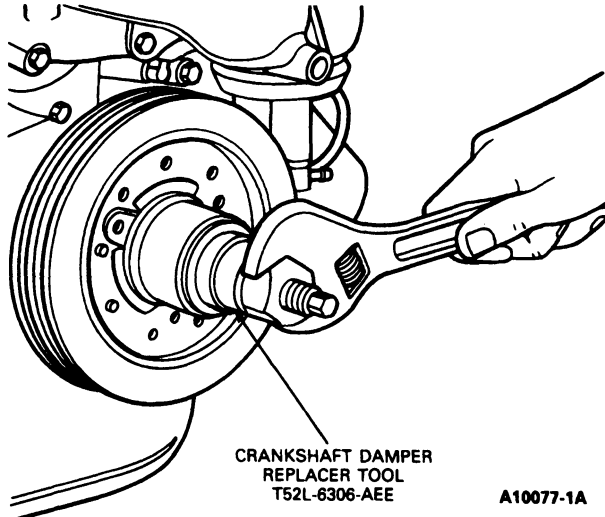
7. Position the front cover onto the cylinder block. Use care when installing the cover to avoid seal damage or possible mislocation.
8. Install Front Cover Aligner T68P-6019-A into proper position. It may be necessary to force the cover downward in a manner to slightly compress the pan seal. This operation can be facilitated by using a suitable tool at the attaching bolt hole locations.



9. Coat the threads of the attaching bolts with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent oil-resistant sealer and install the screws.
10. While pushing in on Front Cover Aligner T68P-6019-A, tighten the oil pan-to-cover attaching bolts to 10-12 N·m (7-9 ft·lb). Remove alignment tool. Tighten the cover-to-cylinder block attaching screws to 17-24 N·m (12-18 ft·lb).
11. Apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to front of crankshaft for damper installation.
12. Install crankshaft damper spacer on the inner Woodruff key.

REMOVAL AND INSTALLATION (Continued)

13. Position crankshaft damper Woodruff key and install crankshaft damper using Crankshaft Damper and Sprocket Replacer T52L-6306-AEE. Install damper attaching screw and washer. Tighten to 95-122 N·m (70-90 ft-lb).



14. Install crankshaft pulley to damper. Tighten four bolts to 11.4-15.6 N·m (100-137 in-lb).
15. Install air conditioning compressor and power steering pump bracket to cylinder head using four bolts. Tighten to 54-71 N·m (40-53 ft-lbs). Tighten nut to water pump stud to 41-54 N·m (30-40 ft-lbs).
16. Attach air conditioning compressor to bracket with four bolts and tighten to 24-31 N·m (18-23 ft-lb).
17. On Econoline, attach power steering pump brace to pump and exhaust manifold. Tighten nuts to 41-54 N·m (30-40 ft-lb).
18. Attach power steering pump lines to pump. Press power steering pump pulley onto pump. Make sure front surface of pulley hub is flush with end of pump shaft.
19. Attach alternator and air pump bracket to cylinder head, block and water pump with four bolts. Tighten 3/8-inch bolts to 41-54 N·m (30-40 ft-lb) and 7/16-inch bolts to 40-53 N·m (40-53 ft-lb).
20. Install secondary air injection (Thermactor) pump to bracket with two bolts. Tighten to 41-54 N·m (30-40 ft-lb). Install air pump pulley. Tighten screws to 12-15 N·m (9-11 ft-lb).
21. Install alternator adjusting bracket to alternator bracket and water pump with two bolts. Tighten to 41-54 N·m (30-40 ft-lb).
22. Install alternator to bracket using two bolts. Do not tighten bolts until drive belt has been tensioned.
23. Install accessory drive belts and adjust belt tension to specifications. Refer to Section 03-05.
24. Install alternator splash shield (Econoline only).
25. Position radiator to lower support. Position upper support to radiator, and install attaching bolts. Connect radiator upper and lower hoses at engine. Connect transmission oil cooler lines. Refer to Section 03-03.
26. Place fan assembly inside radiator shroud and set in position in vehicle. Position the fan and fan spacer on the water pump pulley. Install and tighten the attaching bolts to 17-23 N·m (13-17 ft-lb). Install screws attaching shroud to radiator.
27. The crankcase oil should be drained and refilled with the proper grade and quantity of engine oil before starting the engine.
28. Fill and bleed the cooling system. Refer to Section 03-03.
29. Connect battery(s).
30. Run engine at fast idle and check for coolant and oil leaks. Adjust ignition timing to specification listed on the Vehicle Emission Control Information (VECI) decal.

Front Oil Seal

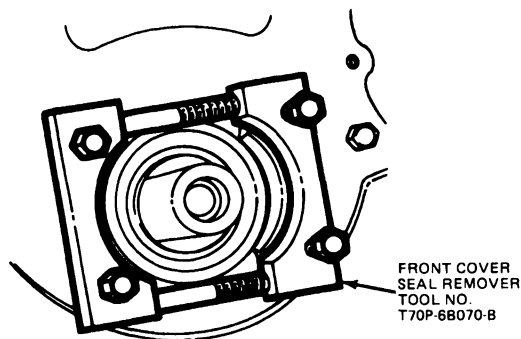
Replacement of the front oil seal is recommended whenever the front cover is removed.

Removal

1. Remove the bolts attaching the fan shroud to the radiator.
2. Remove the fan bolts from the water pump hub. Remove the fan, spacer and shroud.
3. Remove the alternator and power steering drive belts.
4. Remove the crankshaft pulley from the vibration damper. Remove the damper attaching screw and washer. Remove vibration damper using Crankshaft Damper Remover T58P-6316-D.
5. Remove front Woodruff key and slide crankshaft damper spacer off of crankshaft.
6. Place the Front Cover Seal Remover T70P-6B070-B onto the front cover plate over the front seal. Tighten the two through-bolts to force the seal puller under the seal flange.

REMOVAL AND INSTALLATION (Continued)

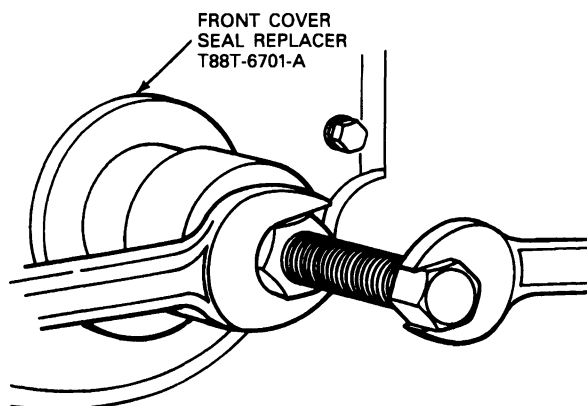
7. Alternately tighten the four puller bolts one half turn at a time. Pull the oil seal from the front cover.



A5765-1B

Installation

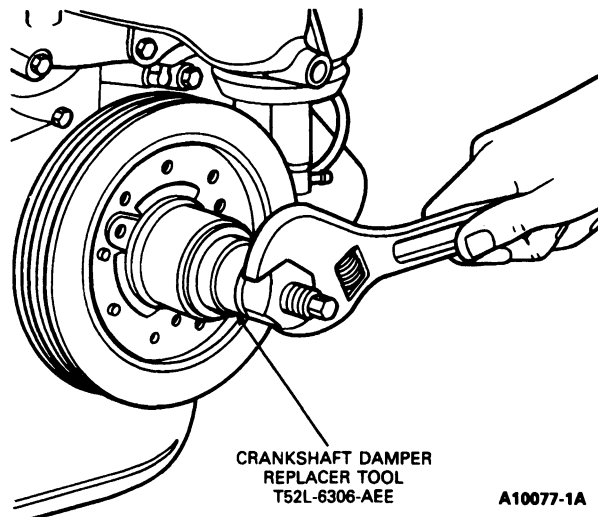
1. Coat a new front cover plate oil seal with Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent and place it onto the Front Cover Seal Replacer T88T-6701-A. Place the sleeve and seal onto the end of the crankshaft and push it toward the engine until the seal starts into the front cover.



A10352-B

2. Place the installation screw, washer, and nut onto the end of the crankshaft. Thread the screw into the crankshaft. Tighten the nut against the washer and installation sleeve to force the seal into the front cover plate. Remove the installation tool from the crankshaft.
3. Install crankshaft damper spacer on the inner Woodruff key. Install Woodruff key for vibration damper.
4. Apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) to the front of the crankshaft for damper installation.

5. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on crankshaft using Crankshaft Damper and Sprocket Replacer T52L-6306-AEE. Install the capscrew and washer. Tighten the screw to 95-122 N-m (70-90 ft-lb). Install the crankshaft pulley.
6. Install the alternator and power steering pump belts.
7. Position the fan shroud over the water pump pulley. Install the fan. Install the fan shroud attaching screws.
8. Adjust the drive belts to specification. Refer to Section 03-05, Accessory Drive.

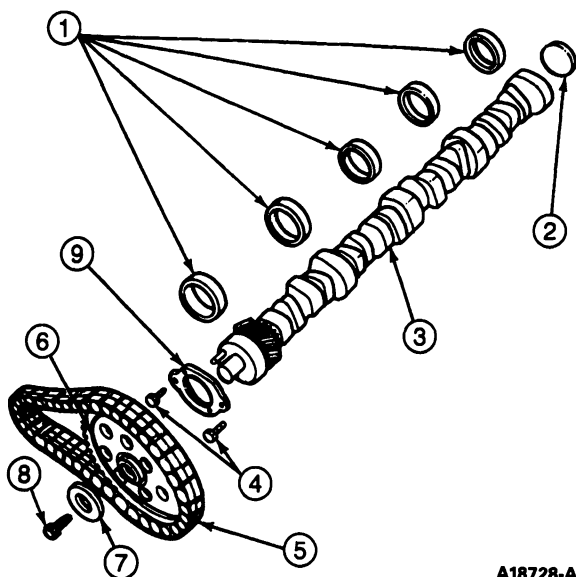


A10077-1A

Camshaft**Removal**

1. Drain radiator and remove. Refer to Section 03-03.
2. Remove cylinder front cover, timing chain and sprockets as described in this section. Check timing chain deflection before removal. Refer to Section 03-00.
3. Remove the intake manifold and throttle body. Refer to Section 03-04C.

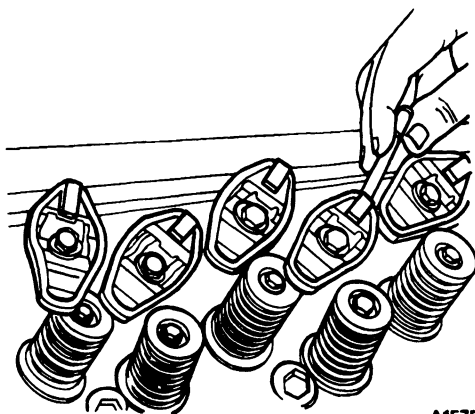
REMOVAL AND INSTALLATION (Continued)



A18728-A

Item	Part Number	Description
1	6251	Camshaft Bearing Kit
2	382080	Rear Bearing Bore Plug
3	6250	Camshaft
4	42910	Bolt 8-12 N-m (70-105 In-Lb)
5	6268	Timing Chain
6	6256	Sprocket
7	6278	Washer
8	43001	Bolt 54-67 N-m (40-50 Ft-Lb)
9	6269	Thrust Plate

4. Remove valve rocker arm covers. Back off all rocker arm fulcrum bolts, turn rocker arms sideways, and remove the push rods keeping them in sequence.



A15758-A

5. Remove the valve tappets with a magnet and place them in a rack in sequence. Rotate the tappets back and forth to loosen them from gum or varnish deposits.

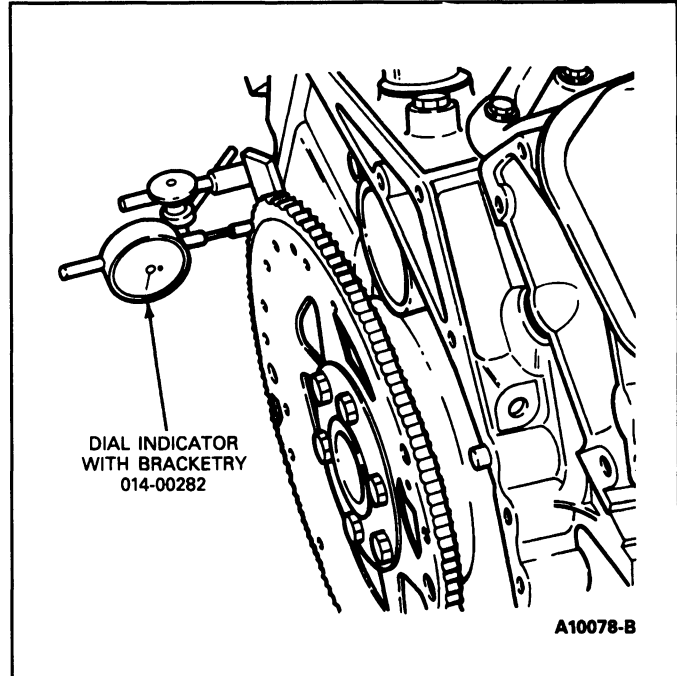
6. Remove the bolts attaching the air conditioning condenser to the chassis, if so equipped. Carefully rest the condenser on the left fender. Secure it in this position. Refer to Section 12-03B.
7. Remove the grille.
8. Remove the camshaft thrust plate attaching bolts, and carefully remove the camshaft from the front of engine. **Do not damage the camshaft bearings by nicking them with the cam lobes.**
- Refer to Section 03-00 for cleaning and inspection procedures, and repair as required.

Installation

1. Oil the camshaft journals and apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the cam lobes. Carefully slide camshaft into position.
2. Install camshaft thrust plate. Tighten bolts to 8-12 N-m (70-105 in-lb). Check camshaft end play following procedure in Section 03-00. If end play is excessive, replace the camshaft thrust plate.
3. Install timing chain, sprockets, oil slinger and front cover as described in this section.
4. Position the radiator in the vehicle and install the radiator upper support to secure radiator. Refer to Section 03-03. Connect the radiator lower hose at the engine oil cooler.
5. Install the grille center support and air conditioning condenser. Refer to Section 12-03B.
6. Clean the tappets externally. Lubricate the tappets and tappet bores with specified engine oil before installing them. Lubricate the push rod ends with Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent. Install the valve tappets and push rods in their original positions.
7. Install intake manifold and throttle body. Refer to Section 03-04C.
8. Rotate the crankshaft damper until No. 1 piston is at TDC at the end of compression stroke. Install the distributor following the procedure in Section 03-07.
9. Apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips. Position rocker arms over push rods and tighten bolts as described in this section. Adjust valve clearance as outlined if necessary.
10. Clean the valve rocker arm covers and cylinder head sealing surfaces. Position new seal, if required, in cover seal groove. Make sure that the seal tang is secured in the notch of the cover.
11. Position cover on the cylinder head and tighten the four rocker arm cover bolt and washer assemblies to 12-15 N-m (9-11 ft-lb), starting at the rearmost bolt and working forward.
12. Connect the radiator upper hose. Connect heater hose at intake manifold and at water pump.

REMOVAL AND INSTALLATION (Continued)

13. Install the accelerator linkage. Install the speed control linkage, if so equipped.
14. Connect engine vacuum lines to their original outlets on the fittings of the intake manifold. Connect PCV valve and hose to right valve rocker arm cover.
15. Install the distributor cap and connect the coil and spark plug wires.
16. Install water pump pulley and fan clutch to water pump hub with four bolts. Install fan assembly to fan clutch with four bolts. Tighten water pump pulley, fan clutch hub bolts, and fan-to-fan clutch hub bolts to 17-23 N·m (13-17 ft-lb). Install fan shroud. Install poly V belt according to instructions on decal on radiator support.
17. Fill and bleed the cooling system. Refer to Section 03-03. Fill and bleed power steering reservoir. Run engine at fast idle and check for leaks.
18. Adjust the ignition timing to specifications listed on the engine decal.
19. Adjust transmission linkage, if necessary. Refer to the Body / Chassis Manual, Section 07-00A or 07-00B. Install the air cleaner and intake duct.

**Flywheel****Removal**

1. Remove the transmission from vehicle. Refer to the Body / Chassis Manual, Section 07-00A or 07-00B. Remove the flywheel mounting bolts and remove flywheel from the crankshaft.
2. Refer to Section 03-00 for inspection.

Installation

1. Install flywheel on crankshaft. Install the mounting bolts. Tighten to 103-115 N·m (75-85 ft-lb).
2. Check flywheel runout and ring gear runout using Dial Indicator With Bracketry 014-00282 or equivalent. Refer to Section 03-00. Refer to Specifications at the end of this section.
3. Install transmission assembly into vehicle. Refer to Section 07-00A or 07-00B.

Camshaft Rear Bearing Bore Plug**Removal**

1. Remove the transmission from the vehicle. Refer to Section 07-00A or 07-00B.
2. Remove flywheel and engine rear cover plate as described in this section.
3. Replace the plug. Refer to Section 03-00.

Installation

1. Install the engine rear cover plate and flywheel following procedure under Flywheel Installation.
2. Install the transmission. Refer to Section 07-00A or 07-00B.

Oil Pan**Removal**

1. Remove the engine cover (E-Series), disconnect the battery, and drain the cooling system. Refer to Section 03-03.
2. Disconnect the fresh air inlet tube and remove the air cleaner assembly.
3. Remove fan shroud, fan, and pulley.
4. On E-350 vehicles, remove upper intake manifold. Refer to Section 03-04C.
5. On F-250-350 and Bronco vehicles, disconnect throttle body linkage and wiring.
6. Disconnect vacuum lines from upper and lower intake manifolds. Tag lines to aid in reassembly.

REMOVAL AND INSTALLATION (Continued)

7. Perform fuel system pre-service as described in Section 03-04C. Using D87L-9280-A and -B or equivalent, disconnect fuel supply and return lines.
8. Disconnect the radiator upper and lower hoses.
9. Disconnect the two transmission oil cooler lines at the radiator. Disconnect engine oil cooler lines at the filter adapter. Remove the power steering pump and position out of the way.
10. Remove the front engine mount attaching through-bolts. Remove the nuts attaching the oil dipstick tube to the exhaust manifold.
11. Remove the oil filler tube and bracket (bolt).
12. If so equipped, rotate air conditioner lines (at rear of compressor) down to clear the dash. Remove air conditioning compressor without disconnecting hoses and set out of the way.
13. Raise the vehicle on a hoist, drain the crankcase, and remove the oil filter.
14. Remove the muffler inlet pipe assembly. Disconnect the manual and kickdown linkage from the transmission.
15. Remove the driveshaft and coupling shaft assembly. Remove the transmission dipstick tube assembly.
16. Remove the dipstick and tube from the oil pan. Place a transmission jack under the engine oil pan. Insert a wood block between the jack surface and the oil pan. Jack the engine upward, pivoting about the rear mount until the transmission contacts the floor pan. Then, block the engine in position at the engine mounts. The engine must remain centralized to obtain the maximum height. The engine must be raised 102mm (four inches) at the mounts to remove the oil pan.
17. Remove the oil pan retaining bolts and remove oil pan flange reinforcement plates. Lower the oil pan. Remove the oil pump and pickup tube attachments. Drop the oil pump and pickup tube assembly into the oil pan. Remove the oil pan rearward from the vehicle.

Installation

1. Clean the oil pan gasket surface at the cylinder block. Clean the oil pan assembly, the oil pump pickup tube, and the screen. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening.
2. Lightly apply Gasket and Trim Adhesive D7AZ-19B508-AA (ESR-M11P17-A) to the cylinder block surface. Also apply a bead of Silicone Rubber D6AZ-19562-AA (ESE-M4G195-A) at the parting line of front cover and block. Position the one-piece silicone gasket to the cylinder block and press lightly until gasket sticks to surface. Position the oil pan with oil pump and pickup tube assembly to the chassis. Install the oil pump assembly to the cylinder block. Tighten attaching bolts to 30-43 N·m (22-32 ft·lb).
3. Position the oil pan to the cylinder block, position reinforcements and install the attaching bolts. Tighten 1 / 4-inch bolts to 10-12 N·m (7-9 ft·lb).
4. Place jack under engine and raise engine enough to remove blocks.
5. Lower engine and remove jack.
6. Position the engine oil dipstick tube to the oil pan and exhaust manifold and install the attaching nut.
7. Re-position the air conditioner lines, if so equipped. If removed, reinstall air conditioning compressor.
8. Install the engine support-to-bracket attaching through-bolts and connect the manual kickdown linkage at the transmission. Install the driveshaft and coupling shaft assembly, and the muffler inlet pipe assembly.
9. Clean the oil filter mounting surface and install the oil filter.
10. Lower the vehicle from the hoist. Install the engine oil filler tube and bracket (Econoline). Attach the oil dipstick tube to the left exhaust manifold (one nut).
11. Install the radiator assembly and connect the two transmission oil cooler lines.
12. Install the fan assembly and shroud, and then connect the lower and upper radiator hoses.
13. Install the upper intake manifold and throttle body. Refer to Section 03-04C.
14. Connect the throttle and transmission linkage at the throttle body.
15. Re-position the power steering pump belt and adjust tension. Refer to Section 03-05. Attach the transmission filler tube to the right cylinder head (two bolts).

REMOVAL AND INSTALLATION (Continued)

16. Install the air cleaner assembly and fresh air inlet tube, fill and bleed the cooling system. Refer to Section 03-03. Connect the battery and fill the crankcase. Start the engine and check for leaks. Install the engine cover making sure guide brackets are not on top of sheet metal. If latches are hard to secure, or if seal bulb will not compress, cover is not properly aligned.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM)(12A650) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

Oil Pump

Remove and install the oil pump as outlined. The oil pump and oil pan must be removed together.

Crankshaft Rear Oil Seal

Removal

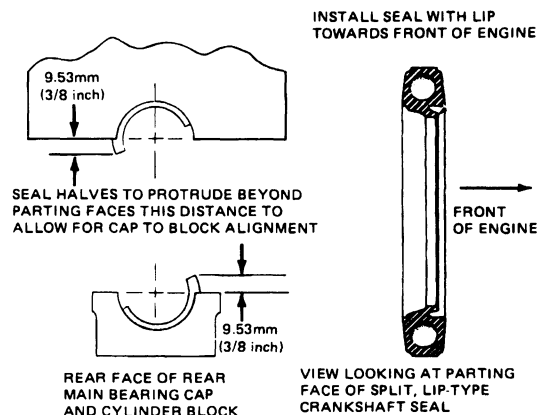
1. Remove the oil pan and the oil pump (if required).
2. Loosen all the main bearing cap bolts, thereby lowering the crankshaft slightly but not to exceed 0.7938mm (1/32 inch).
3. Remove the rear main bearing cap, and remove the oil seal from the bearing cap and cylinder block. On the block half of the seal use a seal removal tool, or install a small metal screw in one end of the seal, and pull on the screw to remove the seal. **Exercise caution to prevent scratching or damaging the crankshaft seal surfaces.**

Installation

1. Carefully clean the seal groove in the cap and block with a brush and solvent such as lacquer thinner, Ford Spot Remover, B7A-19521-A or equivalent. Also, clean the area where sealer is later to be applied. Dry the area thoroughly, so that no solvent touches the seal.
2. Dip the split lip-type seal halves in clean engine oil.

3. Carefully install the upper seal (cylinder block) into its groove with undercut side of seal toward the FRONT of the engine, by rotating it on the seal journal of the crankshaft until approximately 9.525mm (3/8 inch) protrudes below the parting surface.

Be sure no rubber has been shaved from the outside diameter of the seal by the bottom edge of the groove. Do not allow oil to get on the sealer area.



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4. Tighten the remaining bearing cap bolts to specifications.
5. Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine, allow the seal to protrude approximately 9.525mm (3/8 inch) above the parting surface to mate with the upper seal when the cap is installed.
6. Apply an even 1.588mm (1/16 inch) bead of RTV silicone rubber sealer, (D6AZ-19562-B or equivalent), to the areas shown following the procedure given in the illustration.

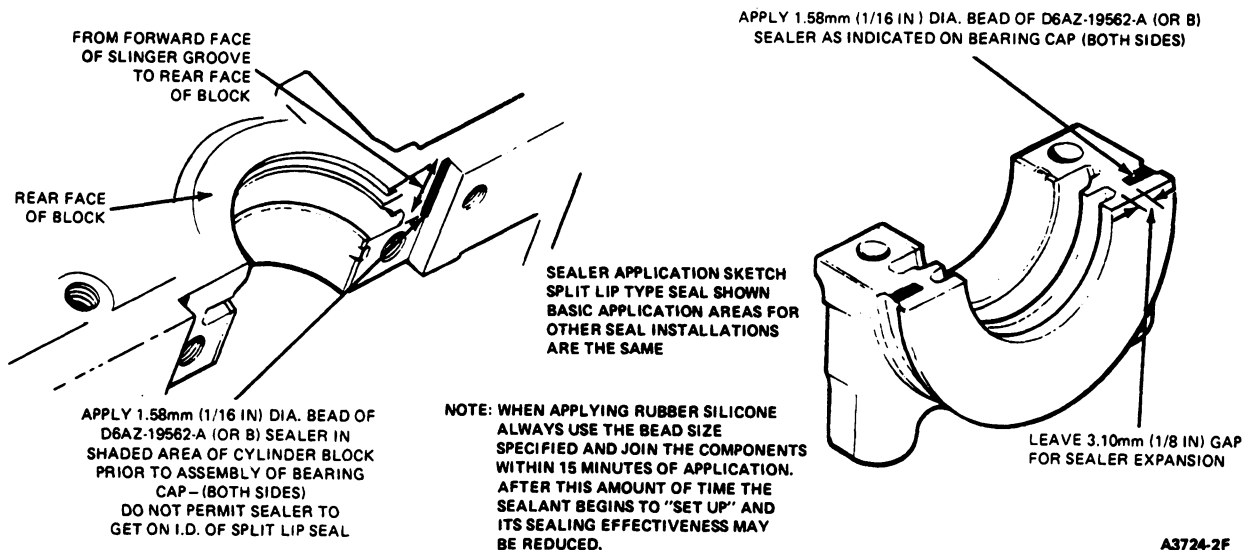
NOTE: This sealer sets-up in 15 minutes.

Install the rear main bearing cap. Tighten the bolts to specifications listed in the specific engine section in this manual.

7. Install the oil pump and oil pan. Fill the crankcase with the proper amount and type of oil.

REMOVAL AND INSTALLATION (Continued)

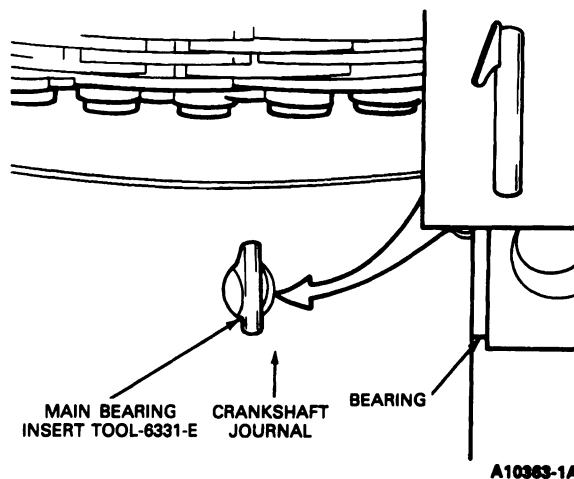
8. Operate the engine and check for oil leaks.

**Main Bearing**

Main and connecting rod bearing inserts are selective fits. Refer to Section 03-00.

Removal

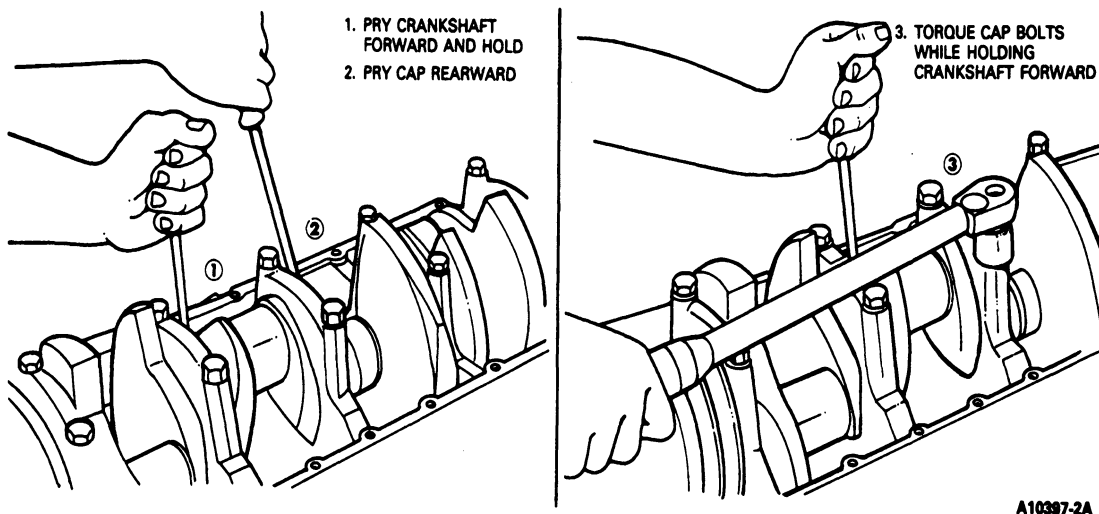
1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan, oil pump and related parts as described in this section.
2. Replace one bearing at a time, leaving other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.
3. Insert Main Bearing Insert TOOL-6331-E in oil hole in crankshaft.
4. Rotate the crankshaft in the direction of engine rotation to force bearing out of block.
5. Clean the crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear.

**Installation**

1. To install upper main bearing, place plain end of bearing over shaft on locking tang side of block and partially install bearing so Main Bearing Insert TOOL-6331-E can be inserted into oil hole in crankshaft. With Main Bearing Insert TOOL-6331-E in oil hole, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.
2. Fit the main bearings with Plastigage. Refer to Section 03-00.
3. After the bearing has been fitted, apply light coat of specified engine oil to journal and bearings. Install the bearing cap. Tighten the cap bolts to 129-142 N·m (95-105 ft-lb).
4. Repeat the procedure for remaining bearings requiring replacement.

REMOVAL AND INSTALLATION (Continued)

5. If the rear main bearing is to be replaced, remove the rear main bearing cap. Remove and discard the rear oil seal.
6. Clean rear journal oil seal groove and mating surfaces of block and rear main bearing cap.
7. Install the new seal as described in this section.
8. Refer to Crankshaft Rear Oil Seal in this section for procedure used in sealing the rear main bearing cap. After sealing, install the rear main bearing cap. Tighten cap bolts 129-142 N·m (95-105 ft·lb).
9. If thrust bearing cap (6330) (No. 3 main bearing) has been removed, install as follows:
Install the thrust bearing cap with bolts finger-tight. Pry the crankshaft forward against the thrust surface of upper half of bearing. Hold the crankshaft forward and pry thrust bearing cap to rear. This aligns thrust surfaces of both halves of bearing. Retain forward pressure on crankshaft. Tighten cap bolts to 129-142 N·m (95-105 ft·lb).

Tightening Thrust Bearing Cap

10. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening.
11. Install the oil pan and oil pump as described in this section.
12. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

Connecting Rod Bearing**Removal**

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan, oil pump and related parts as described in this section.
2. Turn the crankshaft until connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from rod and cap.
3. Make sure bearing inserts and bearing bore in connecting rod and cap are clean. Foreign material under inserts will distort bearing and cause a failure.

4. Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance. Refer to Specifications.

Installation

Refer to Section 03-00 for cleaning and inspection procedures.

1. Fit connecting rod bearings using Plastigage® or equivalent. Refer to Section 03-00.
2. Install the bearing inserts in the connecting rod and cap with tangs in the slots provided.
3. Pull the connecting rod assembly down firmly on the crankshaft journal (guide rod to prevent crankshaft journal damage).
4. Apply a light coat of specified engine oil to the journal and bearings. Install the connecting rod cap. Make sure the connecting rod bolt heads are properly seated in the connecting rod. Tighten the nuts to 55-61 N·m (41-45 ft·lb).
5. Repeat the procedure for the remaining connecting rods that require new bearings.
6. Install oil pan and related parts as described in this section.

REMOVAL AND INSTALLATION (Continued)

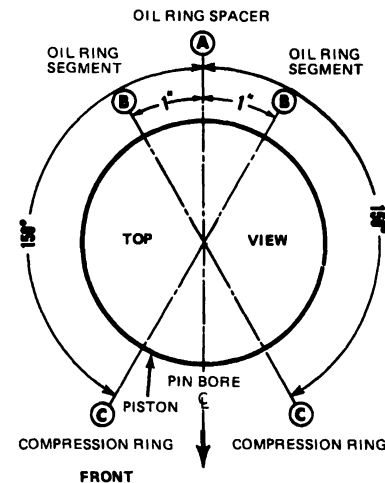
Pistons and Connecting Rods

Removal

1. Drain the cooling system and crankcase. Refer to Section 03-03. Remove the intake manifold, cylinder heads, oil pan and oil pump as outlined.
2. Remove any ridge and / or deposits from upper end of cylinder bores as follows:
Turn the crankshaft until the piston to be removed is at bottom of its travel. Place a cloth on top of the piston to collect cuttings. Remove any ridge and / or deposits from the upper end of the cylinder bore. Remove the cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturer. **Never cut into ring travel area in excess of 0.79mm (1/32 inch) when removing ridges.** Repeat the procedure at the remaining cylinders. Refer to Section 03-00.
3. Make sure all connecting rod caps are marked so they can be installed in their original positions.
4. Turn the crankshaft until the connecting rod being removed is down.
5. Remove the connecting rod nuts and cap.
6. Push the connecting rod and piston assembly out through the top of the cylinder with the handle end of a hammer or a suitable piston hammer. **Avoid damage to the crankshaft journal and cylinder wall when removing the piston and rod.**
7. Remove the bearing inserts from the connecting rod and cap.
8. Install the cap on the connecting rod from which it was removed.

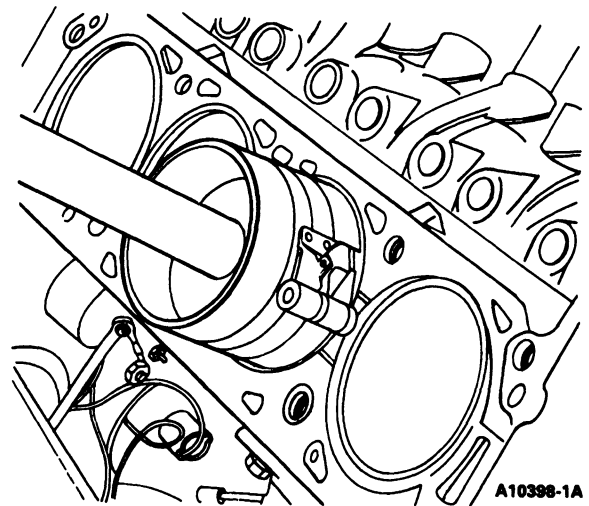
Installation

1. If new piston rings are to be installed, remove the cylinder wall glaze. Refer to Section 03-00. Clean cylinder bores with soap and water after honing or deglazing. Dry and oil immediately after cleaning.
2. Oil the piston rings, pistons and cylinder walls with recommended quality engine oil. **Be sure to install pistons into cylinders from which they were removed or to which they were fitted. Connecting rod and bearing caps are numbered from 1 to 4 in the right bank, and 5 to 8 in the left bank, beginning at the front of engine. Numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.**
3. Make sure ring gaps (oil ring spacer A, oil ring segments B, and compression ring C) are properly spaced around circumference of piston.



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4. Turn the crankshaft until the piston rod journal reaches the bottom of its stroke.
5. Install Piston Ring Compressor D81L-6002-C or equivalent on piston and push in with hammer handle or a suitable piston hammer until it is slightly below top of cylinder. Be sure to guide connecting rods while tapping them into position to avoid damaging crankshaft journals. **Install piston with indentation notch in piston head toward front of engine. Push the piston down into the cylinder until the connecting rod bearings seat on the crankshaft journal.**



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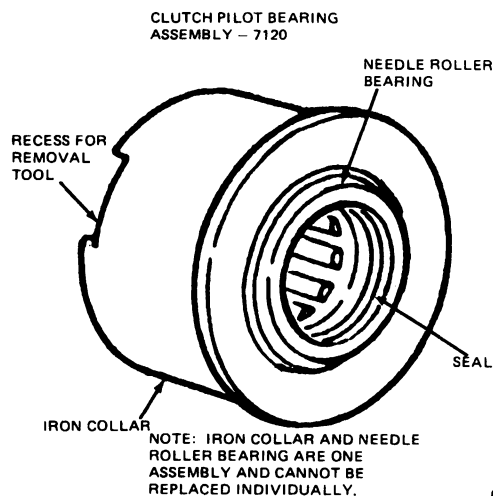
6. Check clearance of each bearing using Plastigage® or equivalent. Refer to Section 03-00.
7. After the bearings have been fitted, apply a light coat of recommended quality engine oil to the journals and bearings.
8. Install the connecting rod cap. Make sure connecting rod bolt heads are properly seated in the connecting rod. Tighten the nuts to 55-61 N·m (41-45 ft·lb).

REMOVAL AND INSTALLATION (Continued)

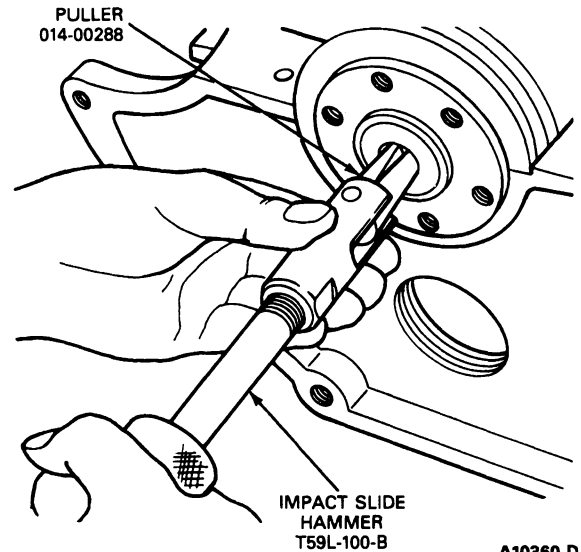
9. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each crankshaft journal. Refer to Section 03-00.
10. Disassemble, clean and inspect oil pump. Refer to Section 03-00. Reassemble or replace pump as required. Clean the oil pump inlet tube screen, oil pan, and the block gasket surfaces.
11. Prime the oil pump by filling the inlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and the oil pan as described in this section.
12. Install the cylinder heads as described in this section.
13. Install the intake manifold. Refer to Section 03-04C.
14. Fill and bleed the cooling system. Refer to Section 03-03. Fill the crankcase to the correct level with the specified engine oil.
15. Start the engine and adjust the ignition timing to specifications listed on the engine decal.
16. Operate the engine at fast idle and check for oil and coolant leaks after the engine temperature has stabilized.
17. Install the air cleaner and intake duct assembly.

Clutch Pilot Bearing**Removal**

A needle roller bearing and adapter assembly is used as a clutch pilot bearing on F-250-350 and F-Super Duty vehicles. It is inserted directly into the engine crankshaft. The bearing and adapter assembly comprises an assembly that cannot be serviced separately. The assembly must be replaced as a unit. The clutch pilot bearing can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pre-greased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.



1. Remove the transmission and flywheel housing, clutch pressure plate and disc. Refer to Groups 07 and 08.
2. Use Impact Slide Hammer T59L-100-B and Rotunda Puller Attachment 014-00288 or equivalents to remove the pilot bearing.

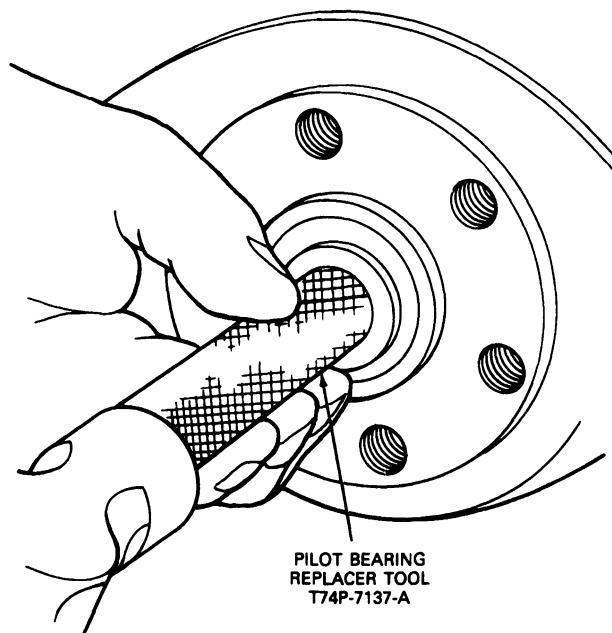
**Installation**

1. Using suitable pilot bearing replacer tool install the pilot bearing with the seal facing the transmission so that the bearing is not cocked.

REMOVAL AND INSTALLATION (Continued)

2. Install the clutch pressure plate, disc, and transmission and flywheel housing. Refer to Groups 07 and 08.

NOTE: Care must be taken not to damage the bearing during transmission installation while the transmission input shaft is being inserted into the bearing.



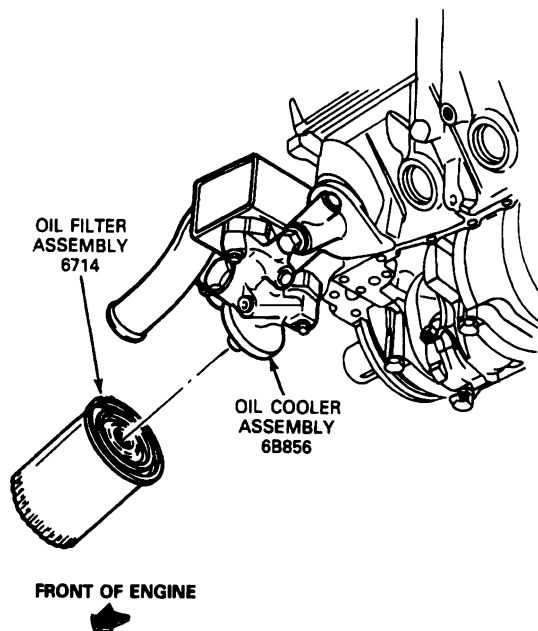
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Oil Filter**Removal**

1. Place a drip pan under the filter. Unscrew the filter from the adapter fitting using an oil filter wrench. Clean the adapter recess. Clean the oil filter gasket surface. Make sure gasket is not stuck on adapter.

Installation

1. Coat the gasket on a new filter with specified engine oil. Place a new filter on the adapter fitting. Hand tighten the filter until the gasket contacts the sealing surface, then tighten another one-half turn.
2. Add one quart of oil. Operate the engine at fast idle and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase to the correct level.



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Engine**E-350**

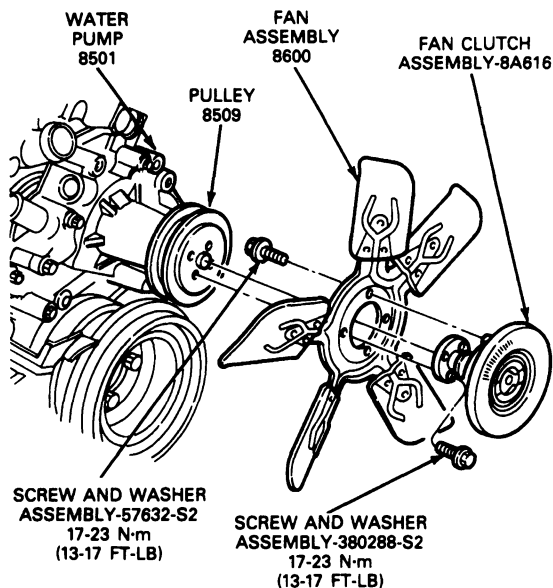
The engine removal and installation procedures are for the engine only (without the transmission attached).

Removal

1. Remove air filter assembly and tubes and disconnect battery ground cable.
2. Remove air deflector, grille and lower grille panel. Refer to the Body / Chassis Manual, Section 01-08.
3. Remove hood latch and set aside.
4. Remove headlight assemblies, parking light assemblies and headlight housing. Refer to the Body / Chassis Manual, Section 17-01.
5. Remove stone deflector, front bumper and air deflector. Refer to the Body / Chassis Manual, Section 01-19.

REMOVAL AND INSTALLATION (Continued)

6. Remove drive belts, fan shroud, fan, fan clutch and pulley.

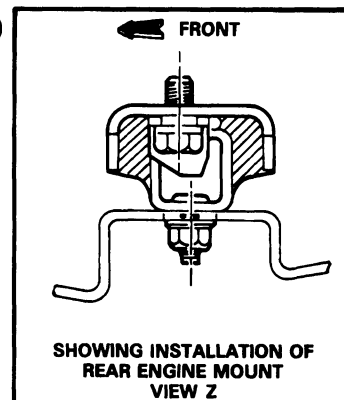
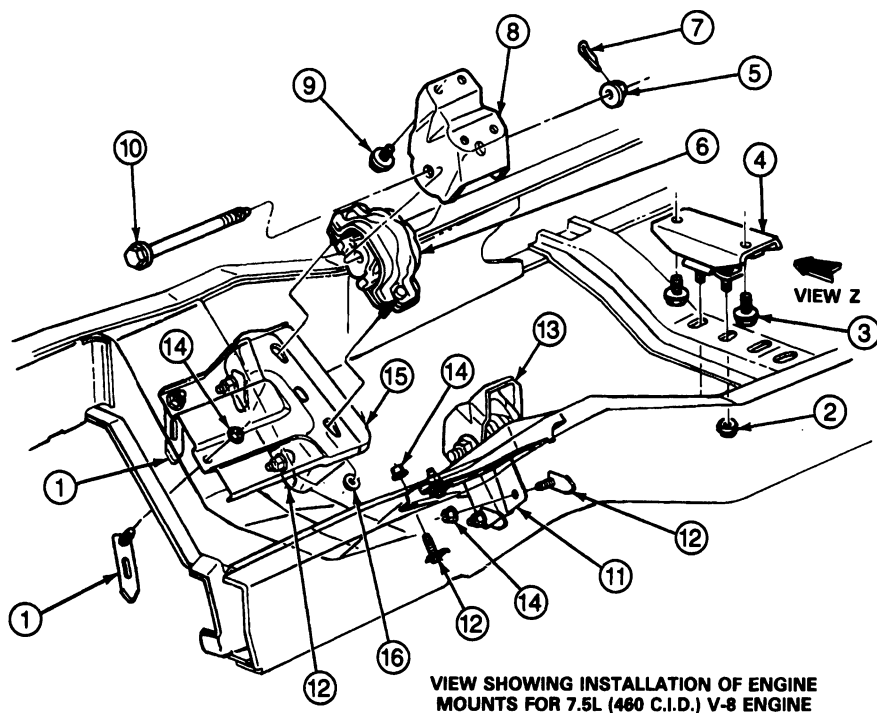


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7. If equipped, drain air conditioning system and remove condenser. Refer to the Body / Chassis Manual, Section 12-03B.
8. Drain radiator. Remove radiator and upper radiator support bracket.
9. Disconnect electrical connection and hose assembly from air conditioning compressor.
10. Remove belt tensioner and electrical bracket behind power steering pump.
11. Disconnect power steering lines from steering gear.
12. Remove bracket with attached air conditioning compressor and power steering pump.
13. Disconnect electrical connections from alternator and remove one alternator adjusting bracket bolt from water pump.
14. Disconnect secondary air injection (Thermactor) pump hoses.
15. Remove bracket with attached alternator and secondary air injection (Thermactor) pump.
16. Disconnect heater hoses.
17. Disconnect electrical junction block, heater vacuum manifold, and fuel pressure regulator vacuum line.
18. Remove oil filler tube, electrical harness support (by oil cooler) and oil dipstick and tube.
19. Remove distributor and ignition wires, Section 03-07.
20. Remove heater bleeder line and power brake booster hose.
21. Position air conditioner lines out of the way.
22. Remove throttle body. Refer to Section 03-04C.
23. Remove secondary air injection (Thermactor) pipes and valve. Separate at valve leaving back pipes installed.
24. Remove inside engine cover.
25. Disconnect transmission electrical connectors.
26. Relieve fuel system pressure. Perform all Pre-Service Procedures. Remove EGR pipe, upper intake manifold, and fuel supply manifold with injectors and wiring. Refer to Section 03-04C.
27. Remove rear lifting eye.
28. Remove PCV valve, hose, and tube.
29. Raise vehicle and remove starter. Refer to Section 03-06A.
30. Disconnect exhaust pipes from manifolds.
31. If vehicle has automatic transmission, remove torque converter housing cover, torque converter-to-flex plate nuts, bottom flywheel housing front plate bolts (2) and bottom transmission-to-engine bolts (3).
32. If vehicle has standard transmission, remove clutch housing bottom cover and bottom transmission-to-engine bolts.
33. Lower vehicle and support transmission with suitable jack.
34. Attach lift to engine.
35. Remove front engine mounting nuts and through-bolts.

REMOVAL AND INSTALLATION (Continued)

Engine Supports, E-350



A6538-E

Item	Part Number	Description
1	N807251-S2	Bolt and Retainer M12-1.75 x 32 Hex Flange
2	N621945-S2	Nut and Washer Assembly 81-108 N-m (60-80 Ft-Lb)
3	390066-S2	Screw and Washer Assembly 81-108 N-m (60-80 Ft-Lb)
4	6D091	Insulator and Retainer Assembly
5	379696-S2	Nut 54-78 N-m (40-58 Ft-Lb)
6	6038	Insulator Assembly
7	N642569-S36	Cotter Pin

(Continued)

Item	Part Number	Description
8	6046	Bracket
9	387811-S100	Bolt 68-94 N-m (50-70 Ft-Lb)
10	385734-S2	Bolt
11	6029	Bracket
12	N807250-S2	Bolt and Retainer M12-1.75 x 32
13	6046	Bracket
14	N802074-S2	Nut M12-1.75 76-104 N-m (56-77 Ft-Lb)
15	6028	Bracket
16	45354-S2	Nut and Washer 7 / 16-14 68-92 N-m (50-68 Ft-Lb)

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36. Remove top transmission-to-engine bolts.
37. With help of assistant, remove engine. Mount engine on work stand.

Installation

1. On vehicles equipped with an automatic transmission, connect the floor crane to the engine. Raise the engine and position it into the vehicle aligning the transmission converter to the flex plate and the engine dowels to the transmission. Lower the engine to the chassis brackets, and align the through-bolt holes on the engine supports and put in through-bolts.

On vehicles equipped with a manual transmission, start the transmission pinion shaft into the clutch disc.

REMOVAL AND INSTALLATION (Continued)

It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.

Align the housing on the engine and insert the housing-to-engine bolts. Alternately tighten bolts to specifications. Refer to appropriate transmission section in Group 07.

2. On vehicles equipped with an automatic transmission, install converter housing-to-cylinder block bolts. Alternately tighten bolts to specifications. Refer to appropriate transmission section in Group 07.
3. Remove lift and transmission jack.
4. Install front engine mount nuts and tighten to 54-78 N·m (40-58 ft·lb).
5. Raise vehicle and install flywheel housing covers.
6. Install new exhaust pipe-to-manifold gaskets and connect exhaust pipes to manifold.
7. Install starter. Refer to Section 03-06A.
8. Lower vehicle.
9. Install PCV valve, hose, and tube.
10. Install rear lifting eye.
11. Install fuel supply manifold with injectors and wiring, upper intake manifold and EGR tube. Refer to Section 03-04C.
12. Plug in transmission electrical connectors.
13. Install inside engine cover making sure guide brackets are not on top of sheet metal. If latches are hard to secure, or if seal bulb will not compress, cover is not properly aligned.
14. Install throttle body. Refer to Section 03-04C.
15. Route air conditioning lines into place.
16. Install lower radiator hose to oil cooler, power brake booster hose and heater bleeder line.
17. Install distributor and ignition wires. Refer to Section 03-07.
18. Install oil dipstick and tube, electrical harness support by oil cooler, electrical brackets and oil filler tube.
19. Connect vacuum line-to-fuel pressure regulator, heater manifold and electrical junction block.
20. Connect heater hoses.
21. Position bracket with attached alternator and air pump. Connect secondary air injection (Thermactor) pump hoses with bracket pulled forward.
22. Install bracket retaining bolts and one alternator adjusting bracket bolt to water pump.
23. Connect alternator electrical connections.
24. Install bracket with attached air conditioning compressor and power steering pump.
25. Connect power steering lines to steering gear.
26. Install electrical bracket behind power steering pump.
27. Install belt tensioner.
28. Connect clutch electrical connection and freon tubes to air conditioning compressor.
29. Install radiator and upper support bracket.
30. Install air conditioner condenser.
31. Install pulley, fan, fan clutch, fan shroud and drive belts. Refer to Section 03-05.
32. Install bumper, stone deflector and air deflector. Refer to the Body / Chassis Manual, Section 01-19.
33. Install headlight housing, parking light assemblies and headlight assemblies. Refer to the Body / Chassis Manual, Section 17-01.
34. Install lower grille panel, grille and air deflector. Refer to the Body / Chassis Manual, Section 01-08.
35. Install and adjust hood latch. Refer to the Body / Chassis Manual, Section 01-02.
36. Connect battery ground cable and fill cooling system. Refer to Section 03-03.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

37. Perform all post-service procedures. Refer to Section 03-04C.
38. Time ignition system. Refer to Section 03-07.
39. Evacuate, charge and test air conditioning system. Refer to Section 12-03.
40. Fill and bleed power steering system.
41. Install air filter assembly. Operate vehicle and check for leaks.

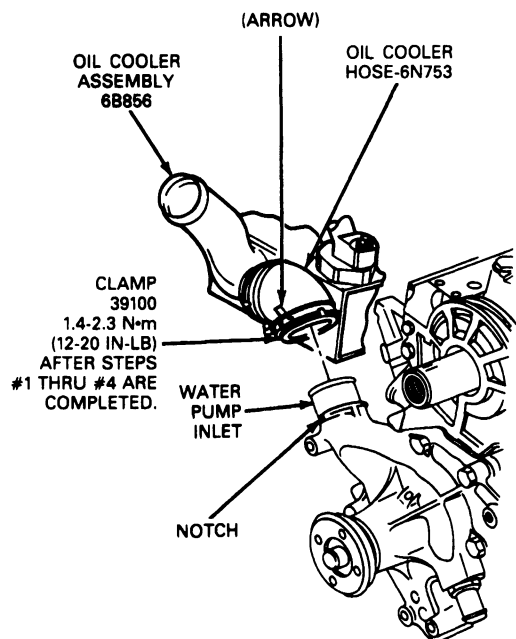
F-250-350, F-Super Duty Chassis Cab and Motorhome Chassis**Removal**

1. Drain the cooling system and the crankcase. Refer to Section 03-03. Remove hood. Refer to Section 01-02.
2. Disconnect the battery cables from the battery.
3. Disconnect the secondary air injection (Thermactor) pump inlet hose at the front of the air cleaner housing. Perform all pre-service procedures. Refer to Section 03-04C.
4. Disconnect the air outlet tube assembly at the throttle body and upper intake manifold. The air cleaner assembly and air outlet tubes can now be removed, after disconnecting the air inlet tube at the air cleaner.
5. Remove the secondary air injection (Thermactor) bypass valve hose connected to the air inlet tube and remove the air inlet tube.

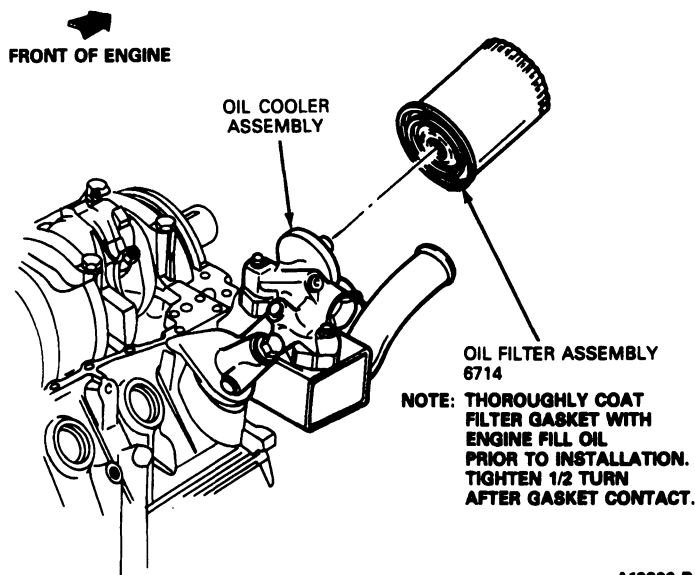
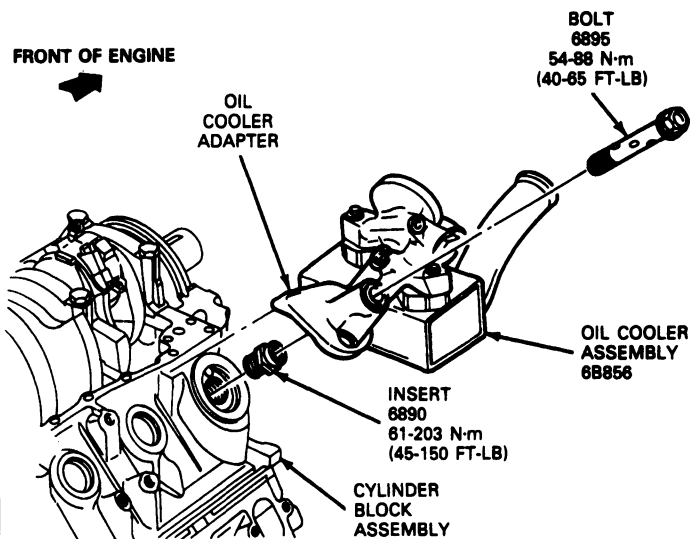
REMOVAL AND INSTALLATION (Continued)

6. Remove the air cleaner and intake duct assembly, including the crankcase ventilation hose and carbon canister hose.

7. Disconnect the radiator lower and upper hose at the radiator. If equipped with an automatic transmission, disconnect the transmission oil cooler lines.

Engine Oil Cooler Installation**ASSEMBLY PROCEDURE**

1. INSTALL INSERT AND TORQUE TO SPEC.
2. PUSH OIL COOLER ASSEMBLY HOSE ONTO WATER PUMP INLET, UNTIL BOTTOMED AGAINST INLET RIDGE.
NOTE: KEEP ARROW ON HOSE ALIGNED WITH NOTCH ON INLET RIDGE.
3. INSTALL OIL COOLER ASSEMBLY TO CYLINDER BLOCK ASSEMBLY BY PILOTING ADAPTER ONTO INSERT.
4. HAND START BOLT, THEN TORQUE TO SPEC.
5. TORQUE HOSE CLAMP TO SPEC.

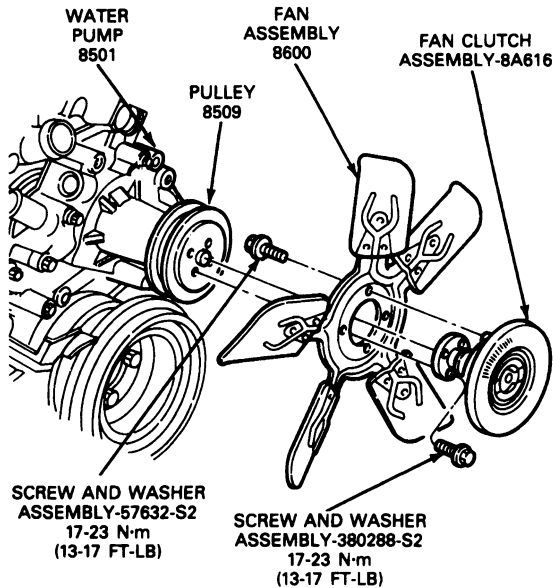


A13823-B

8. If so equipped, discharge the air conditioning system and remove the air conditioning condenser. Refer to the Body / Chassis Manual, Section 12-03A. Disconnect air conditioning lines at the compressor. Disconnect compressor clutch electrical lead.

REMOVAL AND INSTALLATION (Continued)

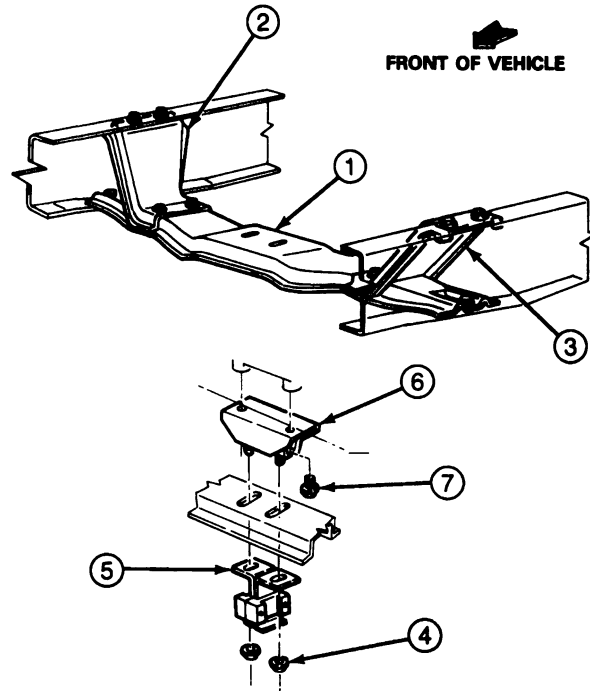
9. Remove the fan shroud and position it over the fan. Remove the radiator. Refer to Section 03-03. Remove the fan shroud, fan clutch, belts and pulley.



A10711-C

10. Remove the alternator bolts and allow the alternator to swing down and out of the way.
11. Disconnect throttle and transmission linkage at throttle body and remove accelerator cable bracket from upper intake manifold. Remove the speed control hardware if so equipped.
12. Disconnect the oil pressure sending unit wire from the sending unit. Disconnect evaporative emission hoses at the evaporative canister.
13. Disconnect the fuel lines at quick disconnect couplings and vacuum lines to the intake manifold.
14. Disconnect EGR tube at left exhaust manifold and upper intake manifold. Plug manifold opening.
15. Disconnect power brake booster vacuum hose, if so equipped.
16. Disconnect the heater hoses from the water pump and intake manifold.
17. Disconnect exhaust air supply bypass valve hose at diverter valve.
18. Remove the flywheel housing-to-engine upper bolts.
19. Disconnect the ground strap from the cylinder block.
20. Remove oil fill tube, dipstick and tube from engine.
21. Raise the front of the vehicle. Disconnect the starter cable from the starter. Remove the starter. Refer to Section 03-06A.

22. Disconnect the muffler inlet pipes from the exhaust manifolds. Disconnect the engine support insulators from the brackets on the frame underbody.



A15816-A

Item	Part Number	Description
1	5060	Support
2	7R314	Gusset
3	7F468	Gusset
4	N621945-S2	Nut 81-109 N·m (60-80 Ft-Lb)
5	4A263	Damper
6	6D091	Insulator and Retainer Assembly
7	39006-S2	Screw 64-71 N·m (48-52 Ft-Lb)

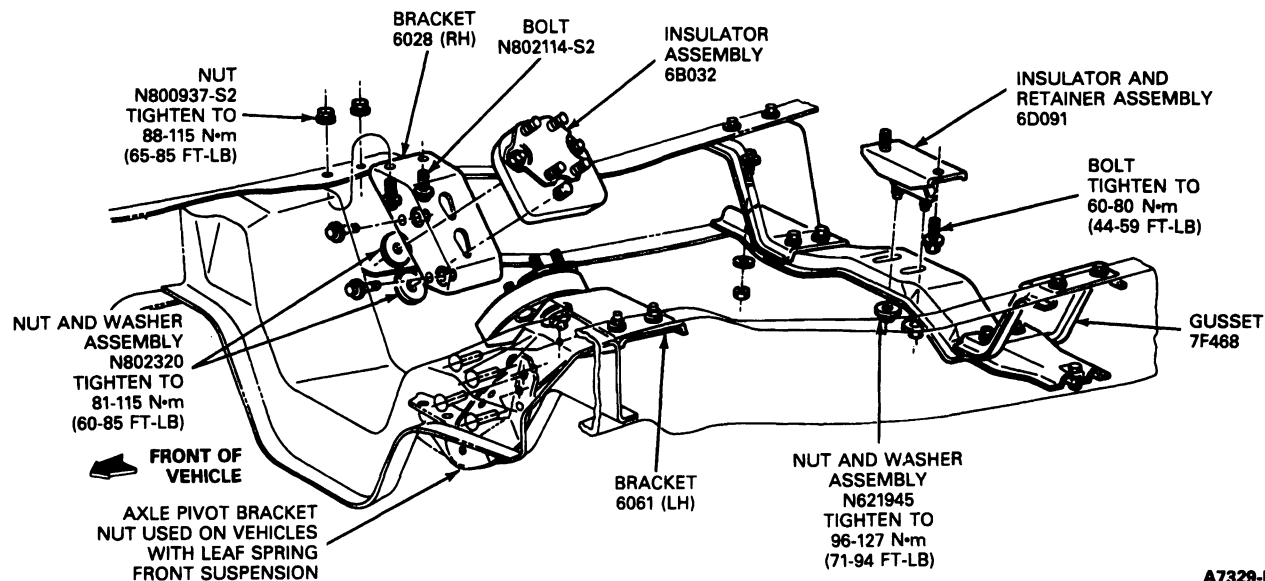
TA15816A

23. Using a Rotunda Transmission Jack 077-00008 or equivalent, support transmission.
24. On a vehicle with automatic transmission, remove the converter inspection plate. Remove the torque converter-to-flywheel attaching bolts. Remove transmission-to-engine bolts.
On vehicles with manual transmission, remove the rear cover plate from the flywheel housing. Remove the remaining flywheel housing-to-engine bolts.
25. Lower the vehicle, and then support the transmission. Install Engine Lifting Brackets T70P-6000 onto the intake manifold lifting eyes. Attach the engine lifting sling.

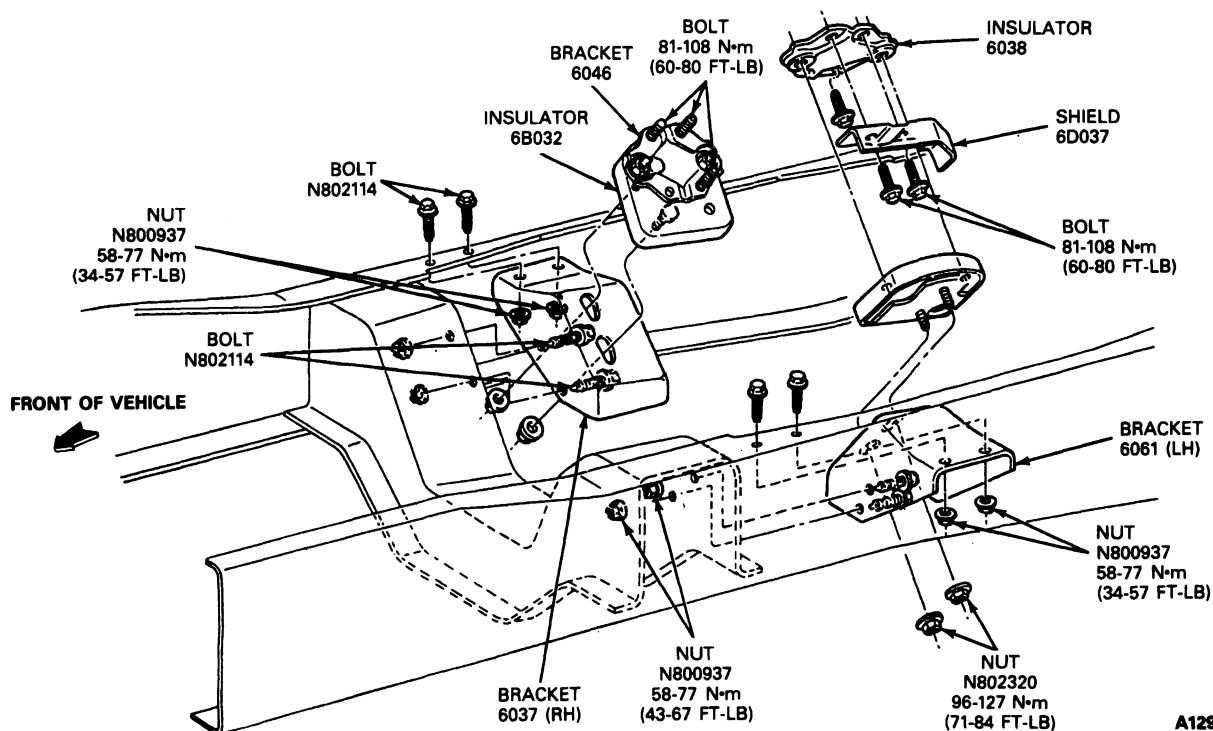
REMOVAL AND INSTALLATION (Continued)

26. Raise the engine slightly and carefully pull it from the transmission. Carefully lift the engine out of the engine compartment so that the rear cover plate is not bent or other components damaged. Install the engine on a work stand.

Engine Supports, F-250-350 and F-Super Duty



Engine Support, F-Super Duty Motorhome Chassis



REMOVAL AND INSTALLATION (Continued)**Installation**

1. Attach the engine lifting brackets and sling. Remove the engine from the work stand.
2. Lower the engine carefully into the engine compartment. Make sure the dowels in the block are through the rear cover plate, then engage dowels with holes in the flywheel housing.
On a vehicle with manual transmission, start the transmission main driveshaft into the clutch disc. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. **If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.**
3. Install the flywheel housing upper bolts.
4. Install the engine support and insulator-to-bracket nuts and washers. Tighten to 81-108 N·m (60-80 ft·lb). Disconnect the engine lifting sling.
5. Install the remaining flywheel housing-to-engine bolts.
6. On a vehicle with automatic transmission, install the converter-to-flywheel attaching bolts. Install the converter inspection plate or the rear cover plate on manual transmissions.
7. Remove the support from the transmission and lower the vehicle.
8. Raise the front of the vehicle. Connect both exhaust manifolds to the muffler inlet pipes. Tighten the nuts to 34-49 N·m (25-36 ft·lb).
9. Position and install the starter and the starter cable. Refer to Section 03-06A.
10. If so equipped, connect the air conditioning compressor magnetic clutch lead wire. Refer to the Body / Chassis Manual, Section 12-03A.
11. Connect the water temperature sending unit wire.
12. Connect the accelerator cable bracket to the intake manifold. Connect the transmission and throttle linkage to the throttle body and speed control linkage, if so equipped.
13. Connect the fuel lines. Reconnect evaporative emission hoses at the evaporative canister.
14. Install the pulley, belt, spacer and fan. Position the fan shroud over the fan.
15. Position the alternator and install the alternator bolts. Connect the battery ground cable. Adjust the belt tension to specification. Refer to Section 03-05.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

16. If so equipped, connect two air conditioning lines to the air conditioning compressor. Refer to the Body / Chassis Manual, Section 12-03A.
17. Install the radiator. Refer to Section 03-03. Connect the radiator upper and lower hoses. Connect the transmission oil cooler lines, if so equipped, and engine oil cooler. Install the fan shroud.
18. If so equipped, install the air conditioning condenser to the radiator. Refer to the Body / Chassis Manual, Section 12-03A.
19. Perform all post-service procedures. Refer to Section 03-04C.
20. Connect the heater hose at the water pump. Fill and bleed the cooling system. Refer to Section 03-03. Fill the crankcase with the proper grade and quantity of oil. Connect the power brake booster vacuum hose, if so equipped.
21. Operate the engine at fast idle and check all gaskets and hose connections for leaks.
22. Install the air outlet tubes to the throttle body and upper intake manifold including the crankcase ventilation hose and carbon canister hose.
23. Evacuate and charge the air conditioning system, if so equipped. Refer to the Body / Chassis Manual, Section 12-03.
24. Install hood. Refer to the Body / Chassis Manual, Section 01-02.

Crankshaft

To perform the following operation, it is necessary to remove the engine and install it on a work stand.

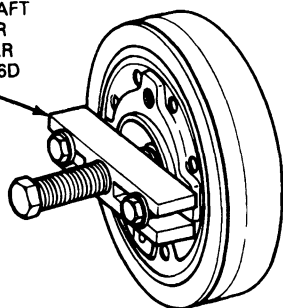
Removal

1. Disconnect the wires from the spark plugs using Spark Plug Wire Remover T74P-6666-A. Remove the spark plugs to allow easy rotation of crankshaft.
2. Remove the oil filter. Slide water pump bypass hose clamp toward the water pump.
3. Remove the crankshaft pulley from the vibration damper.
4. Remove the bolt and washer from the end of the crankshaft. Install Crankshaft Damper Remover T58P-6316-D on the crankshaft vibration damper and remove damper. Remove Woodruff key.

REMOVAL AND INSTALLATION (Continued)

5. Slide crankshaft damper spacer off crankshaft.

CRANKSHAFT
DAMPER
REMOVER
T58P-6316D



A17843-A

6. Remove the cylinder front cover and water pump as an assembly. Check the timing chain deflection. Refer to Section 03-00. Remove the timing chain and sprockets as described in this section.

7. Invert the engine on a work stand. Remove the flywheel and the engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.

8. Make sure all bearing caps (main and connecting rod), are marked for installation into their original locations.

Turn the crankshaft until the connecting rod from which cap is being removed is up, then remove the bearing cap. Push the connecting rod and piston assembly down into the cylinder. Repeat this procedure until all connecting rod bearing caps are removed.

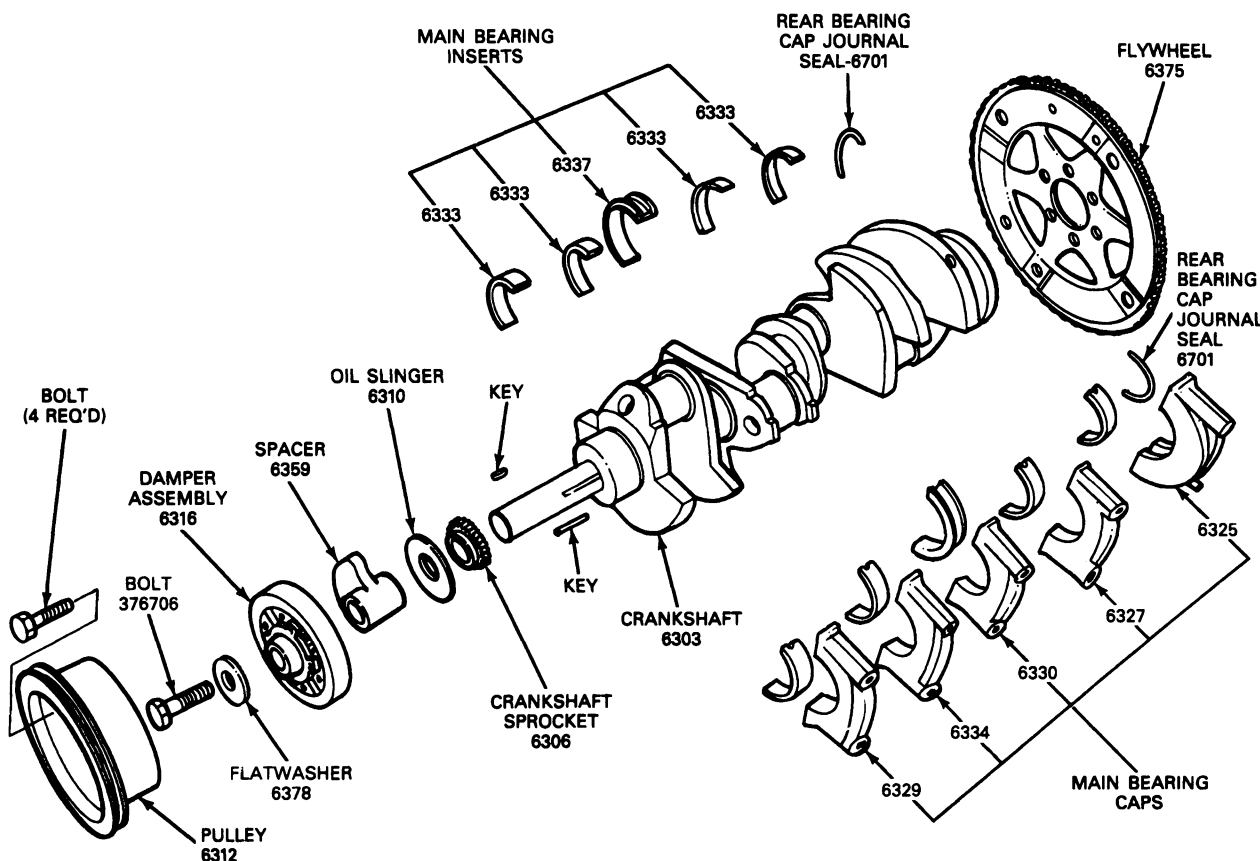
9. Remove the main bearing caps.

10. Carefully lift the crankshaft out of the block so thrust bearing surfaces are not damaged. **Handle the crankshaft with care to avoid possible fracture or damage to finished surfaces.**

Refer to Section 03-00, for cleaning and inspection procedures. Clean the crankshaft damper.

To refinish journals and dress minor imperfections. Refer to Section 03-00.

Crankshaft Assembly



A10399-D

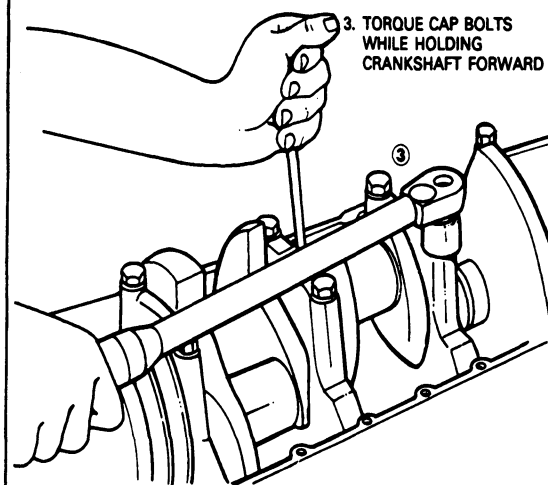
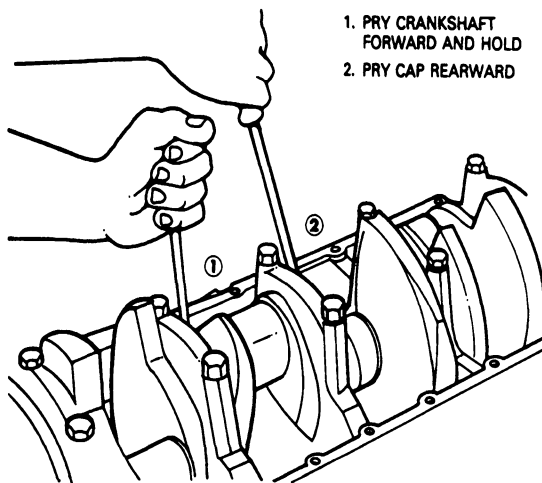
REMOVAL AND INSTALLATION (Continued)

Installation

1. Remove the rear journal oil seal from block and rear main bearing cap.
2. Remove the main bearing inserts from the block and bearing caps.
3. Remove the connecting rod bearing inserts from the connecting rods and caps.
NOTE: If the original bearings are to be reused, all bearings should be marked for installation into their original locations.
4. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearing. Make sure bearing inserts and bearing bores are clean. Foreign material under inserts will distort the bearing and cause failure.
5. Place the upper main bearing inserts in the bores with tang in slot.
CAUTION: The oil holes in the bearing inserts must be aligned with the oil holes in the cylinder block.
6. Install lower main bearing inserts in bearing caps.
7. Clean the rear journal oil seal groove and mating surfaces of the block and rear main bearing cap.

8. Install a new rear main bearing oil seal in the block and cap. Refer to Crankshaft Rear Main Oil Seal in this section.
9. Carefully lower the crankshaft into place. **Be careful not to damage bearing surfaces.**
10. Check the clearance of each main bearing with Plastigage® or equivalent. Refer to Section 03-00.
11. After bearings have been fitted, apply light coat of specified engine oil to journals and bearings. Install a new seal in the rear main bearing cap and install the rear main bearing cap. Install all bearing caps except thrust bearing cap (No. 3 bearing). **Make sure main bearing caps are installed in original locations.** Tighten the bearing cap bolts to 129-142 N·m (95-105 ft·lb).
12. Install the thrust bearing cap with bolts finger-tight.
13. Pry the crankshaft forward against thrust surface of upper half of bearing.
14. Hold crankshaft forward and pry thrust bearing cap to rear. This aligns the rear thrust surfaces of both halves of bearing.

Tightening Thrust Bearing Cap



A10397-2A

15. Retain forward pressure on the crankshaft. Tighten cap bolts to 129-142 N·m (95-105 ft·lb).
16. Force the crankshaft toward the rear of engine.
17. Check the crankshaft end play. Refer to Section 03-00.
18. Install new bearing inserts in the connecting rods and caps. Check clearance of each bearing with Plastigage® or equivalent. Refer to Section 03-00. Also, refer to Specifications in this section.

19. After the connecting rod bearings have been fitted, apply light coat of specified engine oil to journals and bearings.
20. Turn the crankshaft throw to bottom of its stroke. Pull the piston all the way up until rod bearing seats on the crankshaft journal. Cover rod bolt ends with section of rubber hose to prevent crankshaft journal damage during installation.
21. Install the connecting rod cap. Make sure connecting rod bolt heads are properly seated in connecting rod. Tighten nuts to 55-61 N·m (41-45 ft·lb).

REMOVAL AND INSTALLATION (Continued)

22. After piston and connecting rod assemblies have been installed, check side clearance between connecting rods on each connecting rod crankshaft journal. Refer to Specifications.
23. Install timing chain and sprockets, oil slinger, damper spacer, cylinder front cover and crankshaft damper as described in this section.
24. Install the engine rear cover plate. Position flywheel on crankshaft flange. Install and tighten the bolts to 103-115 N·m (75-85 ft-lb).
25. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling inlet port with engine oil and rotating pump shaft to distribute oil within housing. Install oil pump and oil pan as described in this section.
26. Install the oil filter.
27. Install the spark plugs and connect the spark plug wires.
28. Install the engine in vehicle as outlined.

Camshaft Bearings

Camshaft bearings are available prefinished to size for standard and undersize journal diameters.

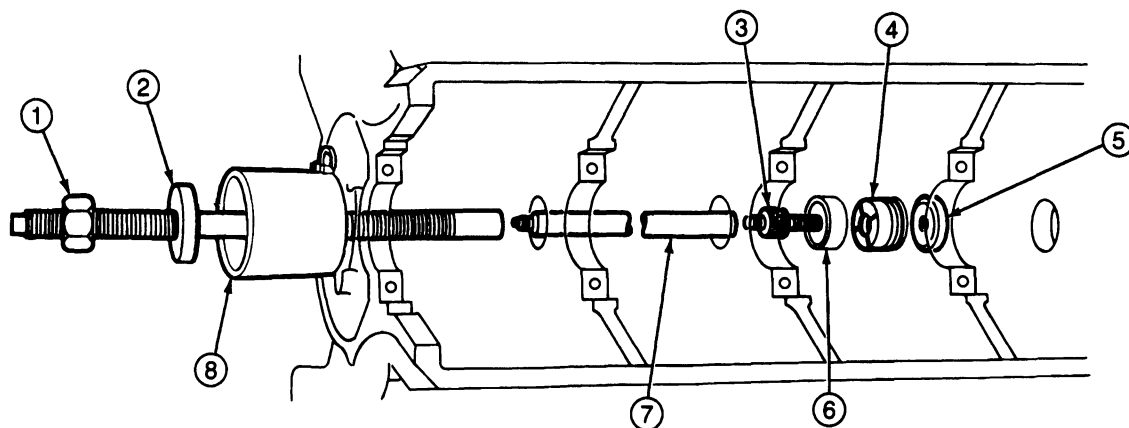
Removal

1. With engine removed and placed in a work stand, remove the camshaft, flywheel, and crankshaft as outlined. Push pistons to top of cylinders.
2. Remove the camshaft rear bearing bore plug. Refer to Section 03-00.
3. Select the proper size expanding collet and backup nut and assemble onto expanding mandrel. With the expanding collet collapsed, install the collet in the camshaft bearing. Tighten backup nut on expanding mandrel until collet fits camshaft bearing.
4. Assemble the puller screw and extension, if necessary, as shown and install on expanding mandrel. Wrap a cloth around threads of the puller screw to protect the front bearing or journal. Tighten pulling nut against the thrust bearing and pulling plate to remove camshaft bearing. Hold a wrench on the end of puller screw to prevent it from turning.

5. Repeat the procedure for each bearing. To remove the front bearing, install puller screw from rear of cylinder block.
6. Position new bearings at bearing bores, and press in place with the tool. Be sure to center the pulling plate and puller screw to avoid bearing damage.

CAUTION: Failure to use correct expanding collet can cause severe bearing damage. Align oil holes in bearings with oil holes in cylinder block before pressing them into block. Be sure front bearing is installed 0.051-0.762mm (0.002-0.003 inches) below front face of cylinder block.

7. Install a new rear cam bore plug. Refer to Section 03-00.
8. Install camshaft, crankshaft and flywheel as described in this section.
9. Install engine into vehicle as described in this section.

Camshaft Bearings, Removal/Installation

A9045-D

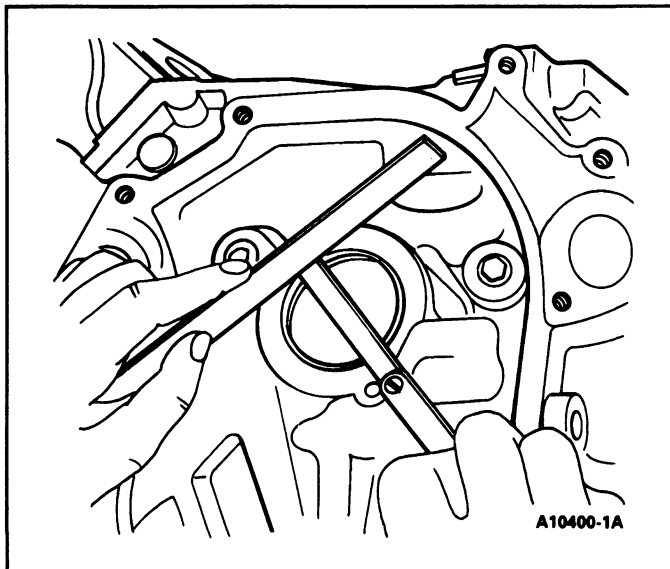
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	—	Pulling Screw
2	—	Pulling Plate
3	—	Expanding Mandrel
4	—	Expanding Collet
5	—	Backup Nut
6	6262	Bearing, Camshaft (Part Number Given is For Reference Only)

(Continued)

Item	Part Number	Description
7	—	Puller Screw Extension
8	—	Front Spacer
NOTE: All items except #6 (Bearing) are included in Camshaft Bearing Set T65L-6250-A		

TA9045A



DISASSEMBLY AND ASSEMBLY

When installing nuts or bolts that must be tightened, oil the threads with light engine oil. Refer to Specifications for proper torque values. **Do not oil threads requiring oil-resistant or water-resistant sealer.**

Valve Tappet

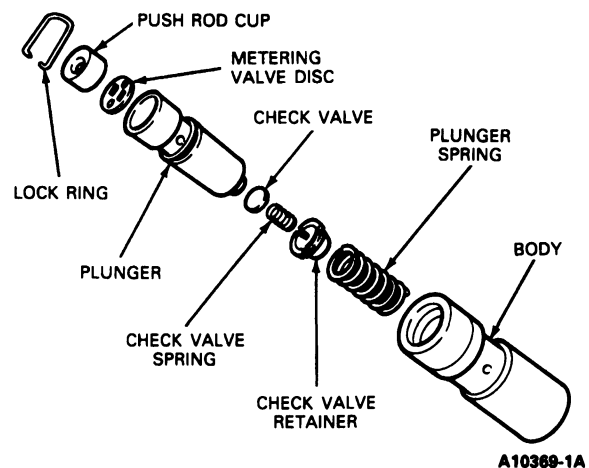
Each tappet is a matched assembly. If parts of one are mixed with those of another, improper valve operation may result. Disassemble and assemble each tappet separately. Valve tappets should be tested after assembly. Refer to Section 03-00. Keep the tappet assemblies in proper sequence so they can be installed in their original bores.

Disassembly

1. Grasp the lock ring with needlenose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.
2. Remove the push rod cup, metering valve disc, and plunger assembly.

3. Carefully remove the plunger spring, check valve spring, check valve retainer and check valve from the plunger.

Refer to Section 03-00 for cleaning and inspection procedures.



Assembly

1. Place the plunger upside down on a clean work bench.
2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).
3. Position the check valve retainer over the check valve and spring. Then, push the retainer down into place on the plunger.
4. Place the plunger spring and the plunger (open end up) into tappet body.
5. Position the metering valve disc in the plunger, and place push rod cup in the plunger.
6. Depress the plunger and position the closed end of lock ring in the groove of the tappet body. With the plunger still depressed, position the open ends of lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.
7. Use Leak Down Tester TOOL-6500-E to fill the tappet with test fluid. Refer to Section 03-00.

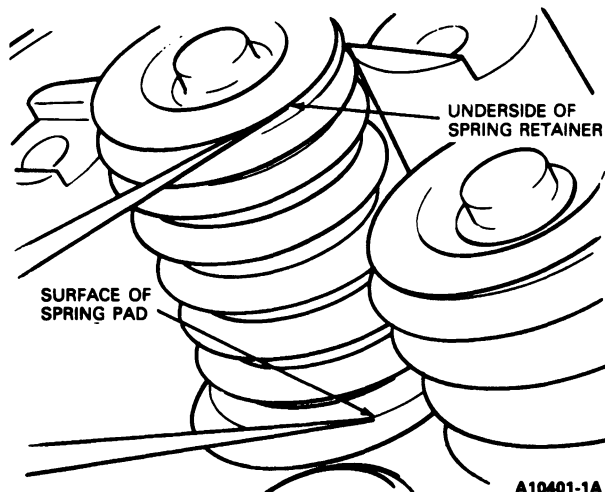
DISASSEMBLY AND ASSEMBLY (Continued)**Cylinder Head****Disassembly**

1. With cylinder head removed from engine, remove rocker arm fulcrum bolts, oil deflectors, fulcrum seats, and rocker arms. Remove exhaust manifolds and spark plugs.
2. Clean carbon from combustion chambers before removing valves.
3. Compress valve springs using Valve Spring Compressor T70P-6049-A. Remove spring retainer locks and release springs. Remove retainers, springs, stem seals, and valves. Discard stem seals.
4. Clean and inspect cylinder head(s) and related components. Refer to Section 03-00.
5. Refer to Section 03-00 for cylinder head and valve repair procedures.

Assembly

Lubricate all valves, valve stems and valve guides with specified engine oil. Apply Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to the valve tips before installation.

1. Install each valve in the port from which it was removed or to which it was fitted. Install new valve stem seal on each valve.
NOTE: Make sure the proper seal application for intake and exhaust are in place.
2. Set valve spring and retainer over valve stem. Compress spring and install retainer locks.
3. With dividers, measure assembled height of valve spring from surface of spring pad on cylinder head to underside of spring retainer. Check dividers with accurate scale. If assembled height exceeds specification, install shim(s) below spring to reduce height to recommended dimension. Refer to specifications listed in the back of this section. **Reducing assembled height below specifications can cause spring breakage and rapid wear of cam lobe.**

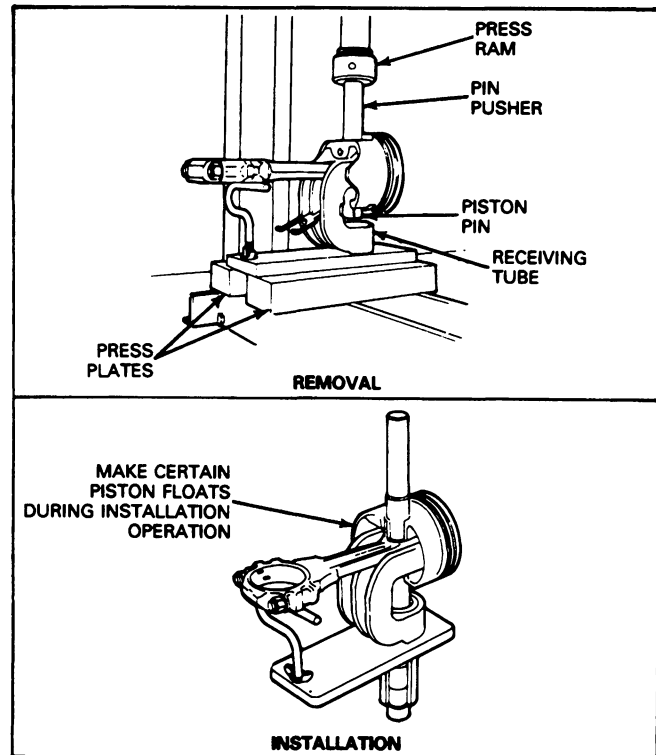
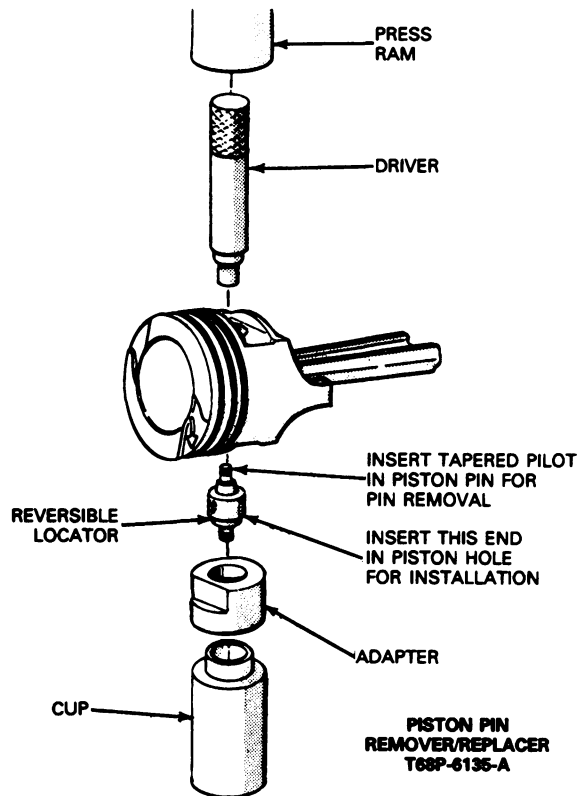


4. Coat the fulcrum seats and sockets with Ford Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent. Make sure the rocker arm fulcrum bolts are in a serviceable condition before installing them. Install rocker arms, fulcrum seats, oil deflectors and fulcrum bolts as outlined under Valve Rocker Arm Installation.
5. Install exhaust manifolds and spark plugs as outlined.

Piston and Connecting Rod**Disassembly**

1. Remove the bearing inserts from the connecting rod and cap.
2. Mark the pistons to make sure they are assembled with same rod and installed in the same cylinders from which they were removed.
3. Using an arbor press and Piston Pin Remover / Replacer T68P-6135-A, press the piston pin from the piston and connecting rod. Remove the piston rings.

Refer to Section 03-00 for cleaning and inspection procedures. Repair if required.

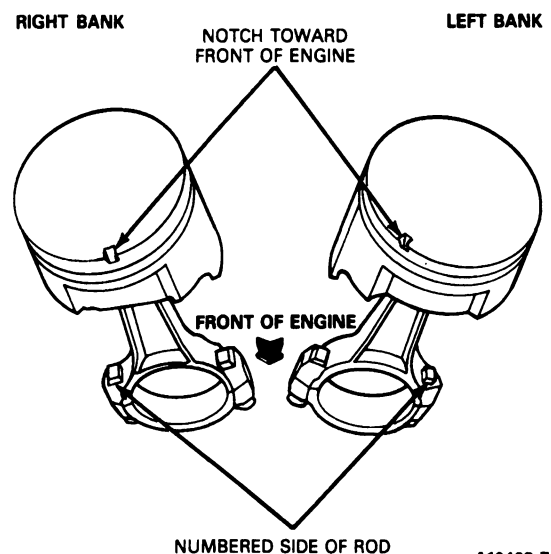
DISASSEMBLY AND ASSEMBLY (Continued)**Piston and Connecting Rod Removal and Installation**

A4871-2D

Assembly

NOTE: Check the fit of a new piston in the cylinder bore before assembling piston and piston pin to connecting rod. Piston pin bore of connecting rod and diameter of piston pin must be within specifications.

1. Apply a light coat of specified engine oil to all parts. Assemble the piston to the connecting rod with the cylinder number side of the connecting rod and indentation notch in piston positioned as shown.



A10402-E

2. Start the piston pin in the piston and the connecting rod. Using an arbor press, press the piston pin through the piston and connecting rod until the end of pin is 1.59-3.18mm (1/16-1/8 inch) below chamfer of the pin bore in the piston.

DISASSEMBLY AND ASSEMBLY (Continued)

3. Check the end gap of all piston rings. End gap must be within specifications. Follow the instructions contained on piston ring package and install the piston rings.
4. Check the ring-side clearance of compression rings with a feeler gauge inserted between the ring and the lower land. Feeler gauge should slide freely around the ring circumference without binding. Any wear will form a step at the inner portion of the lower land. **If the lower lands have high steps, replace the piston.**
5. Make sure the bearing inserts and bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause failure. Install bearing inserts in connecting rod and cap with tangs fitting in slots provided.

2. Make sure that cylinder bores are ridge-reamed before removing piston assemblies, if required.
3. Remove the cylinder head locating dowels and the block drain plugs.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder block in a work stand and install the cylinder head locating dowels and the block drain plugs.
3. Transfer all serviceable parts removed from the old cylinder block as described in this section.
4. Check all assembly clearances following specifications at the end of this section and correct as necessary.

Cylinder Assembly**Disassembly**

1. Mount the old engine on a work stand and remove all the parts not furnished with the new cylinder assembly as described in this section.
2. Remove the four cylinder head locating dowels and the block drain plugs.
3. Remove the old cylinder assembly from the work stand.

Assembly

1. Clean the gasket and seal surfaces of all serviceable parts and assemblies.
2. Position the new cylinder assembly on a work stand and install the cylinder head locating dowels and block drain plugs.
3. Transfer all serviceable parts removed from the old cylinder assembly as described in this section.
4. Check all assembly clearances following specifications listed at the end of this section and correct as necessary.

Cylinder Block

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs. Refer to Section 03-00.

Disassembly

1. Mount the old engine in a work stand and completely disassemble it as described in this section.

ADJUSTMENTS**Valve Clearance**

The valve arrangement on the left bank is E-I-E-I-E-I-E-I and on the right bank is I-E-I-E-I-E-I-E.

A 1.52mm (0.060-inch) shorter push rod or a 1.52mm (0.060-inch) longer push rod is available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the specifications for the pertinent color code.

Valve stem-to-valve rocker arm clearance should be within specifications as outlined at the end of this section. With the hydraulic tappet completely collapsed, repeated valve reconditioning operations (valve and / or valve seat refacing) will decrease the clearance to the point that if not compensated for, the hydraulic valve tappet will cease to function and the valve will be held open.

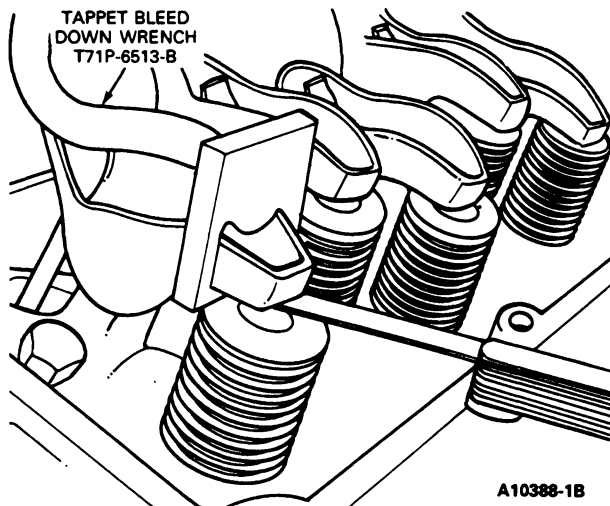
The use of a positive stop valve rocker arm bolt eliminates the need for valve clearance adjustment. However, to obtain accurate valve clearance measurements, it is important that all components be serviceable and installed to specification.

To determine whether a shorter or a longer push rod is necessary, perform the following check:

1. Install an auxiliary starter switch. **Crank the engine with the ignition switch in OFF until the No. 1 piston is on TDC after the compression stroke.**

ADJUSTMENTS (Continued)

2. With the crankshaft in the positions designated in the following Steps 3, 4 and 5, position the hydraulic tappet compressor Tappet Bleed Down Wrench T71P-6513-B on the rocker arm. Slowly apply pressure to bleed down the hydraulic tappet until the plunger is completely bottomed. Hold the tappet in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge. If the clearance is less than specifications, install a shorter push rod. If the clearance is greater than specifications, install a longer push rod.



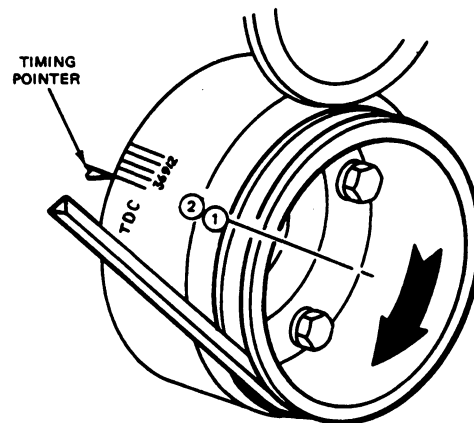
3. With the No. 1 piston at TDC at the end of the compression stroke (Position No. 1), check clearances on the following valves:

No. 1 Intake No. 1 Exhaust
No. 3 Intake No. 4 Exhaust

No. 7 Intake No. 5 Exhaust
No. 8 Intake No. 8 Exhaust

4. After checking the clearance on these valves, rotate the crankshaft 360 degrees to Position No. 2, then check the following valves:

No. 2 Intake No. 2 Exhaust
No. 4 Intake No. 3 Exhaust
No. 5 Intake No. 6 Exhaust
No. 6 Intake No. 7 Exhaust



POSITION 1—NO. 1 AT TDC AT END OF COMPRESSION STROKE.
POSITION 2—ROTATE THE CRANKSHAFT 360 DEGREES
(ONE REVOLUTION) CLOCKWISE FROM POSITION 1.

A7908-1A

SPECIFICATIONS

Refer to the following charts for engine specifications.

GENERAL SPECIFICATIONS

Engine	Bore and Stroke	Firing Order	Oil Pressure Hot @ 2000 RPM kPa (PSI)	Engine Type and Number of Cylinder
7.5L (460 CID) V-8	4.36 x 3.85	15426378	276-606 (40-88)	O.H.V. V-8

CYLINDER HEAD

Engine	Combustion Chamber Volume C.C. ③	Valve Guide Bore Diameter		Valve Seat Width ①		Valve Seat Runout TIR Maximum	Valve Arrangement Front to Rear	Gasket Surface Flatness ②
		Intake	Exhaust	Intake	Exhaust			
7.5L (460 CID) V-8	95.7-98.7	.3433-.3443	.3433-.3443	.060-.080	.060-.080	.002	RT I-E-I-E-I-E-I-E LT E-I-E-I-E-I-E-I	.003 in any 6 in. .006 overall

① Valve seat angle — 45°.

② Gasket surface finish — RMS 60-150.

③ Compression pressure (PSI) of the lowest cylinder must be at least 75% of the highest to be within specification.

VALVE ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

Engine	Rocker Arm Lift Ratio to 1	Push Rod Runout TIR Maximum	Valve Tappet or Lifter			Collapsed Tappet Gap (Clearance)	
			Standard Diameter	Clearance to Bore ①	Hydraulic Lifter Leakdown Rate ②	Allowable	Desired
7.5L (460 CID) V-8	1.73	.015	.8740-.8745	.0007-.0027	10 to 50 seconds for 1/16 travel	.075-.175	.100-.150

① Service limit — .005.

② Time required for plunger to leakdown .0625 in. under load of 50 lbs. using leakdown fluid in tappet.

VALVE SPRINGS

Engine	Valve Spring Compression Pressure Lbs. @ Specified Height		Valve Spring Free Length (Approximate)		Valve Spring Assembled Height		Valve Spring Out of Square Maximum
	Intake ①	Exhaust	Intake	Exhaust	Intake	Exhaust	
7.5L (460 CID) V-8	76-84 @ 1.81 218-240 @ 1.33	76-84 @ 1.81 218-240 @ 1.33	2.06	2.06	1-51/64 — 1-53/64	1-51/64 — 1-53/64	5/64 (.078)

① Service limit — 10% loss of pressure.

VALVES

Engine	Valve Stem to Guide Clearance ①		Valve Head Diameter ②		Valve Face Runout TIR Maximum
	Intake	Exhaust	Intake	Exhaust	
7.5L (460 CID) V-8	.0010-.0027	.0010-.0027	1.965-1.989	1.646-1.661	.002

① Service clearance — .0055.

② Valve face angle — 44°.

CA4943-2G

SPECIFICATIONS (Continued)

VALVES (Continued)

Engine	Standard		Valve Stem Diameter .015 Oversize		.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
7.5L (460 CID) V-8	.3415-.3423	.3415-.3423	.3565-.3573	.3565-.3573	.3715-.3723	.3715-.3723

CAMSHAFT

Engine	Lobe Lift ①		Camshaft End Play		Camshaft Journal to Bearing Clearance ②
	Intake	Exhaust	End Play	Service Limit	
7.5L (460 CID) V-8	.252	.278	.001-.006	.009	.001-.003

① Maximum allowable lift loss — .005.

② Service limit — .006.

CAMSHAFT DRIVE

Engine	Camshaft Journal Diameter — Standard ①					Camshaft Bearing Inside Diameter					Camshaft Front Bearing Location ②	Timing Chain Deflection Inches Maximum
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 1	No. 2	No. 3	No. 4	No. 5		
7.5L (460 CID) V-8	2.1238-2.1248	2.1238-2.1248	2.1238-2.1248	2.1238-2.1248	2.1238-2.1248	2.1258-2.1268	2.1258-2.1268	2.1258-2.1268	2.1258-2.1268	2.1258-2.1268	.040-.060	.500

① Camshaft journal runout — .005 TIR maximum.

② Distance in inches that front edge of the bearing is installed below the front face of the cylinder block.

CYLINDER BLOCK

Engine	Cylinder Bore Diameter ①	Main Bearing Bore Diameter	Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness	Head Gasket Surface Finish	Tappet Bore Diameter
7.5L (460 CID) V-8	4.3600-4.3636	3.1922-3.1934	.5160-.5175	.003 in any 6 in. .006 overall	RMS 90-150	.8752-.8767

① Maximum out-of-round — .0015, Service limit — .005, Maximum taper service limit — .010, Cylinder bore surface finish RMS 18-38, Bore taper service limit — .010

CRANKSHAFT AND FLYWHEEL

Engine	Main Bearing Journal Diameter ①	Main Bearing Journal Runout TIR Maximum ②	Main Bearing Thrust Face Runout TIR Maximum	Main Bearing Journal Taper Maximum Per Inch	Thrust Bearing Journal Length	Main and Rod Bearing Journal Finish RMS Maximum	Main Bearing Thrust Face Finish RMS Maximum
7.5L (460 CID) V-8	2.9994-3.0002	.002	.001	.0005	1.124-1.126	12	25 Front — 23 Rear

① Maximum out-of-round — .0006.

② Service limit — .005.

CRANKSHAFT AND FLYWHEEL (Continued)

Engine	Connecting Rod Journal Diameter ①	Connecting Rod Journal Taper Per Inch Maximum	Crankshaft Free End Play ②
7.5L (460 CID) V-8	2.4992-2.5000	.0006	.004-.008

① Maximum out-of-round — .0006.

② Service limit — .012.

CA4944-2C

SPECIFICATIONS (Continued)

CRANKSHAFT BEARINGS

Engine	Connecting Rod Bearing to Crankshaft Clearance Selective Fit			Main Bearing to Crankshaft Clearance Selective Fit		
	Desired	Allowable	Bearing Wall Thickness Std. ①	Desired	Allowable	Bearing Wall Thickness Std. ①
7.5L (460 CID) V-8	.0008-.0015	.0008-.0025	.0757-.0762	.0008-.0015	.0008-.0026	.0955-.0960

① For .002 undersize add .001 to standard wall thickness.

CONNECTING ROD

Engine	Piston Pin Bore or Bushing I.D.	Rod Bearing Bore I.D. ①	Rod Length Center to Center	Connecting Rod Alignment Maximum Total Difference		Rod to Crankshaft Assembled Side Clearance ③
				Twist ②	Bend ②	
7.5L (460 CID) V-8	1.0386-1.0393	2.6522-2.6530	6.6035-6.6065	.024	.012	.010-.020

① Connecting rod bearing bore maximum out-of-round — .0004.

② Pin bushing and crankshaft bore must be parallel and in same vertical plane within specified total difference when measured at the ends of an 8-inch long bar, 4 inches on each side of rod centerline.

③ Service limit — .023.

PISTON

Engine	Diameter ①			Piston to Bore Clearance Selective Fit	Piston Pin Bore Diameter	Ring Groove Width Compression		
	Coded Red	Coded Blue	.003 Oversize			Top	Bottom	Oil
7.5L (460 CID) V-8	4.3577-4.3583	4.3589-4.3595	4.3601-4.3607	.0022-.0030	1.0401-1.0406	.0805-.0815	.0805-.0815	.188-.189

① Measured at the piston pin bore centerline at 90° to the pin.

SERVICE PISTON SELECTION

Piston Bore Diameter	I.D. Code of Service Piston Required
110.744-110.774 mm (4.3600-4.3612 in.)	Red
110.774-110.805 mm (4.3612-4.3624 in.)	Blue
110.805-110.835 mm (4.3624-4.3636 in.)	Yellow

When replacing pistons, measure cylinder bore as described in General Gasoline Engine Service, Section 21-01. Install service piston matched to piston bore diameter above.

PISTON PIN

Engine	Length	Diameter		To Piston Pin Bore Clearance ①	To Connecting Rod Bushing Clearance
		Standard	.001 Oversize		
7.5L (460 CID) V-8	3.290-3.320	1.0398-1.0403	1.0410-1.0413	.0002-.0005	Interference Fit

① Selective Fit.

PISTON RINGS

Engine	Ring Width Compression		Side Clearance ①			Ring Gap		
	Top	Bottom	Compression		Oil	Compression (in Gauge)		Oil
			Top	Bottom		Top	Bottom	
7.5L (460 CID) V-8	.077-.078	.0770-.0780	.0025-.0045	.0025-.0045	Snug	.010-.020	.010-.020	.010-.035

① Service limit — .002 maximum increase in clearance.

OIL PUMP AND OIL CAPACITY

Engine	Relief Valve Spring Pressure Lbs. @ Specified Length	Driveshaft to Housing Clearance	Relief Valve to Housing Clearance	Rotor Assembly End Clearance	Outer Race to Housing Clearance	Engine Oil Capacity ①			Inner to Outer Rotor Tip Clearance
						U.S. Qts.	Imperial Qts.	Liters	
7.5L (460 CID) V-8	20.6-22.6 @ 2.49	.0015-.0030	.0015-.0030	.004 Maximum	.001-.013	5	4.2	4.7	.012

① Add 1 U.S. quart (or equivalent in Imperial quarts or liters) when replacing filter.

CA4945-2H

SPECIFICATIONS (Continued)

TORQUE LIMITS — 7.5L (460 CID) MFI V-8 ENGINE

NOTE: All values are in N-m (ft-lbs) unless otherwise noted. Oil threads with engine oil unless the threads require oil or water-resistant sealer. The standard torque limits listed below are applicable for all functions not listed in the special torque chart.

1/4-20	5/16-18	5/16-24	3/8-16	3/8-24	7/16-14	7/16-20	1/2-13	9/16-18
8-12 (6-9)	17-24 (12-18)	19-27 (14-20)	30-43 (22-32)	37-51 (27-38)	61-77 (45-57)	55-81 (40-60)	75-81 (55-60)	118-162 (85-120)

PIPE THREADS

1/8-27	1/4-18	3/8-18	1/2-14
7-11 (5-8)	17-24 (12-18)	30-44 (22-23)	34-47 (25-35)

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
Frame Bracket Attaching Bolt		
Locknuts	48-67	35-50
Crossmember Bolts and Locknuts (Left Support Bracket)	98-142	72-105
Insulator and Retainer-to-Bracket Nuts and Washers	81-108	60-80
Nut, Insulator-to-Bracket	54-78	40-58
Insulator-to-Extension Housing (E-250-350)	68-94	50-70
Nut M12-1.75, to Bolt and Retainer	76-104	56-77
Nut and Washer 7/16-14, to Insulator Assembly	68-92	50-68
Insulator-to-Engine Bolts	81-108	60-80
Insulator-to-Lower Bracket Nuts	96-127	71-94
Nut, Bracket-to-Frame	88-115	65-85
Insulator-to-Extension Housing (F-250-350 & F-Super Duty)	60-80	44-59
Nut and Washer Assembly, Insulator-to-Bracket	81-115	60-85
Nut, Bracket-to-Frame	58-77	43-57
Insulator-to-Frame Crossmember Nuts	68-94	50-70
Fulcrum Bolts	25-33	18-25
Cylinder Head Attaching Bolts — In Sequence:		
Step 1	95-108	70-80
Step 2	136-149	100-110
Step 3	177-189	130-140
Muffler Inlet Pipe Stud Nuts	34-52	25-38
Water Pump Cover-to-Cylinder Front Cover Bolts	16-24	12-18
Camshaft Sprocket Capscrew	55-68	40-50
Cover-to-Cylinder Block Attaching Screws	17-24	12-18
Damper-to-Crankshaft Attaching Screw	95-122	70-90
Camshaft Thrust Plate-to-Cylinder Block Bolts	8-12	70-105 In-Lb

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Flywheel-to-Crankshaft Mounting Bolts	103-115	75-85
Oil Pump-to-Cylinder Block Attaching Bolts	30-43	22-32
Oil Pan-to-Cylinder Block Attaching Bolts		
1/4-Inch	10-12	7-9
5/16-Inch	11-15	8-11
Bearing Cap Bolts	129-142	95-105
Connecting Rod Nuts	55-61	41-45
Front Engine Mount Nuts	54-78	40-58
Screw, Insulator and Retainer-to-Transmission	64-71	48-52
Stud, 3/8-16 x 2.82, Exhaust	30-41	22-30
Stud, 3/8-16 x 3.79, Exhaust	30-41	22-30
Locknut, Spark Plug Heat Shield	13-24	10-18
Bolt, 3/8-16 x 2.75, Exhaust	30-41	22-30
Bolt, 3/8-16 x 1.62, Exhaust	30-41	22-30
Nut, 3/8-16, Spark Plug Heat Shield	22-37	11-27
Crankshaft Pulley Bolts	54-71	40-53
Alternator/Air Pump Bracket — to — Head Bolt (7/16 inch)	54-71	40-53
Alternator/Air Pump Bracket — to — Head Block and Water Pump Bolts (3/8 inch)	41-54	30-40
Alternator Adjusting Arm Bolts	41-54	30-40
Alternator Pivot Bolt	54-71	40-53
Alternator Locking Bolt (Med & Lg Frame Alt)	30-40	22-29
Alternator Locking Bolt (Sm Frame Alt)	41-54	30-40
Air Pump Pivot Bolt	41-54	30-40
Air Pump Locking Bolt	41-54	30-40
Air Pump Pulley Bolts	12-15	9-11
AC/PS Bracket — to — Water Pump Stud Nut	41-54	30-40
AC/PS Bracket — to — Head Bolts	54-71	40-53
PS Pump — to — Bracket Bolts	41-54	30-40
PS Pump Brace — to — PS Pump and Exhaust Manifold Nuts	41-54	30-40

(Continued)

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Belt Tensioner Bolt	68-92	51-67
AC Compressor Bolts	24-31	18-23
AC Idler Bolts	24-31	18-23

TA4946A

TYPICAL ENGINE INFORMATION LABEL

ADJUSTMENTS NOTE

IGNITION TIMING SPECIFICATION

ENGINE VACUUM HOSE ROUTING (TYPICAL)

FORD MOTOR COMPANY IMPORTANT ENGINE INFORMATION

THIS VEHICLE IS EQUIPPED WITH EEC IV/EPI SYSTEMS. IDLE SPEEDS AND IDLE MIXTURES ARE NOT ADJUSTABLE. SEE SHOP MANUAL FOR ADDITIONAL INFORMATION.

ADJUST IGNITION TIMING WITH THE TRANSMISSION IN NEUTRAL. PARKING BRAKE SET AND THE WHEELS BLOCKED. ENGINE MUST BE AT NORMAL OPERATING TEMPERATURE.

(1) TURN OFF ENGINE.
 (2) DISCONNECT THE IN-LINE SPOUT CONNECTOR (-OD- OR -OH-).
 (3) RE-START PREVIOUSLY WARMED-UP ENGINE.
 (4) ADJUST IGNITION TIMING TO 10° BTDC.
 (5) TURN OFF ENGINE AND RESTORE ELECTRICAL CONNECTION.

THIS ENGINE CONFORMS TO U.S. EPA AND CALIFORNIA REGULATIONS APPLICABLE TO 1988 MODEL YEAR NEW HEAVY DUTY ENGINES. THIS ENGINE IS CERTIFIED FOR USE IN ALL HEAVY DUTY VEHICLES.

VACUUM HOSE ROUTING


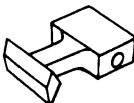


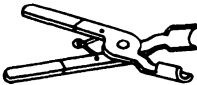
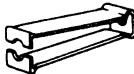
ENGINE TYPE

SPARK PLUG GAP SPECIFICATION

CATALYST

SPARK PLUG: 1. 16F-43C 2. 16F-43C 3. 16F-43C 4. 16F-43C 5. 16F-43C 6. 16F-43C 7. 16F-43C 8. 16F-43C 9. 16F-43C 10. 16F-43C 11. 16F-43C 12. 16F-43C 13. 16F-43C 14. 16F-43C 15. 16F-43C 16. 16F-43C 17. 16F-43C 18. 16F-43C 19. 16F-43C 20. 16F-43C 21. 16F-43C 22. 16F-43C 23. 16F-43C 24. 16F-43C 25. 16F-43C 26. 16F-43C 27. 16F-43C 28. 16F-43C 29. 16F-43C 30. 16F-43C 31. 16F-43C 32. 16F-43C 33. 16F-43C 34. 16F-43C 35. 16F-43C 36. 16F-43C 37. 16F-43C 38. 16F-43C 39. 16F-43C 40. 16F-43C 41. 16F-43C 42. 16F-43C 43. 16F-43C 44. 16F-43C 45. 16F-43C 46. 16F-43C 47. 16F-43C 48. 16F-43C 49. 16F-43C 50. 16F-43C 51. 16F-43C 52. 16F-43C 53. 16F-43C 54. 16F-43C 55. 16F-43C 56. 16F-43C 57. 16F-43C 58. 16F-43C 59. 16F-43C 60. 16F-43C 61. 16F-43C 62. 16F-43C 63. 16F-43C 64. 16F-43C 65. 16F-43C 66. 16F-43C 67. 16F-43C 68. 16F-43C 69. 16F-43C 70. 16F-43C 71. 16F-43C 72. 16F-43C 73. 16F-43C 74. 16F-43C 75. 16F-43C 76. 16F-43C 77. 16F-43C 78. 16F-43C 79. 16F-43C 80. 16F-43C 81. 16F-43C 82. 16F-43C 83. 16F-43C 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SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

Tool Number/ Description	Illustration
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T74P-6375-A Flywheel Holding Tool	 T74P-6375-A
TOOL-6500-E Hydraulic Tappet Leak Down Tester	 TOOL-6500-E
T71P-6513-B Tappet Bleed Down Wrench	 T71P-6513-B
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A
T73P-6571-A Valve Seal Installer	 T73P-6571-A

SPECIAL SERVICE TOOLS

Tool Number	Description
D87T-6250-A	Cam Bearing Installer
D87L-9280-A	Disconnect Tool
D87L-9280-B	Disconnect Tool

ROTUNDA EQUIPMENT

Tool Number	Description
014-00288	Puller Attachment
014-00282	Dial Indicator with Bracketry
014-00290	Piston Ring Compressor
014-00275	Cam Bearing Set
014-00293	Gear and Pulley Puller
077-00008	Transmission Jack

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VEHICLE APPLICATION

Econoline Series, F-Series and F-Super Duty Series
Vehicles Equipped with Diesel Engines

DESCRIPTION AND OPERATION**Engine Description**

The 7.3L diesel engine is a four-cycle, naturally aspirated V-8 with overhead valves. It displaces 7.3 liters (444 cu. in.). The right bank of cylinders are numbered 1, 3, 5, 7, with number 1 being at the front. The firing order is 1-2-7-3-4-5-6-8.

The crankcase has been specially designed to withstand the loads of diesel operation. It utilizes four bolt main bearing caps to provide a strong support for the rotating parts. The crankcase also incorporates internal piston oil cooling jets which direct oil to the underside of the piston.

The crankshaft is a five main bearing unit with fore and aft thrust controlled at the center (No. 3) bearing. Heavy-duty forged steel connecting rods attach to the crankshaft, two to each bearing throw. The piston pin is a free-floating type, permitting the pin to move or float freely in piston and rod. The piston pin is retained by snap rings.

The camshaft is supported by five insert-type bearings pressed into the block. It is driven by a gear keyed to the crankshaft. Camshaft end thrust is controlled by a thrust flange located between the front camshaft journal and the thrust flange spacer.

The aluminum-alloy pistons are fitted with two compression rings and one oil ring.

The hydraulic valve tappets minimize engine noise and maintain zero valve lash (tappet clearance). This eliminates the need for periodic adjustment. The hydraulic valve tappets incorporate camshaft roller followers for improved camshaft wear characteristics.

The cylinder head assemblies feature precombustion chambers which provide superior combustion characteristics. The cylinder head assemblies are equipped with positive valve-rotating mechanisms located at the bottom of the intake and exhaust valve springs.

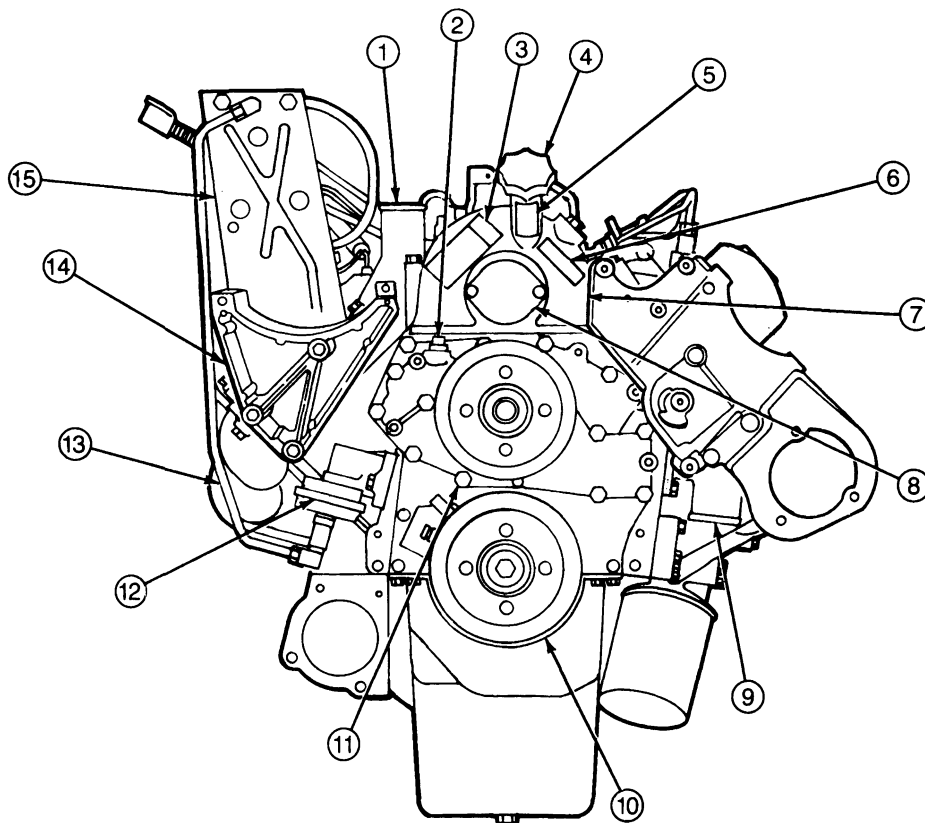
A solid-state glow plug system and block heater provide excellent cold weather start capability.

The engine is equipped with a combination fuel filter / fuel heater / water separator. The E-Series locates the fuel filter assembly on a bracket on the right side of the engine. The F-Series locates the fuel filter assembly on the left side of the engine by utilizing a filter base with an integral filter bracket.

The engine is equipped with a fully closed crankcase ventilation system. Crankcase vapors are directed to the intake manifold from a port in the crankcase depression regulator (CDR) valve. It regulates crankcase pressure by providing a connection between the valley pan and the intake manifold. The crankcase depression regulator (CDR) valve is mounted on the intake manifold.

The rotary-type injection pump is located between the cylinder heads in a recess in the front of the engine. The engine governor is integral with the fuel injection pump. Operating principles and service instructions for the fuel system components are also provided in this section.

The fuel injection pump used on the 7.3 liter diesel engine is located between the cylinder heads and the intake manifold in the vee at the front of the engine. It is an opposed plunger, inlet metered, positive displacement, distributor type pump.

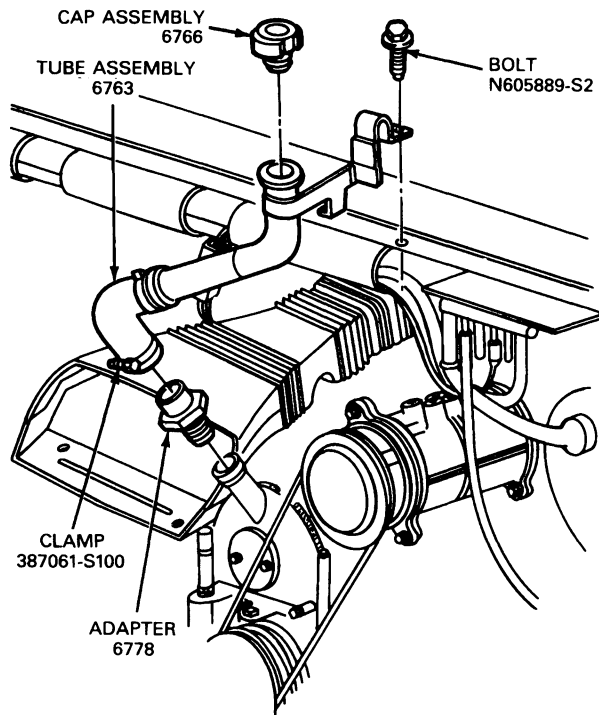
DESCRIPTION AND OPERATION (Continued)**7.3L Diesel, Front View, F-Series Shown, E-Series Similar**

A10884-D

Item	Description
1	Coolant Outlet
2	Heater Return
3	Engine Code Label
4	Oil Fill Cap
5	Oil Change Information Label
6	Serial Number Label
7	Injection Pump Gear Tower

(Continued)

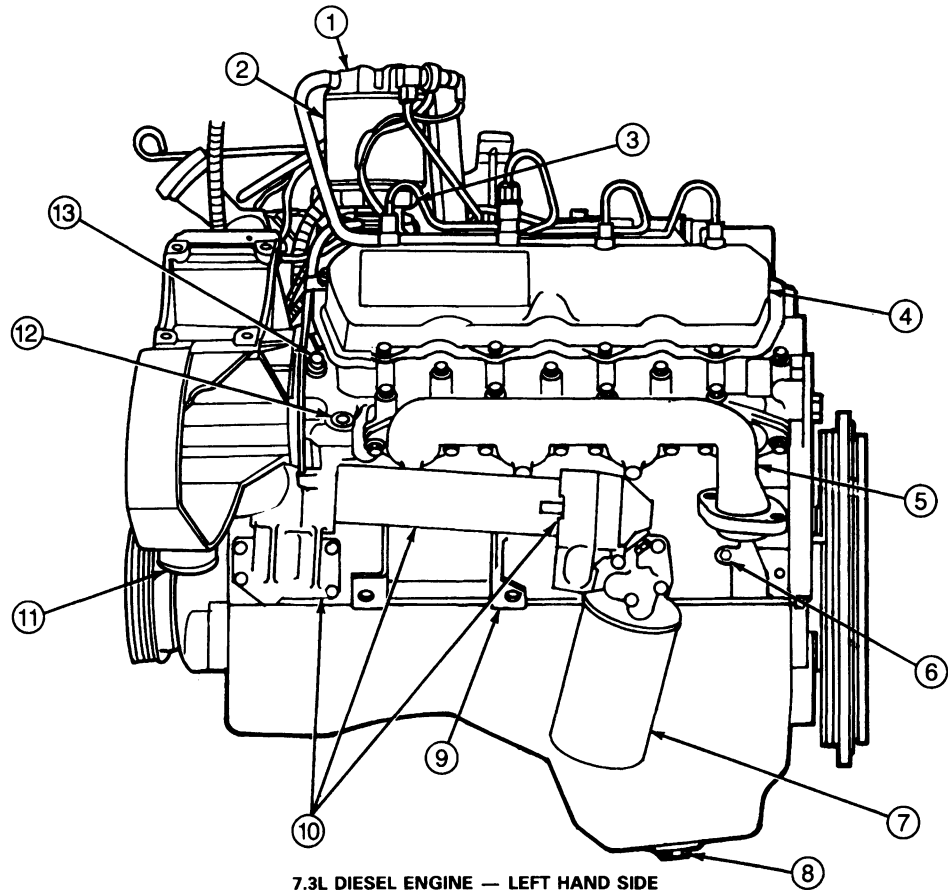
Item	Description
8	Injection Pump Cover Plate
9	Coolant Inlet
10	Crankshaft Pulley
11	Water Pump Pulley
12	Fuel Supply Pump
13	Fuel Supply Pump to Fuel Filter Header
14	Alternator Bracket
15	Fuel Filter Header Mounting Bracket

DESCRIPTION AND OPERATION (Continued)**Oil Fill Tube, E-Series, 7.3L Diesel**

A16240-B

DESCRIPTION AND OPERATION (Continued)

7.3L Diesel, Left Side, F-Series Shown, E-Series Similar

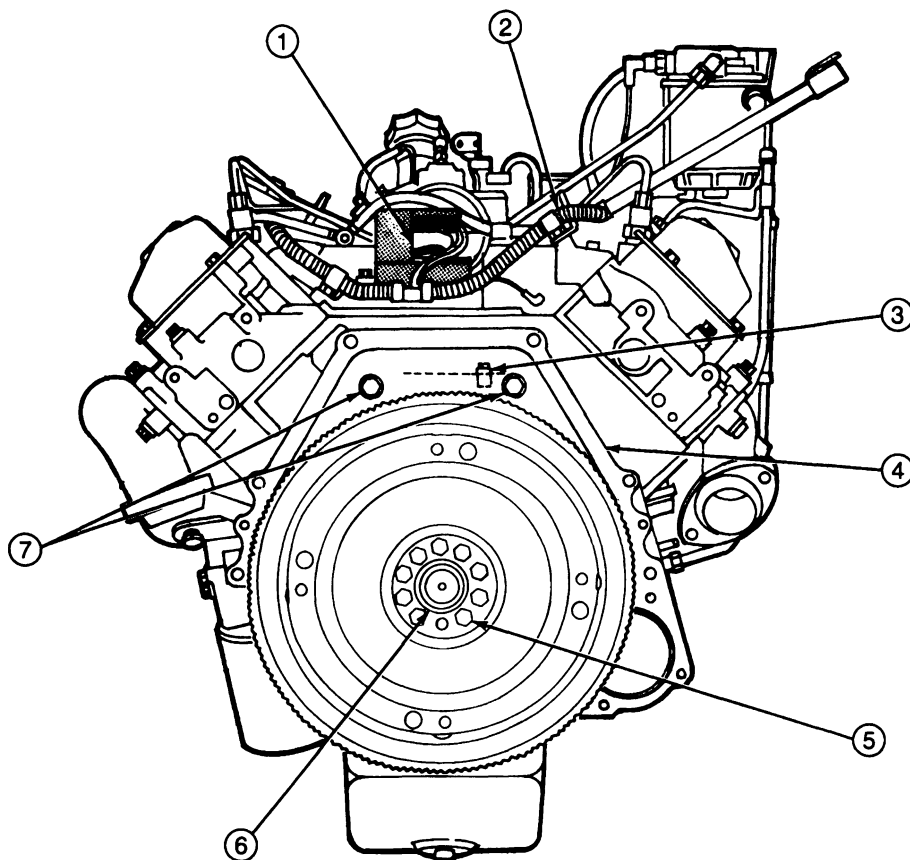


A10885-C

Item	Description
1	Fuel Filter Header with Fuel Heater
2	Fuel Filter Element
3	Water Separator Drain Bowl
4	Valve Cover
5	Exhaust Manifold
6	Coolant Drain

(Continued)

Item	Description
7	Lube Oil Filter
8	Oil Drain Plug
9	Engine Mount
10	Oil Cooler Assembly
11	Coolant Inlet
12	Engine Temperature Warning Lamp Connector Location
13	Coolant Temperature Sending Unit

DESCRIPTION AND OPERATION (Continued)**7.3L Diesel, Rear View, F-Series**

A10886-B

Item	Description
1	"Solid State" Glow Plug Controller
2	Glow Plug Harness
3	Oil Pressure Sensing Unit

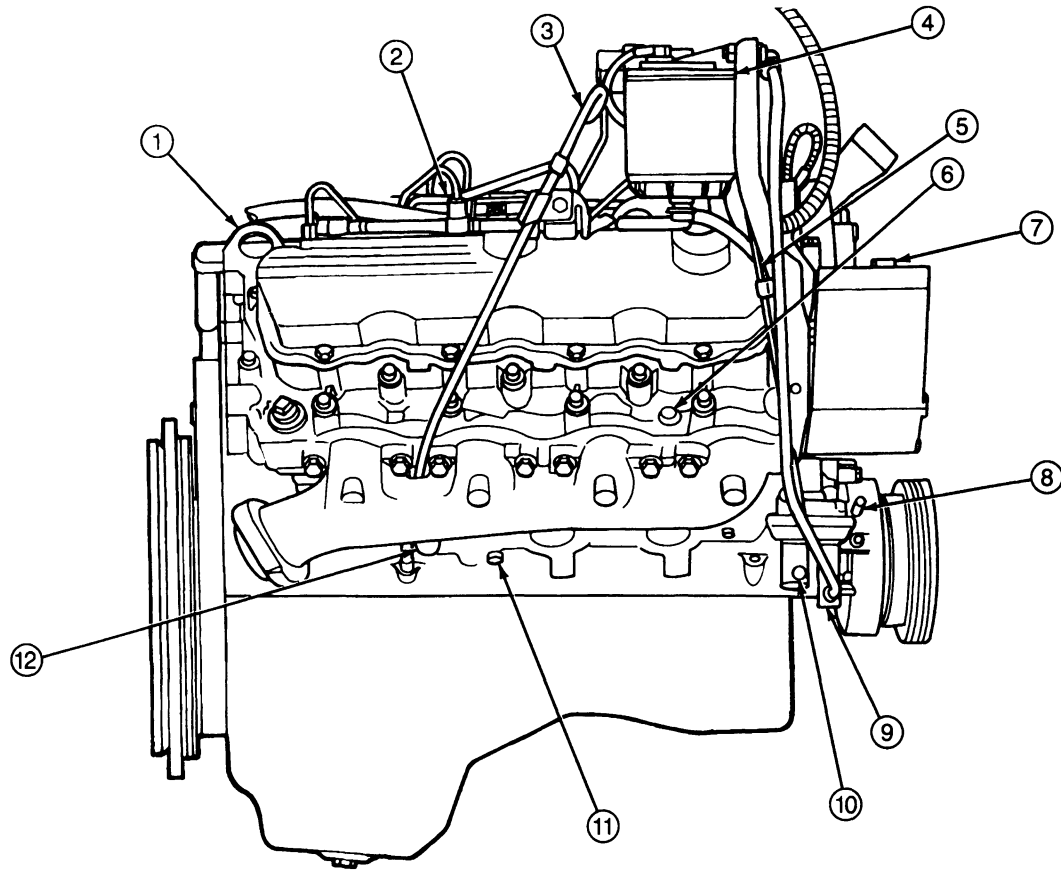
(Continued)

Item	Description
4	Flywheel Adapter Housing
5	Flywheel Mounting Bolts
6	Reinforcement Ring (Automatic Transmission Only)
7	Adapter Housing Bolts

DESCRIPTION AND OPERATION (Continued)

7.3L Diesel, Right Side, F-Series

7.3L DIESEL ENGINE — RIGHT HAND SIDE

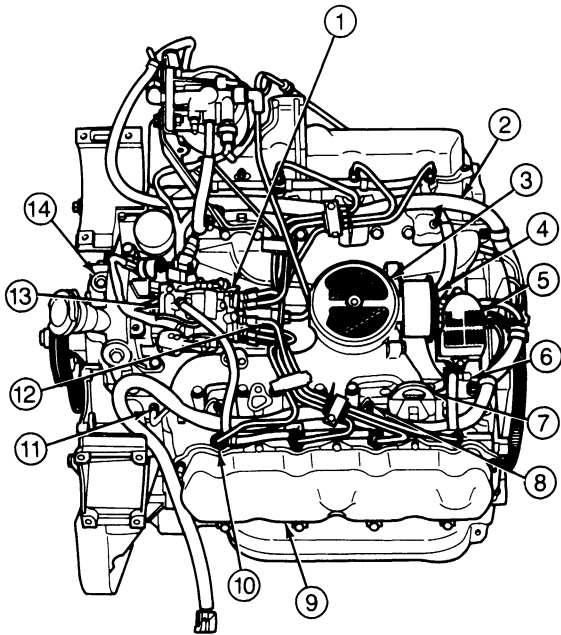


A10887-C

Item	Description
1	Lifting Eye (3 Places)
2	Air Inlet
3	Oil Level Gauge
4	Combination Fuel Filter, Fuel Heater and Water Separator
5	Water Drain Tube

(Continued)

Item	Description
6	Heater Supply
7	Heater Return
8	Timing Indicator
9	Vibration Damper
10	Fuel Inlet
11	Coolant Drain
12	Crankcase Coolant Heater Location

DESCRIPTION AND OPERATION (Continued)**7.3L Diesel, Top View, F-Series**

A19022-A

Item	Description
1	Fuel Injection Pump
2	Glow Plug Harness
3	Air Inlet
4	CDR Valve
5	Glow Plug Controller
6	Fuel Return Nipple

Item	Description
7	Lifting Eye (3 Places)
8	Glow Plugs (8)
9	Exhaust Emissions Label
10	Injection Nozzles
11	Coolant Temperature Sensing Unit
12	High Pressure Injection Lines (8)
13	Fast Idle Solenoid
14	Heater Return

Cooling System

Coolant flows from the radiator, to the water pump, to the engine right and left banks.

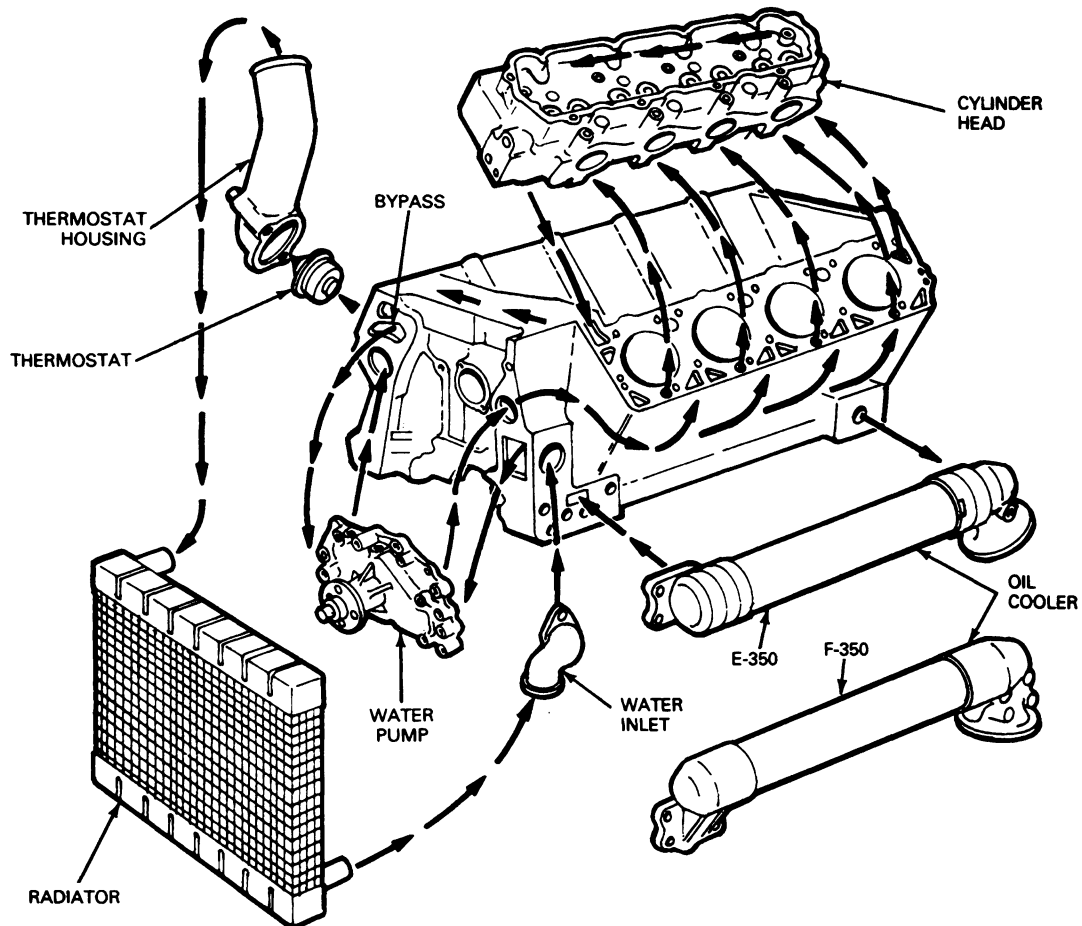
Circulation of the coolant is from the front to the rear of the crankcase. Coolant flows from the crankcase to the cylinder head through positive cooling passages, and through one passage at the front and rear bulkhead of the cylinder head. Coolant flows between the precombustion chambers and valve seats toward the front. Coolant exits the cylinder head into a common cavity which runs across the front of the crankcase. This cavity routes coolant to the thermostat housing.

When the thermostat is closed, coolant bathes the thermostat and runs through the bypass orifice which is located below the thermostat. No coolant is allowed to enter the radiator.

When the coolant reaches 89°C (192°F) the thermostat begins to open. At the same time, the bottom of the thermostat moves closer to the bypass opening. The volume of coolant allowed to bypass is decreased, and coolant is permitted to circulate through the radiator. The thermostat is fully open at 100°C (212°F). Refer to Section 12-02A or 12-02B for heater hose routing. Refer to the engine front and left side views for coolant temperature sender, heater supply, heater return, and coolant drain locations.

DESCRIPTION AND OPERATION (Continued)

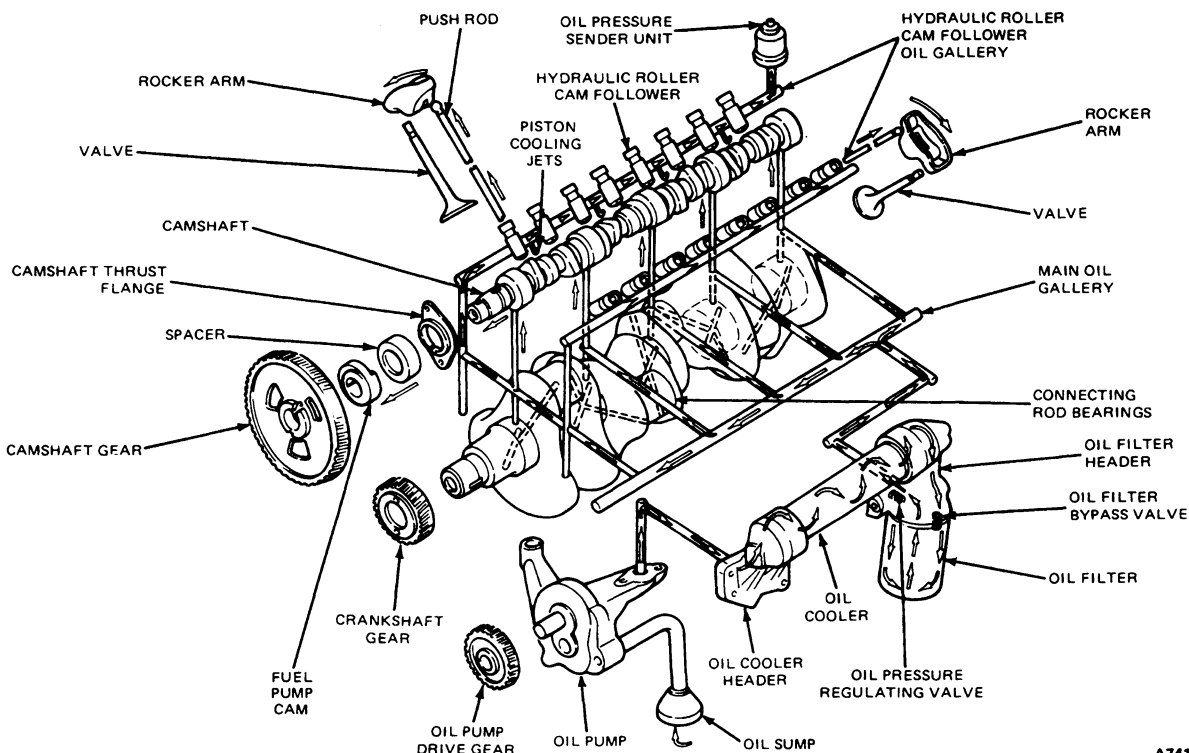
Coolant Flow



A10689-2A

DESCRIPTION AND OPERATION (Continued)**Lubrication System**

Lubrication oil is drawn out of the sump through the pick-up screen and oil pick-up tube to the oil pump. Oil pump flow is 45.4 liters (12 gallons) per minute at 3300 rpm and a pressure of 275-482 kPa (40-70 psi). From the oil pump, oil is passed through drilled passageways in the crankcase to the oil cooler header, then through the oil cooler. Oil flows around the outside of the heat exchanger tubes, which carry coolant. The oil passes from the oil cooler to the oil filter header. At the oil filter header, the oil pressure regulator valve controls the volume and pressure of filtered oil supplied to the engine. The rear oil filter header also incorporates a bypass valve which opens if the oil filter becomes clogged. Five cross passages distribute oil to vertical passages, which feed crankshaft main bearings, camshaft bearings and two tappet galleries. The piston cooling jets are fed from the same passage as the valve tappets. The connecting rod bearings are fed from the main bearings through drilled passages in the crankshaft. The timing gears are lubricated by oil splash. Oil passes through the hydraulic tappet rollers and up the hollow push rods to lubricate the rocker arm assemblies and valve stems.

Oil Flow

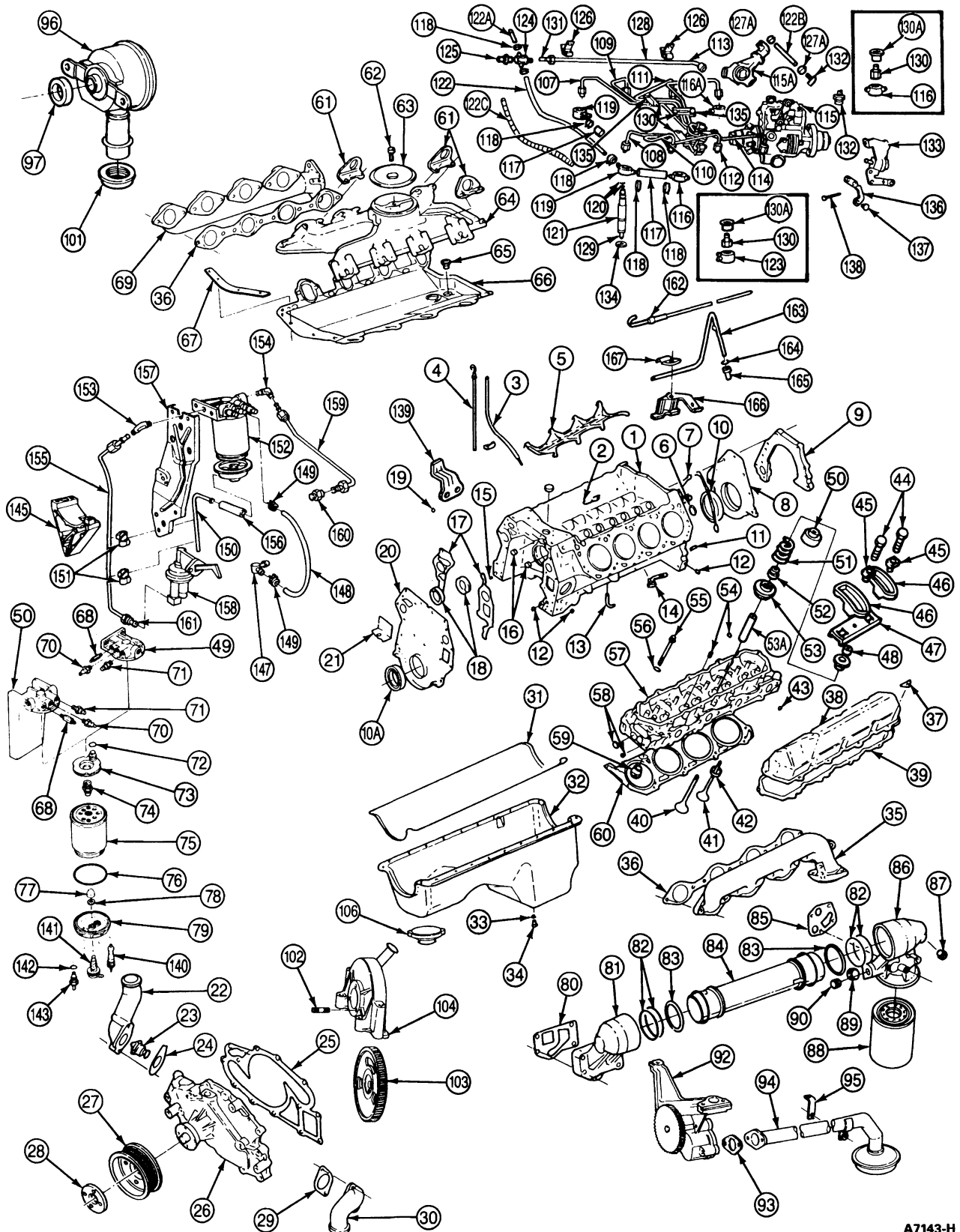
A7410-2A

Engine Components

Refer the following exploded views and indices when performing procedures in this section. Part descriptions and part numbers listed in the keys correspond with the Ford Master Parts Catalog.

DESCRIPTION AND OPERATION (Continued)

7.3L Diesel, Exploded External View



A7143-H

DESCRIPTION AND OPERATION (Continued)

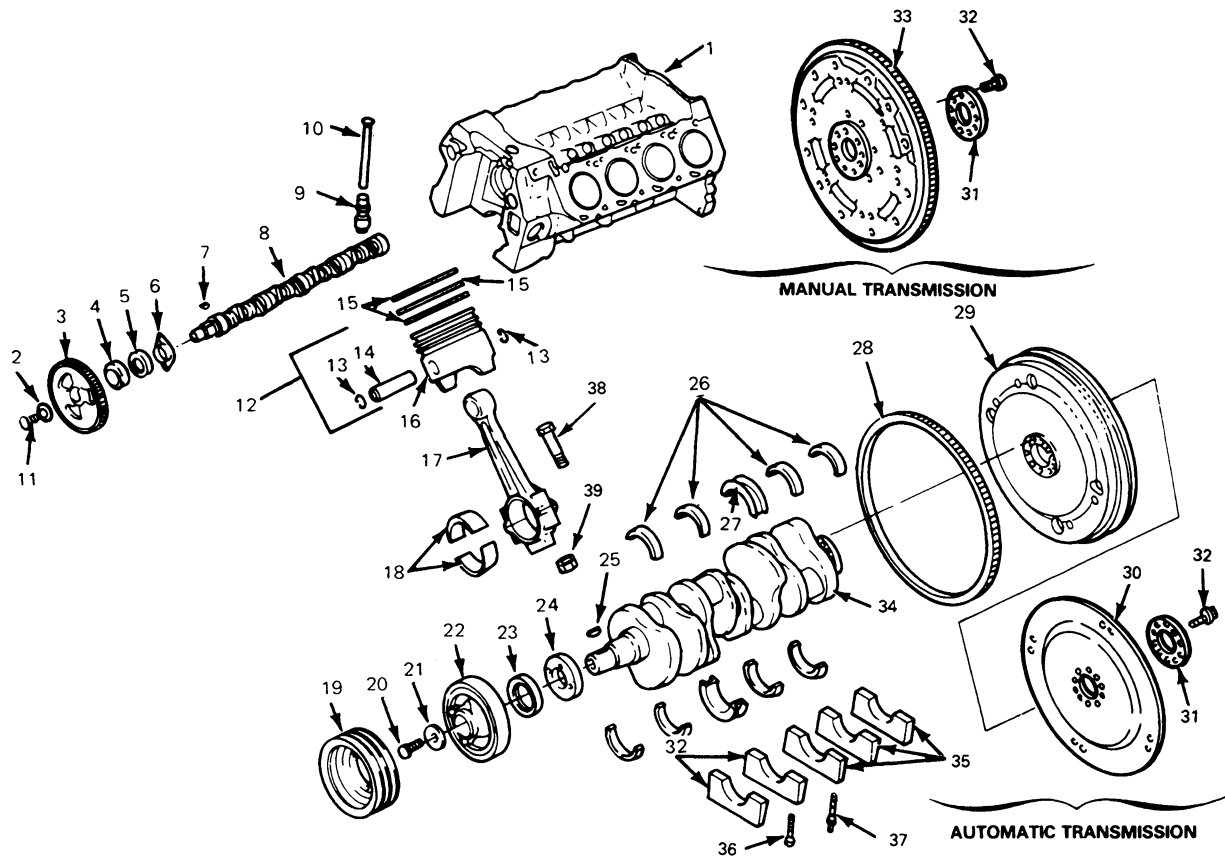
7.3L Diesel, Exploded External View (Legend)

REF. NO.	BASIC PART NO.	DESCRIPTION	REF. NO.	BASIC PART NO.	DESCRIPTION	REF. NO.	BASIC PART NO.	DESCRIPTION	REF. NO.	BASIC PART NO.	DESCRIPTION
1	6009H	Cylinder Block Assy.	45	—	Post, Valve Lever	89	—	Plug, 1/2 Inch	132	9E939	Temperature Switch
2	6C329A	Guide, Tappet	46	—	Lever, Valve	90	—	Plug, 1/2 Inch	133	12B526	Bracket and Solenoid-Fast Idle
3	6754	Tube Assembly, Oil Level Gauge (F-Series)	47	—	Retainer, Valve Lever Post	92	6600	Oil Pump Assy.	134	—	Gasket Nozzle (8)
4	6750	Oil Level Gauge (F-Series)	48	—	Lock, Valve Spring Retainer	93	6626	Gasket, Oil Pick-Up	135	9N653	Clamp
5	6C330A	Retainer, Tappet Guide	49	6514A	Retainer, Valve Spring (36)	94	6622	Pick-Up Tube	136	9F541	Kickdown Lever (Auto. Trans.)
6	6026A	Plug, Engine (1-1/2" O.D.)	50	—	Shield, Oil (Exhaust)	95	6A661	Bracket, Oil Pick-Up	137	9D927	Screw, Kickdown Lever
7	6D083A	Gasket, Rear Cover	51	6513B	Spring, Valve, with Damper (16)	96	6A665	CDR Valve	138	9F539	Adjusting Screw (Kickdown Lever)
8	6L080A	Cover Assembly, Engine, Rear	52	6571A	Seal, Valve Stem-Intake (8)	97	6A892	Seal Ring, CDR Valve	139	6786	Bracket, Oil Level Tube Support (F-Series)
9	6A369A	Adapter, Flywheel to Transmission	53	6K533A	Rotator, Assembly Valve (16)	100	6758	Crankcase Vent Tube	140	—	Vent/Valve Assembly
10	6701A	Rear Oil Seal, Crankshaft	54	—	Guide, Valve (Service)	101	6769	Grommet, Valley Cover	141	—	Manual Drain Valve
10A	—	Front Oil Seal	55	6065A	Plug, 1/2 inch NPTF (4)	102	9F733	Mounting Stud, Injection Pump	142	—	Water Sensor O-Ring
11	6B041B	Dowel Pin, Fly Wheel Adapter	56	6015A	Bolt Cylinder Head (34)	103	9A546	Drive Gear, Injection Pump	143	—	Water Sensor Probe
12	87614S	Pipe Plug, 1/8 NPTF	57	6L015A	Washer, Cylinder Head Bolt (34)	104	9C516	Adapter Housing, Injection Pump	144	—	Fuel Pump Supply Gasket
13	6C327A	Piston Cooling Jet	58	6049A	Cylinder Head Assembly (2)	106	6766	Cap, Oil Filler	145	—	Alternator Bracket
14	6A051A	Heater Assembly, Block	59	6026B	Plug, 1/4 Inch	107	9A555H	Pipe w/Nuts Pump to Cyl. 8	146	—	Sealing O-Ring
15	6B041A	Dowel Pin, Front Cover Plate	60	6057A	Insert, Combustion Chamber (8)	108	9A555G	Pipe w/Nuts Pump to Cyl. 7	147	—	Fuel Return Tee (At Nozzle)
16	6026E	Cup Plug	61	6051B	Gasket, Cylinder Head (2)	109	9A555F	Pipe w/Nuts Pump to Cyl. 6	148	—	Hose, 3/16" ID x 10" Long
17	6020A	Gasket, Front Cover Plate	62	—	Eye, Lifting (3)	110	9A555E	Pipe w/Nuts Pump to Cyl. 5	149	—	Hose Clip
18	6A251A	Bearing Kit, Camshaft	63	9C629A	Insert, Bolt Thread-Air Cleaner Stud	111	9A555D	Pipe w/Nuts Pump to Cyl. 4	150	—	Water Drain Tube
19	6A628A	Ball, Oil Indicator Hole 11/32"	64	9F460A	Screen, Intake Manifold	112	9A555C	Pipe w/Nuts Pump to Cyl. 3	151	—	Drain Tube Clamp (Z)
20	6B070A	Plate, Front Cover	65	9424B	Manifold, Intake	113	9A555B	Pipe w/Nuts Pump to Cyl. 2	152	—	Fuel Filter/Water Separator Element
21	—	Indicator, Timing (Part of Front Cover)	66	9A450A	Manifold, Intake	114	9A555A	Pipe w/Nuts Pump to Cyl. 1	153	—	Elbow
22	8592G	Connection, Water Outlet	67	9439B	Drain Plug, Valley Pan	115	9A543	Injection Pump	154	—	Elbow, Fuel Supply Pump to Filter Header
23	8575	Thermostat	68	96470A	Gasket and Valley Pan	115A	—	Valve, Vacuum Modulator (Auto. Trans.)	155	—	Fuel Pump to Fuel Header Tube (With Two Nuts and Two Sleeves)
24	8255A	Gasket, Water Outlet	69	9430A	Strap, Valley Pan	116	—	Fuel Return Tee	156	—	Hose, 3/16" x 2-5/16" Long
25	8507A	Gasket, Water Pump	70	—	Fuel Priming Valve and Cap	116A	—	Elbow, Fuel Return (F-Series)	157	—	Fuel Filter Header Mounting Bracket
26	8501D	Water Pump	71	—	Manifold, Exhaust, Right	117	—	Hose	158	—	Fuel Supply Pump
27	8509D	Pulley, Water Pump	72	—	Continuous Vent with Check Valve	118	—	Clip	159	—	Filter to Injection Pump Tube (With Two Nuts and Two Sleeves)
28	8546A	Spacer, Fan	73	—	Vacuum Switch (Fuel Filter Element Replacement Indicator)	119	9A564	Fuel Return Tee	160	—	Connector Fitting
29	8255A	Gasket, Water Inlet	74	—	Fuel Heater O-Ring	120	87032-S92	O-Rings	161	—	Inverted Flare Tube Nut
30	8592D	Connection, Water Inlet	75	—	Fuel Heater	121	9E527	Injection Nozzle Holder	162	—	Oil Level Gauge — E-Series
31	D6AZ-19562-A	RTV Sealant	76	—	Threaded Insert	122	—	Fuel Return Hose	163	—	Tube Assembly, Oil Level Gauge — E-Series
32	6675C	Oil Pan	77	—	Fuel Filter Element	122A	—	Hose	164	—	O-Ring, Oil Level Gauge — E-Series
33	6734A	Gasket, Oil Pan Drain	78	—	Drain Bowl O-Ring	122B	—	Hose, Pump to Fuel Return Tube	165	—	Oil Level Gauge Tube, Lower — E-Series
34	6730A	Plug, Oil Pan Drain	79	—	Drain Valve Stem Cap	122C	—	Guard, Rear Fuel Return Hose	166	—	Bracket, Oil Level Gauge Tube — E-Series
35	9431B	Manifold, Exhaust, Left	80	—	Drain Valve Seal	123	—	Fuel Return Tee (E-Series)	167	—	Retainer, Oil Level Gauge Tube — E-Series
36	9448A	Gasket Exhaust Manifold	81	6A636A	Water Separator Drain Bowl	124	9F734	Fuel Return Junction Fitting			
37	6A532A	Washer, Valve Cover	82	6A636A	Gasket, Oil Cooler, Front Header	125	—	Nipple, Fuel Return			
38	6582C	Valve Cover	83	6K649A	Header, Oil Cooler, Front	126	9N659	Clamp			
39	6584A	Gasket, Valve Cover	84	6C610A	O-Ring, Oil Cooler (2)	127	9F736	Elbow			
40	6507D	Valve, Intake (8)	85	6A642A	O-Ring, Oil Cooler (2)	127A	—	Clip			
41	6505	Valve, Exhaust	86	6A636B	Cooler, Oil	128	9D308	Tube			
42	6057B	Insert, Exhaust Valve Seat	87	6881B	Gasket, Oil Cooler, Rear Header	129	—	Nozzle Tip			
43	6026F	Plug, Ball Type 13/32" (8)	88	6K862A	Header, Oil Cooler, Rear	130	—	Sensor, Fuel Line Pressure			
44	—	Bolt, Valve Lever and Washer			Plug, 1/4-Inch	130A	—	Cover			
					Oil Filter	131	9C387	Sleeve Seal, Fuel Return (2)			

CA7144-2F

DESCRIPTION AND OPERATION (Continued)

7.3L Diesel, Exploded Internal View



REF. NO.	BASIC PART NO.	DESCRIPTION	REF. NO.	BASIC PART NO.	DESCRIPTION
1	6009H	Cylinder Block Assembly	21	6278B	Washer, Crankshaft
2	6278A	Washer, Camshaft	22	6379A	Damper, Crankshaft
3	6256A	Gear, Camshaft	23	6700A	Seal, Crankshaft Front Oil
4	6287A	Eccentric, Fuel Pump	24	6306A	Gear, Crankshaft Drive
5	6265A	Spacer, Camshaft Gear	25	6B316A	Key, Crankshaft Alignment
6	6269A	Camshaft Thrust Plate	26	6333A	Bearng, Crankshaft
7	6L269A	Key, Camshaft Alignment	27	6337A	Bearing, Crankshaft Thrust
8	6250B	Camshaft	28	6384A	Ring Gear, Flywheel
9	6500A	Roller Tappet	29	—	Flywheel — Automatic Transmission
10	6565A	Push Rod	30	—	Flex Plate — Automatic Transmission
11	6K252A	Bolt, Camshaft Drive Gear	31	—	Reinforcement Ring
12	6108G	Set, Piston, Pin	32	6379A	Bolt, Flywheel to Crankshaft
13	6140A	Retainer, Piston Pin	33	6477	Flywheel Dual Mass — Manual Transmission
14	6135B	Piston Pin	34	6303A	Crankshaft (with Bearings)
15	6148D	Piston Rings	35	—	Bearing Cap (Part of Cyl. Block Assy.)
16	—	Piston (Not Available Separately)	36	6345A	Bolt, Bearing Cap
17	6200A	Connecting Rod	37	6345B	Stud, Bearing Cap
18	6211A	Bearing Kit, Connecting Rod	38	6214A	Bolt, Connecting Rod
19	6A312A	Pulley, Crankshaft	39	6212A	Nut, Connecting Rod
20	—	Bolt, Hex Head			

CA7840-2E

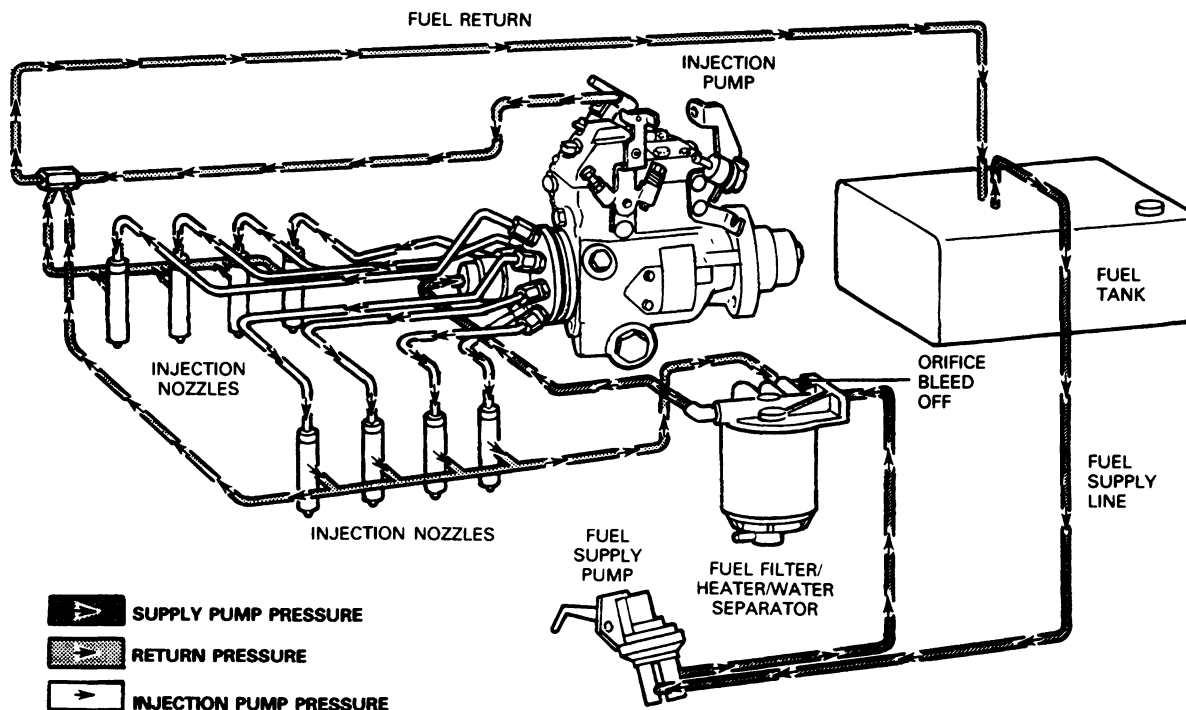
DESCRIPTION AND OPERATION (Continued)

Fuel System

WARNING: USE MOTORCRAFT® FUEL FILTER/WATER SEPARATOR FD-829 OR EQUIVALENT.

Fuel from the tank is routed to the fuel supply pump through a combination fuel filter, heater and water separator. The filter header contains a continuous vent (orifice bleed-off system) which aids starting by eliminating the need to manually prime the fuel filter. A vacuum switch is incorporated into the fuel filter header which will activate an instrument panel lamp, indicating the need for filter replacement. The water separator portion of the filter assembly has a probe which activates an instrument panel lamp when the filter requires draining at the water and sediment drain (located on the bottom of the assembly).

NOTE: Proper filtration of diesel fuel cannot be overemphasized. It is essential for long component life and reliability.

Fuel Flow

A10890-2A

Injection Pump

The diesel fuel injection pump accurately meters and delivers fuel to a nozzle in each cylinder at high pressure and at precisely timed intervals.

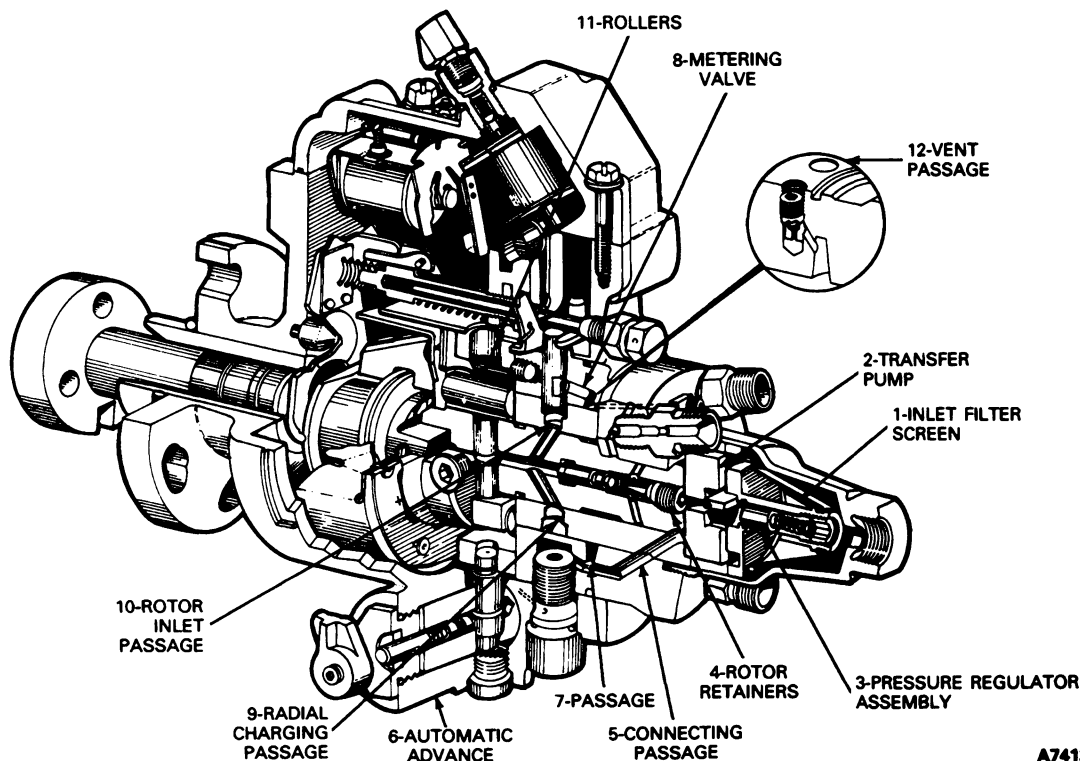
Refer to following illustration for pump operating principles. Fuel flows into the injection pump inlet through an inlet filter screen (1). Fuel then flows to the vane-type fuel transfer pump (2). Excess fuel from the transfer pump is bypassed through the pressure regulator assembly (3) to the suction side.

DESCRIPTION AND OPERATION (Continued)

Fuel under transfer pump pressure flows through the center of the transfer pump rotor, past the rotor retainers (4) into the hydraulic head. It then flows through a connecting passage (5) in the head to the automatic advance (6) and up through a radial passage (7) to the metering valve (8). The position of the metering valve, controlled by a governor, regulates fuel flow into the radial charging passage (9) which incorporates the head charging ports. As the rotor revolves, the two rotor inlet passages (10) align with the charging ports in the hydraulic head, allowing fuel to flow into the pumping chamber. With further rotation, the inlet passages move out of alignment and the discharge port of the rotor aligns with one of the head outlets. While the discharge port is opened, the rollers (11) contact the cam lobes forcing the plungers together. Fuel trapped between the plungers is then pressurized and delivered by the nozzle to the combustion chamber.

In addition, an air vent passage (12) in the hydraulic head connects the outlet side of the transfer pump with the pump housing. This allows air and some fuel to be bled back to the fuel tank through the return line. Fuel bypassed in this way fills the housing, lubricates the internal components, cools and carries off any small air bubbles.

Injection Pump Internal View



A7412-28

Injection Nozzle Assemblies

Description

The injection nozzles are of the inwardly opening, differential, hydraulically operated, pintle-type. Their function is to direct a metered amount of fuel, under high pressure from the fuel injection pump, into the engine combustion chamber.

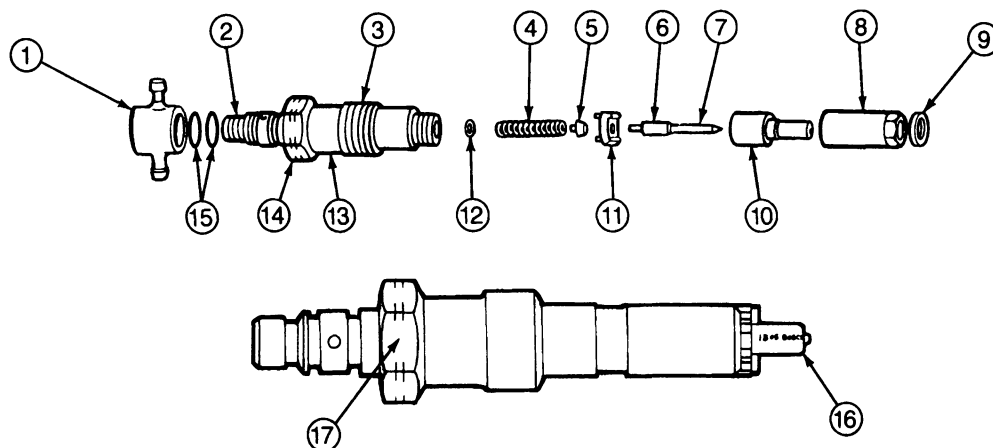
The injection nozzle assembly consists of two subassemblies. The nozzle holder retains the nozzle in its correct position in the cylinder head and provides channels for conducting diesel fuel to the nozzle. The nozzle consists of two parts: valve body and nozzle valve. These parts are lapped to form an extremely close-fitting matched set.

The nozzle valve carries an extension at its lower end, called the pintle.

DESCRIPTION AND OPERATION (Continued)**Operation**

A metered quantity of fuel passes through ducts to the pressure chamber located just above the spring seat. At the instant the pressure of fuel acting on the differential area of the valve exceeds a predetermined spring-load, it lifts the valve from its seat and fuel flows from the nozzle. Fuel cut-off occurs as the valve is seated by the nozzle spring. A small amount of fuel leakage to the spring cavity is necessary for lubrication. This fuel leakage drains through to a leak-off outlet.

Nozzle opening pressure and spray pattern should be inspected every 96,500 km (60,000 miles). Refer to Nozzle Testing in the Powertrain Control / Emissions Diagnosis Manual ¹.

Injection Nozzle and Holder Assembly

A10688-C

Item	Description
1	Fuel Return Tee
2	High Pressure Connection
3	Nozzle Retaining Threads
4	Spring
5	Spring Seat
6	Nozzle Valve
7	Pintle
8	Nozzle Cap Nut (Retainer)

(Continued)

Item	Description
9	Copper Gasket
10	Valve Body
11	Spacer With Dowels
12	Pressure Adjusting Shims
13	Nozzle Holder Body
14	Nozzle Mounting Surface
15	O-Ring Seals
16	Nozzle Tip Part Number Location
17	Stamped Code

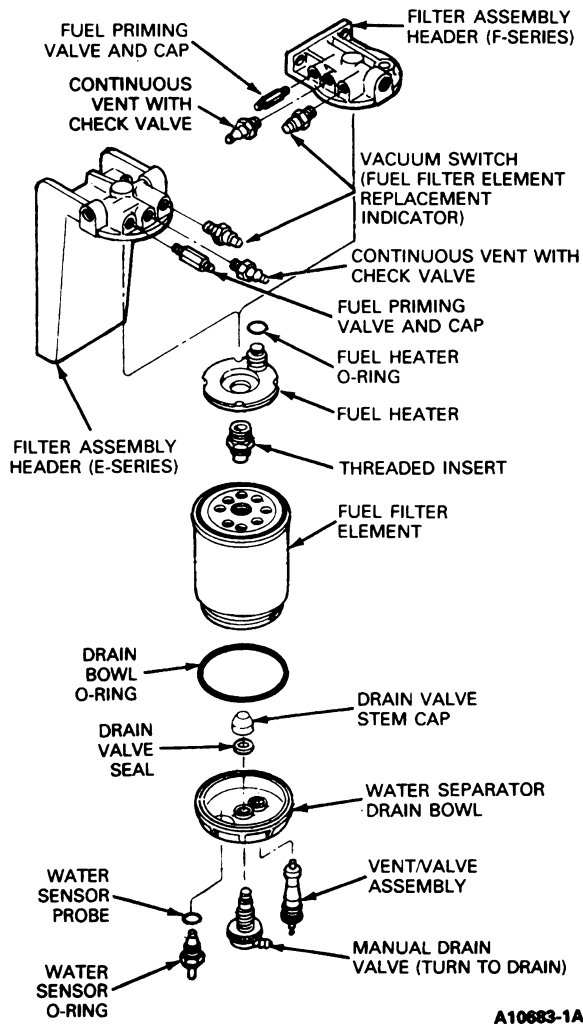
Fuel Filter / Fuel Heater / Water Separator

The 7.3L diesel engine is equipped with a fuel filter / fuel heater / water separator assembly. A WATER IN FUEL indicator lamp is provided on the instrument panel to alert the operator. The lamp should glow when the ignition switch is in the ON position to indicate proper lamp and water sensor function. If the lamp glows continuously while the engine is running, the water must be drained from the fuel filter / fuel heater / water separator manual drain valve as soon as practical to prevent damage to the fuel injection system.

¹ Can be purchased as a separate item.

DESCRIPTION AND OPERATION (Continued)

Drain water from the fuel filter / fuel heater / water separator manual drain valve whenever the warning lamp comes on or every 8,046 km (5,000 miles). The WATER IN FUEL lamp will glow when approximately 103 ml (3.5 fluid ounces) of water accumulates in separator.

**Drain**

1. Stop vehicle and shut off engine.
NOTE: To avoid engine stall-out caused by air entering the fuel system, do not drain fuel / water separator while engine is running.
2. Place an appropriate container under the fuel filter / fuel heater / water separator drain tube to collect drain fluid. The drain tube is attached to the manual drain valve at base of water separator drain bowl.

3. Manually open drain valve by unscrewing. Allow drain valve to remain open approximately 15 seconds or until clear (water-free) diesel fuel flows from drain tube. Close drain valve by threading into water separator drain bowl until liquid no longer drains from drain tube.

WARNING: MAKE SURE THAT DRAIN VALVE IS FULLY AND SECURELY CLOSED.

4. Re-start the engine and check WATER IN FUEL lamp. The lamp should not glow. If it continues to glow, have fuel system checked and repaired.

Drain all traces of water from the fuel filter / fuel heater / water separator as outlined at 8,046 km (5,000 mile) intervals as specified in the maintenance schedule. At this service interval, if the warning lamp is not glowing, examine the draining fluid to determine when clear diesel fuel flows from the drain tube. Stop draining procedure as soon as clear diesel fuel appears.

Glow Plug Fast Start System

The 7.3L diesel engine utilizes a solid-state glow plug system to aid in the start of the engine. The system pre-heats air in the combustion chamber to aid ignition of the fuel.

The system consists of eight glow plugs (one for each cylinder), a solid-state glow plug controller / power relay assembly, two fusible links located between the power relay and the glow plug harness (one for each bank of four glow plugs), WAIT TO START lamp and a wiring harness which incorporates eight fusible wires (one for each glow plug).

CAUTION: Hard starting will result if the ignition switch is left on for over two minutes without starting the engine. If the ignition switch is turned off, it can be turned on immediately and the glow plug heating cycle will start again.

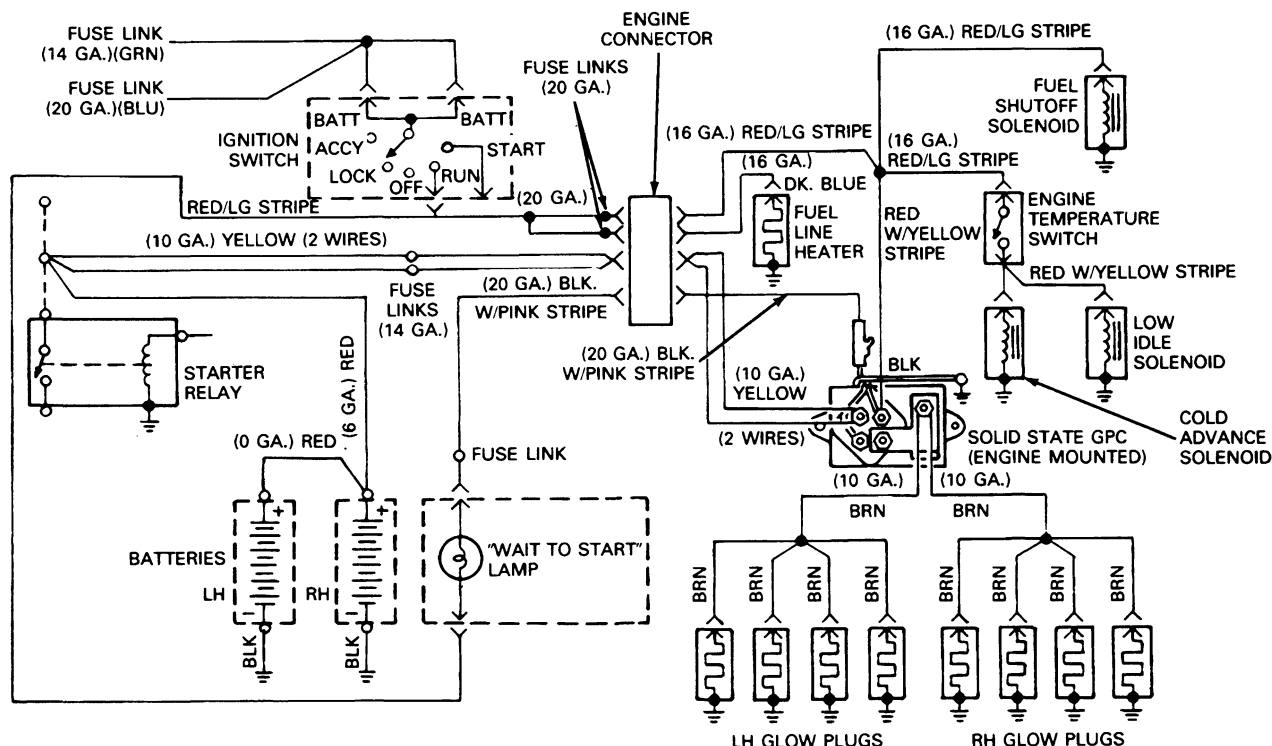
An after-glow operation allows the glow plugs to cycle on and off after the WAIT TO START lamp has turned off. This helps to reduce white smoke during engine warm-up. The lamp will **NOT** cycle on and off during this operation.

The solid-state system determines the glow plug temperature by electronically measuring the resistance of the glow plugs and maintains temperature regardless of ambient conditions. The system uses positive temperature coefficient (PTC) glow plugs with push-on bullet terminals. These are **NOT** interchangeable with previous model year glow plugs.

CAUTION: Never bypass the power relay of the glow plug system. Constant battery current (12 volts) to glow plugs will cause them to overheat and fail, possibly resulting in severe engine damage.

DESCRIPTION AND OPERATION (Continued)

Glow Plug Schematic



A10202-2B

Dual Mass Flywheel (Manual Transmission Only)

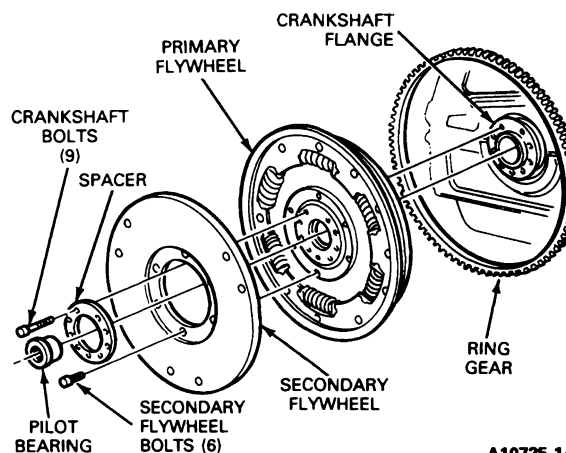
The flywheel assembly used on the 7.3L V-8 diesel engine is known as a dual mass flywheel. The purpose of the dual mass flywheel is to provide one inertia mass connected directly to the engine crankshaft and a second inertia mass connected through the clutch system to the transmission. The dual mass flywheel provides the same functions as the conventional flywheel with mounting surfaces for the starter ring gear, clutch pilot bearing and clutch pressure plate and the friction surface for contact with the clutch disc.

The first inertia mass provides sustaining energy to maintain engine operation between the times that the cylinders fire, and to maintain smooth power delivery.

The second inertia mass provides sustaining energy to the transmission.

Between these two inertia masses a series of springs and friction elements provide smooth, quiet operation and a torque limitation function to protect the drivetrain from impact shock.

The bearing used to mount the second inertia mass onto the first requires no lubrication.



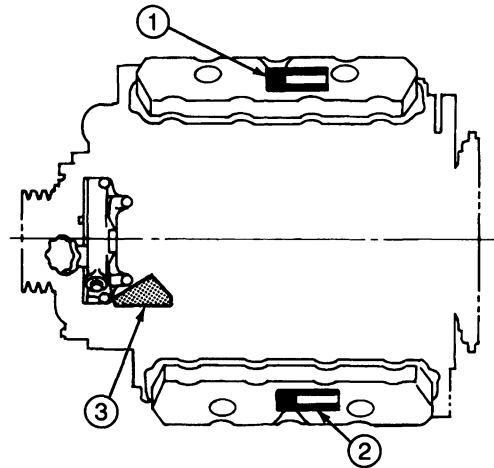
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Vehicle and Engine Identification

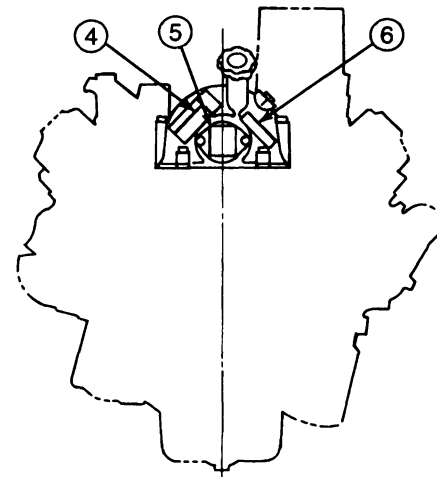
Vehicle identification, the location of the vehicle rating and data plates and engine code information is fully covered in Section 00-01. For specific and exact engine identification an engine code label is affixed to the gear tower. Refer to the illustrations for examples of engine identification labeling.

DESCRIPTION AND OPERATION (Continued)

Always refer to the engine code label when replacement parts are required or when checking engine calibrations. Some engine parts vary with engine application and vehicle type. The codes contain all pertinent information relating to dates, optional equipment and revisions. The Ford Master Parts Catalog contains a complete listing of the codes and their application. Additional identification information can be found in the permanent engine serial number (stamped on the front side of the crankcase) the emission label (affixed to the valve cover), or the engine serial sequence number label or oil change information label (near the engine code label on front of engine).

Engine Identification

7.3L TOP VIEW



7.3L FRONT VIEW

A10892-B

DESCRIPTION AND OPERATION (Continued)

Engine Code Label

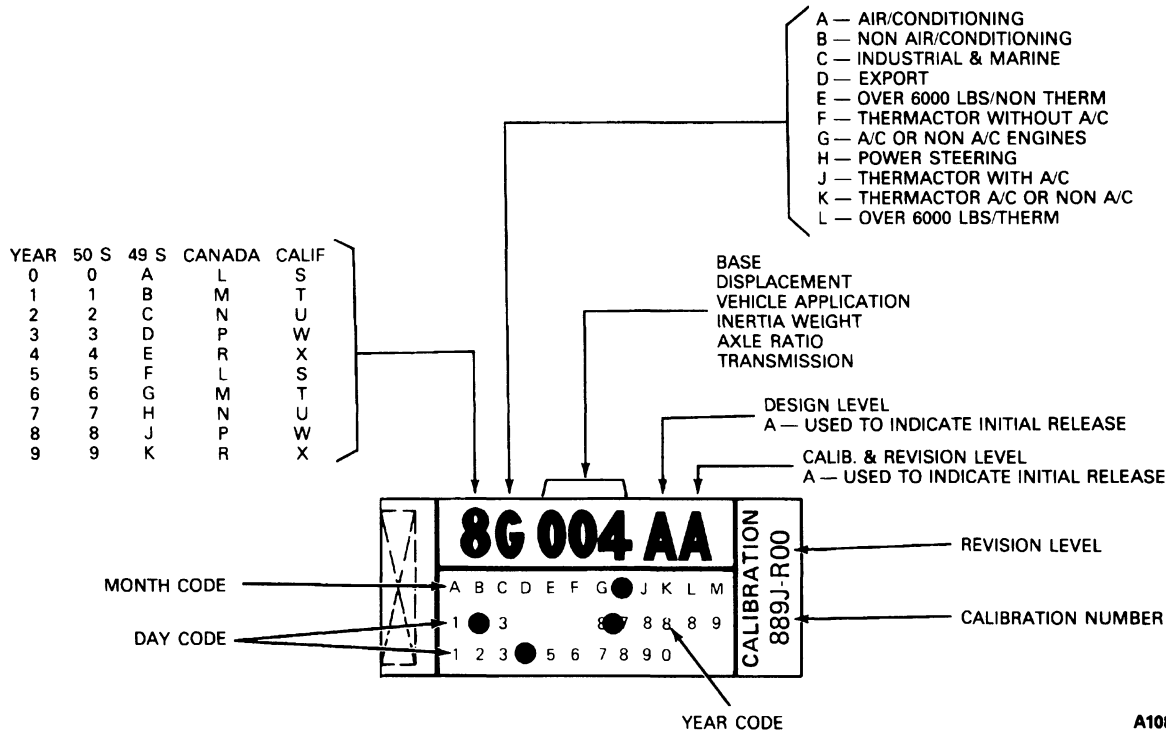
ENGINE SERIAL NUMBER CHART

ENGINE DISPLACEMENT	VARIATION CODE	COUNTRY OF ORIGIN	SERIAL SEQUENCE NUMBER
7.3	DU2	U	500001*

7.3 = Engine Displacement in Liters
 D = Naturally Aspirated
 U2 = OEM Application

U = Country of Origin - U.S.A.
 000501 = Starting Sequence Number
 * = Used to Prevent Tampering

ENGINE CODE LABEL IDENTIFICATION CHART



A10893-2A

Engine Emission Label

INTERNATIONAL® EMISSION CONTROL INFORMATION 7.3LD ENGINE FAMILY Engine Manufactured By: NAVISTAR INTERNATIONAL TRANSPORTATION CORP.	MODEL	*A 166 HA ()	A185 ()	ENGINE CODE
	ADV. BHP@ RPM	166@ 3300	185@ 3300	
	FUEL RATE@ ADV. BHP MIN° STROKE	53.5	58.5	
	INITIAL INJECTION TIMING DEGREES BTDC	MARKS ALIGNED		
	DISPLACEMENT: 7.3 LITERS	CURB IDLE RPM: 650 ± 50		
ENGINE SHIPPING DATE	SETTINGS MUST BE MADE WITH ENGINE AT NORMAL OPERATING TEMPERATURE AIR CONDITIONING OFF MANUAL TRANSMISSION IN NEUTRAL/AUTOMATIC TRANSMISSION IN DRIVE			
	NAVISTAR 1809150C1			
THIS ENGINE HAS A PRIMARY INTENDED SERVICE APPLICATIONS AS A LIGHT HEAVY-DUTY DIESEL ENGINE AND CONFORMS U.S. EPA CANADIAN AND CALIFORNIA REGULATIONS APPLICABLE TO 1988 MODEL YEAR HEAVY-DUTY DIESEL ENGINES CALIF. REGULATIONS NOT APPLICABLE TO A185HA				

A10689-2A

DIAGNOSIS AND TESTING

Engine Oil Leaks

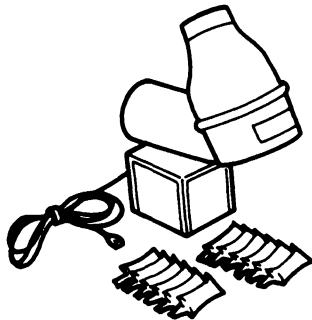
CAUTION: Do not wash or steam clean the engine with engine running. Serious damage to the injection pump could result.

When diagnosing engine oil leaks, the source and location of the leak must be positively identified before any repairs are made. Prior to using this procedure, it is important to clean the cylinder block, cylinder head(s), valve cover(s), oil pan and flywheel housing areas with a suitable solvent to remove all traces of oil.

CAUTION: Do not use an air pressure leak test kit for diagnosing engine oil leaks. Loss of sealing may result at the valley pan seal.

To perform oil leak diagnosis use Oil Leak Detector Rotunda Model 112-00001 or equivalent.

Leak Test Kit Rotunda Model 112-00001



A7911-1A

To perform oil leak diagnosis use Oil Leak Detector Rotunda Model 112-00001 or equivalent.

CAUTION: Dye may cause irritation. Avoid contact with skin or eyes. Wash thoroughly after handling.

1. Open two containers of dye by cutting off end of spout and empty entire contents of containers into crankcase.
2. Drive vehicle for five to ten miles at various road speeds.
3. Turn on spot lamp (lamp requires 3-5 minutes to warm up).
4. Open hood. Remove air cleaner and install Intake Manifold Cover T83T-9424-A or equivalent over intake manifold opening.
5. Inspect sealed and / or gasketed areas for leaks with the spot lamp. A leak will appear as a bright contrasting yellow-green fluorescence. Examine the following areas, as required:

Under Hood

- a. Valve cover gaskets and around bolts.
- b. Crankcase front cover gaskets.
- c. Front and rear valley pan end seals.
- d. Cylinder head gaskets.
- e. Injection pump mounting adapter to crankcase.

- f. Injection pump to adapter.
- g. Front oil fill tube and oil fill cap.
- h. Fuel supply pump and / or mounting gasket.
- i. Oil pressure sending unit.
- j. Cup plugs and / or pipe plugs at the end of oil passages.

Under Engine, With Vehicle on Hoist

- a. The complete oil pan perimeter.
- b. Crankcase front cover gaskets.
- c. Front crankshaft seal.
- d. Oil filter seal.
- e. Oil cooler mounting gaskets and header O-rings.
- f. Fuel supply pump and / or mounting gasket.
- g. Oil level indicator (dipstick) tube connections.

With Transmission Removed

- a. Flywheel mounting bolts.

With Transmission and Flywheel Removed and Flywheel Mounting Bolt Holes Plugged

- a. Rear crankshaft seal.
- b. Rear cup plugs and / or pipe plugs.
- c. Rear cover gasket.
- d. Rear cover oil pan seal.

NOTE: Install specified sealant on flywheel bolts and install flywheel as outlined in this section.

Oil Cooler Internal Leakage Test

When oil is found in the cooling system or coolant in the oil, the oil cooler assembly should be inspected for leakage.

Areas of possible leakage are:

- O-rings
- Oil cooler bundle (tubes)
- Front header
- Rear header

Clean the cooling system if oil is found in the coolant. Refer to Section 03-03. If coolant is found in the oil, change engine oil and filter.

1. Remove oil cooler assembly from engine with filter installed as outlined in this section.
2. Inspect the gaskets at the header flanges for leakage of coolant into the oil or oil into the coolant.

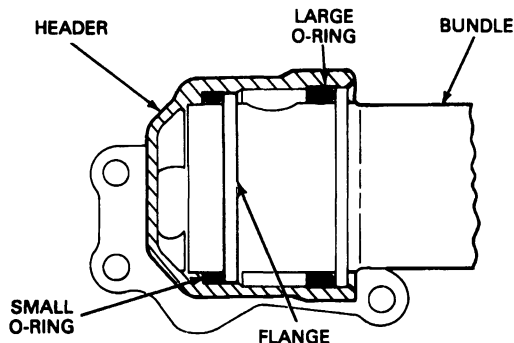
NOTE: Use original oil cooler tube and NOT test cooler tube included with Rotunda model 014-00726 Oil Cooler Internal Leakage Tester or equivalent.

DIAGNOSIS AND TESTING (Continued)

3. Using new header gaskets, assemble Rotunda Oil Cooler Internal Leakage Tester 014-00726 or equivalent to the engine oil cooler. Follow instructions provided with kit.

Oil Cooler Internal Leakage Test Equipment, Rotunda Model 014-00726

NOTE: Install the large O-ring on the oil cooler bundle first, then install the small O-ring on the cooler bundle.



NOTE: **INSTALL THE LARGE O-RING ON THE OIL COOLER BUNDLE FIRST, THEN INSTALL THE SMALL O-RING ON THE COOLER BUNDLE.**

A8704-C

4. Pressurize coolant side of front header test plate (adapter A) at air supply fitting with 276.8 kPa (40 psi) air pressure.
5. Check for air leakage at the plastic tube or each header cover plate. If air leakage is not felt, place a cup of water up to the plastic tubes and look for bubbles. There should be no bubbles for a one-minute time period.
NOTE: If no leakage is observed, the complete oil cooler assembly (headers, O-rings and cooler bundle tube) **DOES NOT** have an internal leak. Install the oil cooler assembly to the engine as outlined in this section. Continue engine diagnostic procedures to identify the source of the leak.
NOTE: Steps 3 through 5 may also be used as a functional test of a newly overhauled oil cooler assembly.
6. If air leakage is observed, unbolt the test kit tie bar and remove the front and rear headers from the cooler bundle (with cover plates attached to headers). Replace the four cooler bundle O-rings.
7. Bolt the test kit tie bar to the rear header cover plate. Repeat Steps 4 and 5 with the cooler assembly submerged in water. If leakage persists, isolate the worn or damaged component in the oil cooler assembly as follows:
 - a. For a leaking oil cooler still covered by warranty (3 years, 80,465km or 50,000 miles) go to Step 8.
 - b. For a leaking oil cooler not covered by warranty go to Step 10.

8. For a leaking oil cooler covered by warranty, replace and retest the following oil cooler components in the following sequence until no leakage is observed:
 - a. Front header
 - b. Rear header
 - c. Cooler bundle (tube)

NOTE: Prior to each retest, inspect the condition of the affected header gasket(s) and O-rings and replace if damaged.

9. Assemble the affected test kit cover plate(s) and tie bar. Repeat Steps 4 and 5 with cooler assembly submerged in water. If leak persists, replace the next component listed in Step 8. If no leakage was observed, go to Step 12.
 10. For a leaking oil cooler not covered by warranty, replace and test the following oil cooler components in the following sequence until no leakage is observed:
 - a. Cooler bundle (tube)
 - b. Front header
 - c. Rear header
- NOTE: Prior to each retest, inspect the condition of the affected header gasket(s) and O-rings, replace if damaged.
11. Assemble the affected test kit cover plate(s) and tie bar. Repeat Steps 4 and 5 with cooler assembly submerged in water. If leak persists, replace the next component listed in Step 8. If no leakage was observed, go to Step 12.
 12. Install oil cooler assembly onto engine with new gaskets as outlined.

Compression Test

The following procedure is to be used when checking compression:

1. Make sure battery is fully charged. Operate the engine until normal operating temperature is reached. Turn the ignition switch to OFF. Remove air cleaner and / or intake opening cover. Disconnect injection pump solenoid leads from injection pump to prevent accidental engine starting. Remove all glow plugs.
2. Install Rotunda Compression Tester 014-00701 or equivalent in No. 1 cylinder glow plug hole.
3. Crank the engine (with the ignition switch off) at least five pumping strokes. Record highest reading indicated. Note the approximate number of compression strokes required to obtain the highest reading.
4. Repeat the check on each cylinder, cranking the engine approximately the same number of compression strokes.

DIAGNOSIS AND TESTING (Continued)

Test Conclusion

Compression pressures are considered normal if the lowest reading cylinder is within 75 percent of the highest. Variations exceeding 75 percent indicate an improperly seated valve or worn or broken piston rings.

CAUTION: Do not add oil to cylinder. This could cause hydrostatic lock.

Compression Test Pressures

HIGHEST CYLINDER	LOWEST CYLINDER
Maximum kPa (PSI)	Minimum kPa (PSI)
1792 (260)	1344 (195)
1929 (280)	1447 (210)
2067 (300)	1551 (225)
2205 (320)	1654 (240)
2343 (340)	1757 (255)
2481 (360)	1860 (270)
2619 (380)	1964 (285)
2756 (400)	2067 (300)
2894 (420)	2171 (315)
3032 (440)	2274 (330)

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Hydraulic Valve Tappet

Hydraulic tappet noise may be caused by any of the following:

1. Excessive collapsed tappet gap.
2. Sticking tappet plunger.
3. Tappet check valve not functioning properly.
4. Air in lubrication system.
5. Leakdown rate too rapid.
6. Excessive valve guide wear.

Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts, or wear of tappet roller, push rod, rocker arm, rocker arm fulcrum or valve tip. Using Tappet Bleed-Down Wrench T83T-6500-A or equivalent collapse tappet and check gap between valve tip and rocker arm to determine if any valve train parts are damaged, worn, or out of adjustment.

A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. Sticking plungers can sometimes be serviced by disassembling the tappet and removing the dirt, chips or varnish causing the condition.

A non-functional tappet check valve may be caused by an obstruction (dirt or chips) preventing it from closing when the cam lobe is lifting the tappet. Non-functional tappet check valves may also be caused by a broken check valve spring.

Air bubbles in the lubrication system prevent the tappet from supporting the valve spring load. Bubbles may be caused by too high or too low an oil level in the oil pan, by air being drawn into the system through a hole or crack, or a leaking gasket on the oil pump pickup tube.

If leakdown time is below specifications for used tappets, noisy operation may result. If no other cause for noisy tappets can be found, check leakdown rate and replace any outside the specification. Refer to Hydraulic Tappet Leakdown Testing in Section 03-00. The procedures are the same for diesel and gasoline engines.

Static (Engine Off) Valve Train Analysis

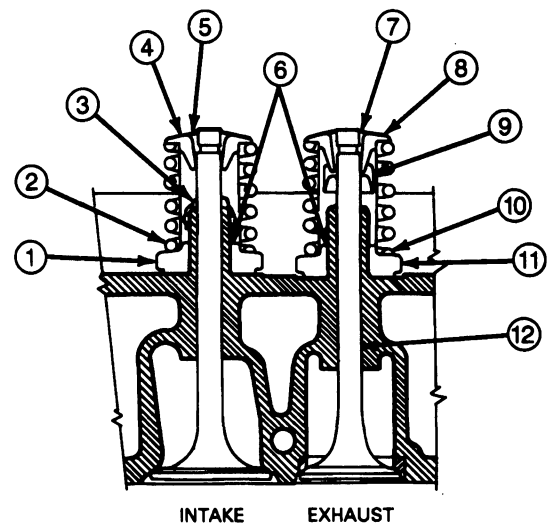
Rocker Arm Cover Removal

Remove rocker arm covers as outlined in this section.

Valve Train Analysis

Check for damaged and / or severely worn parts; for correct assembly and use of correct parts.

1. Check rocker arm assemblies for loose mounting bolts or plugged rocker arm oil hole.
2. Check for bent push rods or clogged passages.
3. Check valve spring assembly for broken or damaged parts.
4. Check retainer and keys for proper seating of keys on valve stem in retainer.
5. Check for proper seating of the positive valve rotator.
6. Check valves and cylinder head. Check cylinder head gasket for proper installation. Check for plugged oil drain holes, worn or damaged valve tips, missing or damaged valve stem oil seals. Check collapsed tappet gap.



A15993-A

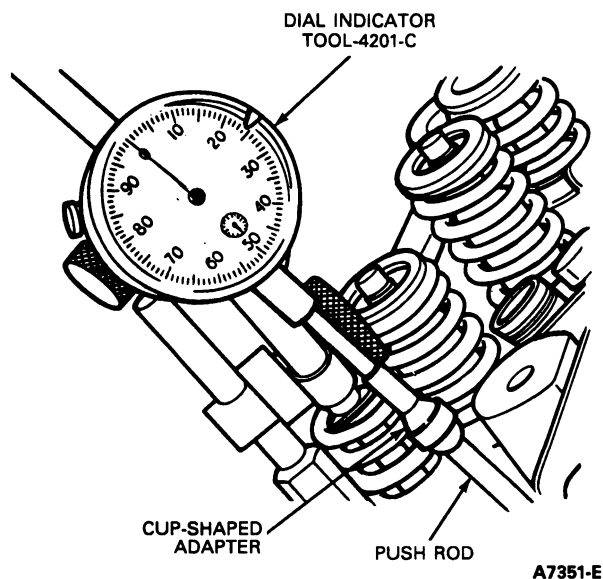
DIAGNOSIS AND TESTING (Continued)

Item	Part Number	Description
1	6K533	Valve Rotator
2	6513	Spring with Damper
3	6571	Valve Stem Seal (Intake Only)
4	6514	Retainer
5	6518	Retainer Lock
6	6510	Valve Guide
7	6514	Retainer Lock
8	6518	Retainer
9	6517	Oil Shield (Exhaust Only)
10	6513	Spring with Damper
11	6K533	Valve Rotator
12	—	Valve Guide Bore

Camshaft Lobe Lift

Check lift of each lobe (in consecutive order) and make a note of readings.

1. Remove fresh air inlet tube and air cleaner and install Intake Manifold Cover T83T-9424-A.
2. Remove valve cover(s) as outlined.
3. Remove fulcrum bolts, fulcrum seats and rocker arms as outlined.
4. Make sure push rod is in valve tappet socket. Install Dial Indicator D78P-4201-G and Dial Indicator Bracketry TOOL-4201-C or D78P-4201-F or equivalent so that indicator ball socket adapter using suitable cup-shaped adapter is on the end of the push rod and in the same plane as push rod movement.

Camshaft Lobe Lift Test

5. Rotate crankshaft by hand until tappet is on base circle of crankshaft lobe. At this point, push rod will be in its lowest position.

NOTE: Remove glow plugs with Glow Plug Socket D83T-6002-A or equivalent to facilitate turning engine over by hand.

6. Zero dial indicator. Continue to rotate crankshaft slowly until push rod is in fully raised position.
7. Compare total lift recorded on indicator with specification.
8. To check accuracy of original indicator reading, continue to rotate crankshaft until the indicator reads zero. If the lift on any lobe is below specified wear limits, the camshaft and the valve tappet operating on the worn lobe(s) must be replaced.
9. Remove the dial indicator.
10. Install rocker arms, fulcrum seats and fulcrum bolts as outlined. Tighten bolts to specification.
11. Install the valve cover(s) as described in this section. Tighten bolts to specification.
12. Remove intake manifold cover, install air cleaner and tighten to specification.

Valve Cover Installation

Install both valve covers as outlined in this section.

Camshaft End Play

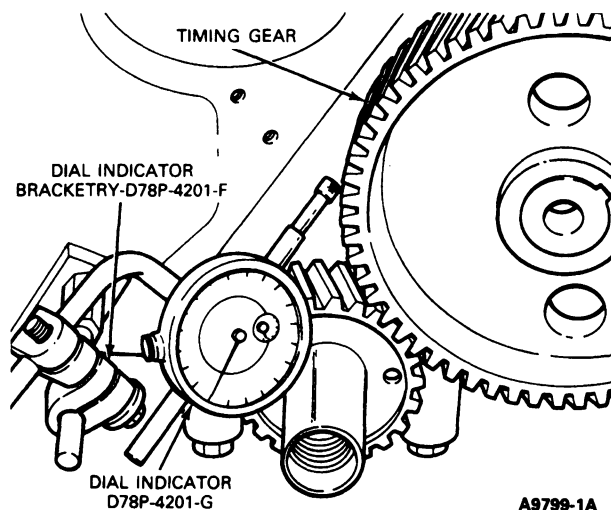
Refer to diagnosis and testing procedure in Section 03-00. This procedure is the same for diesel and gasoline engines.

Drive Gear Backlash (All Gears)

Remove engine front cover as outlined in this section.

DIAGNOSIS AND TESTING (Continued)

Install Dial Indicator Bracketry D78P-4201-F and Dial Indicator D78P-4201-G or equivalent on the cylinder block. Check the backlash between the drive gear and the driven gear with a dial indicator at six equally spaced teeth. Hold the gear firmly against the block while making the check. Refer to Specifications for backlash limits.



A9799-1A

Crankshaft End Play

Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

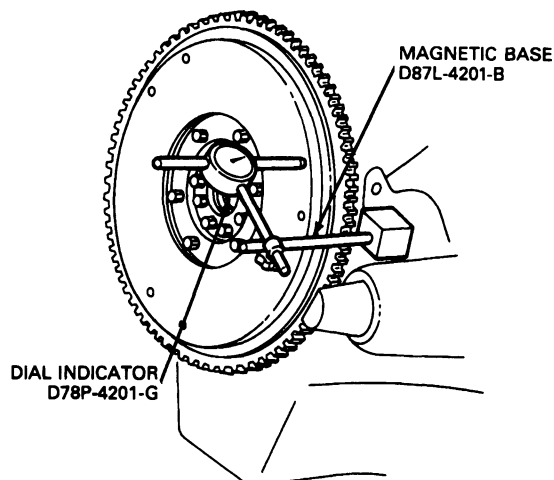
Flywheel Runout, Manual Transmission

NOTE: This procedure is performed with transmission removed. Refer to Group 07.

NOTE: Remove glow plugs with Glow Plug Socket D83T-6002-A or equivalent to facilitate turning engine over by hand.

Install Dial Indicator Bracketry D78P-4201-F and Dial Indicator D78P-4201-G or equivalent so that the indicator point bears against the flywheel face, one-inch from the edge of the flywheel. Zero the dial indicator. Turn flywheel, making sure it is fully forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

If flywheel clutch face runout exceeds specifications listed at the end of this section, remove flywheel. Check for burrs between flywheel and face of the crankshaft mounting flange. If no burrs exist, check crankshaft mounting flange runout. If excessive, machine mounting flange or replace crankshaft. If not excessive, reface or replace secondary flywheel. If the ring gear runout exceeds specifications, check installation of gear to flywheel flange. If it is not properly seated, re-install it to flywheel. If it is properly seated, replace it. Refer to Flywheel Ring Gear, Removal and Installation in this section for applicable procedures.



A10724-C

Flywheel Runout, Automatic Transmission

Remove the glow plugs with Glow Plug Socket D83T-6002-A or equivalent to facilitate turning engine over by hand.

Install a dial indicator so that the indicator point rests on the ring gear face adjacent to the gear teeth.

Push the flywheel and crankshaft fully forward or rearward to prevent crankshaft end play from being indicated as flywheel runout.

Zero the dial indicator. Turn the flywheel one complete revolution while observing the total indicator reading (TIR). If TIR exceeds specifications listed at the end of this section, remove flywheel and check for burrs between flywheel and face of crankshaft mounting flange. If no burrs exist, check runout of crankshaft mounting flange. If crankshaft flange face exceeds specifications, machine the mounting flange or replace crankshaft. If crankshaft flange face runout is not excessive, check installation of ring gear to flywheel. If not properly seated, remove and reinstall ring gear to flywheel. If ring gear is properly seated, replace flywheel.

DIAGNOSIS AND TESTING (Continued)**Diagnostic Procedures, Engine Performance and Glow Plug System**

Diagnostic procedures for engine performance, fuel injection and glow plug fast start system are covered in the Powertrain Control/Emissions Diagnosis Manual². Injection pump timing and nozzle performance are also covered in the Powertrain Control/Emissions Diagnosis Manual².

REMOVAL AND INSTALLATION

NOTE: Lightly oil attaching bolt and stud threads before installing, except those specifying special sealant.

Engine Assembly**F-Series Vehicles****Removal**

1. Disconnect both battery ground cables.
2. Scribe alignment marks at hood hinges for reference during installation. Remove hood.
3. Drain cooling system. Refer to Section 03-03.
4. Remove air cleaner and intake duct assembly.
5. Install Intake Manifold Cover T83T-9424-A over air intake opening.
6. Remove radiator fan shroud.
7. Remove fan and clutch assembly as outlined, using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.
CAUTION: Left-hand thread. Remove by turning nut clockwise.
8. Disconnect radiator upper and lower hoses from radiator.
9. Disconnect automatic transmission oil cooler lines at radiator, if so equipped.
10. Remove radiator. Refer to Section 03-03.
11. Loosen air conditioner compressor, if so equipped, and remove drive belt. Remove air conditioner compressor, and position it on radiator upper support, refer to Section 12-03A.
12. Loosen power steering pump and remove drive belt.
13. Remove power steering pump and position out of the way on left side of engine compartment.
14. Disconnect alternator wires at alternator.
15. Disconnect oil pressure sending unit wire at sending unit located at back of engine.
16. Disconnect accelerator cable from injection pump.

17. Disconnect speed control cable from injection pump, if so equipped.
18. Remove accelerator cable bracket (with cables attached), from intake manifold and position out of the way.
19. Disconnect transmission kick down rod from injection pump, if so equipped.
20. Disconnect main wiring harness connector from right side of engine.
21. Disconnect engine ground strap from rear of engine.
22. Disconnect fuel return hose from left rear of engine.
23. Remove vacuum supply hose from vacuum pump, if so equipped.
24. Remove two upper transmission-to-engine attaching bolts.
25. Disconnect heater hoses from water pump and right cylinder head.
26. Disconnect water temperature sender wire from sender on left front of engine block.
27. Disconnect water temperature overheat lamp switch wire from switch on top front of left cylinder head.
28. Position wires out of the way.
29. Raise vehicle.
30. Disconnect both battery ground cables from lower front of engine.
31. Disconnect and cap fuel inlet line at fuel supply pump.
32. Disconnect starter cables at starter motor.
33. Disconnect muffler inlet pipe at exhaust manifolds.
34. Disconnect engine insulators from No. 1 crossmember.
35. Remove flywheel inspection plate.
36. Remove four converter-to-flywheel attaching nuts, if so equipped.
37. Lower vehicle.
38. Support transmission. Remove four lower transmission-to-engine attaching bolts.
39. Attach Rotunda Universal Load Positioning Sling 014-00036 or equivalent to engine.
CAUTION: Use care not to damage windshield wiper motor when lifting engine out of vehicle.
40. Raise engine high enough to clear No. 1 crossmember and pull forward.
41. Rotate the front of the engine approximately 45 degrees to the left and lift it out of the engine compartment.

² Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)**Installation**

NOTE: If the engine to be installed has been overhauled or has been in storage, take the following precaution to prevent piston and bearing scuffing. Prime the entire engine lubricating system to fill the oil cooler, oil filter and cylinder block galleries with the specified type and grade of oil.

CAUTION: Use care not to damage windshield wiper motor when installing engine into vehicle.

1. Lower engine into engine compartment.
2. Start transmission mainshaft into clutch disc. It may be necessary to adjust position of transmission in relation to engine if mainshaft binds or will not enter clutch disc. If engine hangs up after mainshaft enters clutch disc, rotate crankshaft slowly (transmission in gear) until mainshaft splines mesh with clutch disc splines.
3. Align torque converter with flywheel studs, if so equipped.
4. Lower engine onto engine insulator brackets on No. 1 crossmember.
5. Install four lower transmission-to-engine attaching screws and lockwashers and tighten to 54-68 N·m (40-50 ft·lb).
6. Remove engine lifting sling.
7. Raise vehicle.
8. Install four torque converter-to-flywheel attaching nuts, if so equipped, and tighten to specifications.
9. Install flywheel inspection plate and tighten bolts to specifications.
10. Install engine insulator support-to-crossmember bracket attaching nuts and washers and tighten to 102-129 N·m (75-95 ft·lb).
11. Connect muffler inlet pipes to exhaust manifolds and tighten nuts to 34-49 N·m (25-36 ft·lb).
12. Connect both battery ground cables to the lower front of the engine and tighten bolts to specifications.
13. Connect starter cables to starter and tighten to specifications.
14. Install fuel pump inlet line onto fuel pump and tighten to specifications.
15. Lower vehicle.
16. Connect water temperature sender wire to sender on left front of engine block.
17. Connect wire to water temperature overheat lamp switch on top of left cylinder head.
18. Install heater hoses onto right cylinder head and water pump and tighten clamps to 2-3 N·m (18-27 in·lb) double-wire clamp, 3-4 N·m (27-35 in·lb) screw-type clamp.
19. Connect engine ground strap at rear of engine.
20. Connect fuel return hose at left rear of engine.
21. Connect vacuum supply hose to vacuum pump.
22. Connect transmission kickdown rod, if so equipped.

23. Install accelerator cable bracket onto intake manifold and tighten to 16-23 N·m (15-18 ft·lb).
24. Connect accelerator cable to injection pump.
25. Connect speed control cable, if so equipped, to injection pump.
26. Connect oil pressure gauge sender wire to oil pressure sender.
27. Connect alternator wires to alternator.
28. Install power steering pump and drive belt. Do not adjust belt at this time.
29. Install air conditioning compressor and drive belt. Refer to Section 12-03A.
30. Adjust air conditioning compressor and power steering pump drive belts to specifications. Refer to Section 03-05.
31. Install radiator. Refer to Section 03-03.
32. Connect automatic transmission oil cooler lines at radiator, if so equipped. Refer to Section 07-01A.
33. Connect upper and lower radiator hoses to radiator and tighten hose clamps to 3-4 N·m (26-35 in·lb) screw clamps, 2-3 N·m (18-27 in·lb) double-wire clamps.
34. Fill and bleed the cooling system. Refer to Section 03-03.
35. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.

CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.

Tighten nut to 54-163 N·m (40-120 ft·lb).

36. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in·lb).
 37. Remove intake manifold cover. Install air cleaner. Refer to Section 03-12.
 38. Install intake duct assembly.
 39. Install hood, aligning scribe marks drawn on hood during removal.
 40. Connect battery ground cables at both batteries.
- NOTE:** On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
41. Check the engine oil level and fill as needed with specified type and grade of oil.
 42. Run engine and check for fuel, oil and coolant leaks.

Econoline Vehicles**Removal**

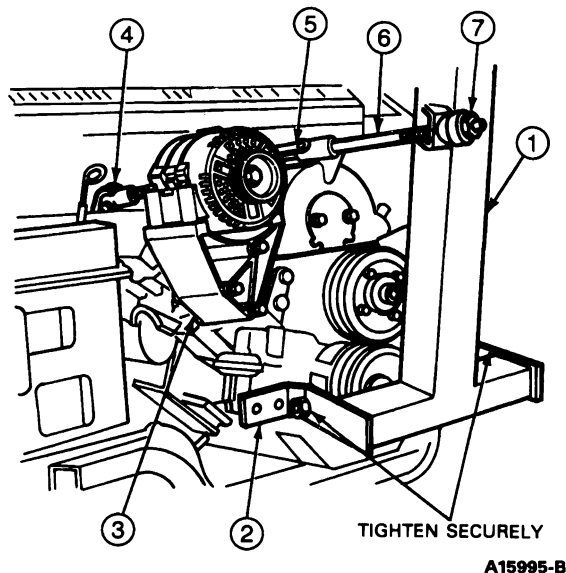
The engine removal and installation procedures are for the engine only (transmission not attached).

1. Disconnect both battery ground cables.
2. Drain coolant.

REMOVAL AND INSTALLATION (Continued)

3. Remove air intake hoses and air filter assembly and install T83T-9424-A over air intake opening.
4. Discharge air conditioning system if equipped. Refer to Section 12-03.
5. Remove front bumper, air deflector, and stone guard. Refer to Section 01-19.
6. Remove air deflector and grille. Refer to Section 01-08B.
7. Remove headlamp and side lamp assemblies and housing. Refer to Section 17-01.
8. Remove transmission oil cooler if separate cooler is used.
9. Remove grille support and lower grille panel. Refer to Section 01-08B.
10. Remove hood latch from upper radiator support and set aside with cable attached.
11. Remove radiator and fan shroud. Leave upper and lower radiator hoses attached to engine.
12. Disconnect air conditioning lines to condenser using A/C Spring Lock Coupling Disconnect Tool Set T84L-19623-B.
13. Remove air conditioning condenser.
14. Remove oil cooler lines and bracket.
15. Remove upper radiator support.
16. Remove fan and fan clutch and all belts.
17. Disconnect electrical connection, hoses and tubes from air conditioning compressor. Remove bracket with assembled compressor.
18. Disconnect power steering hoses at steering gear and remove bracket with assembled power steering pump.
19. Remove alternator adjusting bracket.
20. Remove upper and lower radiator hoses from engine.
21. Disconnect electrical connections to engine from main wiring harness and disconnect alternator electrical connections. Tag wires to aid in installation.
22. Remove transmission oil cooler line bracket from front of engine.
23. Remove ground cable from engine.
24. Disconnect vacuum pump hose from main junction.
25. Disconnect bleeder hose from heater hose and remove disconnect heater hoses from heater core.
26. Disconnect fuel hose from fuel pump. Remove fuel filter assembly.
27. Remove throttle cable bracket and dipstick tube bracket.
28. Remove inside engine cover.
29. Remove fuel return hose and transmission dipstick tube.

30. Remove three top transmission-to-engine bolts.
31. Raise vehicle.
32. Disconnect starter electrical and transmission electrical connections.
33. On vehicles with automatic transmission, remove flywheel housing cover and torque converter-to-flywheel nuts.
34. Remove four engine mount nuts.
35. Lower vehicle and support transmission with suitable transmission jack.
36. Attach Rotunda Floor Crane and Lifting Attachment 014-00071 or equivalent according to instructions with crane.
37. Remove remaining transmission-to-engine bolts.
38. Raise floor crane boom until the crane supports the weight of the front of the engine.
39. Adjust nut on floor crane turnbuckle until turnbuckle supports weight of rear of engine.
40. Remove engine, adjusting floor crane turnbuckle as necessary to tilt engine as removal requires.



Item	Part Number	Description
1	209646	Engine Lifting Attachment ³
2	304264	Left Bracket ³
3	6007	7.3L Engine Assembly
4	—	Rear Engine Lifting Eye
5	20900	Turnbuckle ³
6	304283	Adjusting Screw ³
7	12121	Adjusting Nut ³

41. Mount engine on repair stand and remove crane and lifting attachment.

³ Part of Rotunda 014-00312 6.9/7.3 Diesel Engine Lifting Bracket for Econoline.

REMOVAL AND INSTALLATION (Continued)**Installation**

CAUTION: If engine to be installed has been overhauled or has been in storage, take the following precaution to prevent piston and bearing scuffing. Prime entire engine lubricating system to fill oil cooler, oil filter and cylinder block galleries with the specified type and grade of oil.

1. Attach Rotunda Floor Crane and Lifting Attachment 014-00071 or equivalent to engine according to instructions with crane. Remove engine from repair stand.
2. On vehicles equipped with automatic transmission, raise the engine and position it into the vehicle aligning the transmission converter to the flex plate and the engine dowels to the transmission. Lower the engine to the chassis brackets, align the through-bolt holes on the engine supports and insert through-bolts.
On vehicles equipped with manual transmission, start the transmission pinion shaft into the clutch disc.
It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.
Align the housing on the engine and insert the housing-to-engine bolts. Alternately tighten bolts to specifications in Group 07.
3. On vehicles equipped with an automatic transmission, install converter housing-to-cylinder block bolts. Alternately tighten bolts to specifications in Group 07.
4. Remove floor crane lifting attachment and transmission jack.
5. Raise vehicle.
6. Install engine mount nuts and tighten to specification.
7. Connect starter and transmission electrical connections.
8. Install new gaskets and connect exhaust pipes to exhaust manifolds. Install sound shield bolts.
9. Lower vehicle.
10. Install transmission dipstick tube.
11. Install fuel return hose.
12. Install inside engine cover.
13. Install bracket for dipstick tube and throttle cable bracket.
14. Install fuel filter assembly and fuel hose to fuel pump.
15. Connect heater hoses to heater core. Install bleeder hose to heater hose.
16. Connect vacuum pump hose to main junction.
17. Install transmission oil line bracket to front of engine block.

18. Install alternator adjusting bracket.
19. Connect electrical connections to alternator and engine.
20. Install assembled power steering pump and bracket and connect power steering pump hoses to steering gear.
21. Install assembled air conditioning compressor and bracket. Connect manifold tubes and electrical connection to compressor.
22. Install fan and all belts and adjust according to Section 03-05.
23. Install oil filler tube.
24. Install upper radiator support.
25. Install air conditioning condenser and attach lines. Refer to Section 12-03B.
26. Install radiator and fan shroud.
27. Install hood latch and adjust. Refer to Section 01-08B.
28. Install lower grille panel and grille support. Refer to Section 01-08B.
29. Install transmission oil cooler.
30. Install headlamp housings, turn signal / parking lamp assemblies, and headlamp assemblies. Refer to Section 17-01.
31. Install grille and air deflector. Refer to Section 01-08B.
32. Install front bumper, air deflector and stone guard. Refer to Section 01-19.
33. Evacuate and charge air conditioning system. Refer to Section 12-03.
34. Fill cooling system. Fill with proper grade of engine oil. Start engine and bleed power steering system. Check for leaks and engine and accessories operation.

Engine Front Insulators**F-Series Vehicles****Removal and Installation**

1. Disconnect ground cables from both batteries.
2. Remove fan shroud attaching bolts and remove fan shroud.
3. Raise vehicle.
4. Remove nuts attaching insulators to crossmember.
5. Disconnect muffler inlet pipes at exhaust manifolds.
6. Remove bolts attaching insulators to engine block.
7. Lower vehicle.
8. Install Rotunda Universal Load Positioning Sling 014-00036 or equivalent to lifting eyes on engine and raise engine high enough for insulators to clear crossmember.

REMOVAL AND INSTALLATION (Continued)

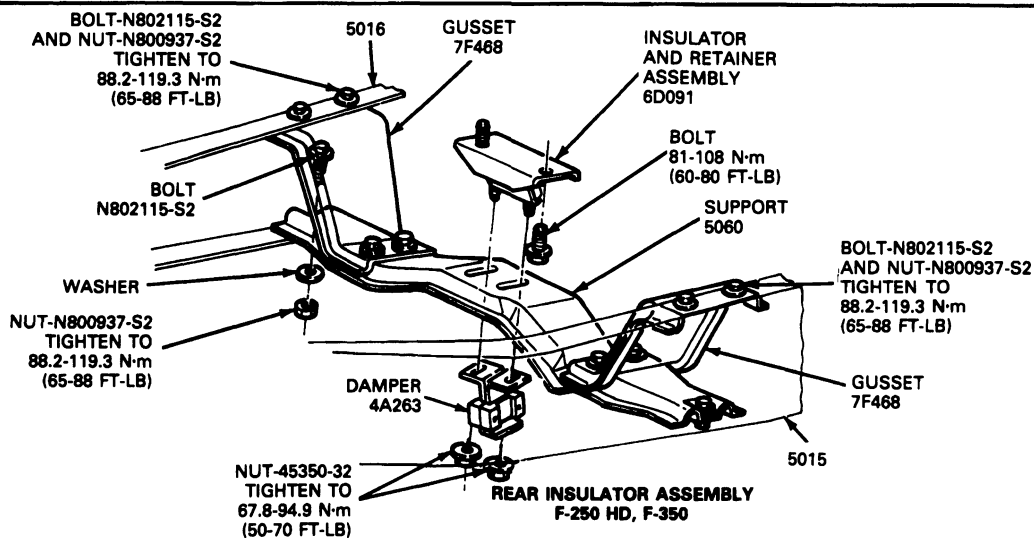
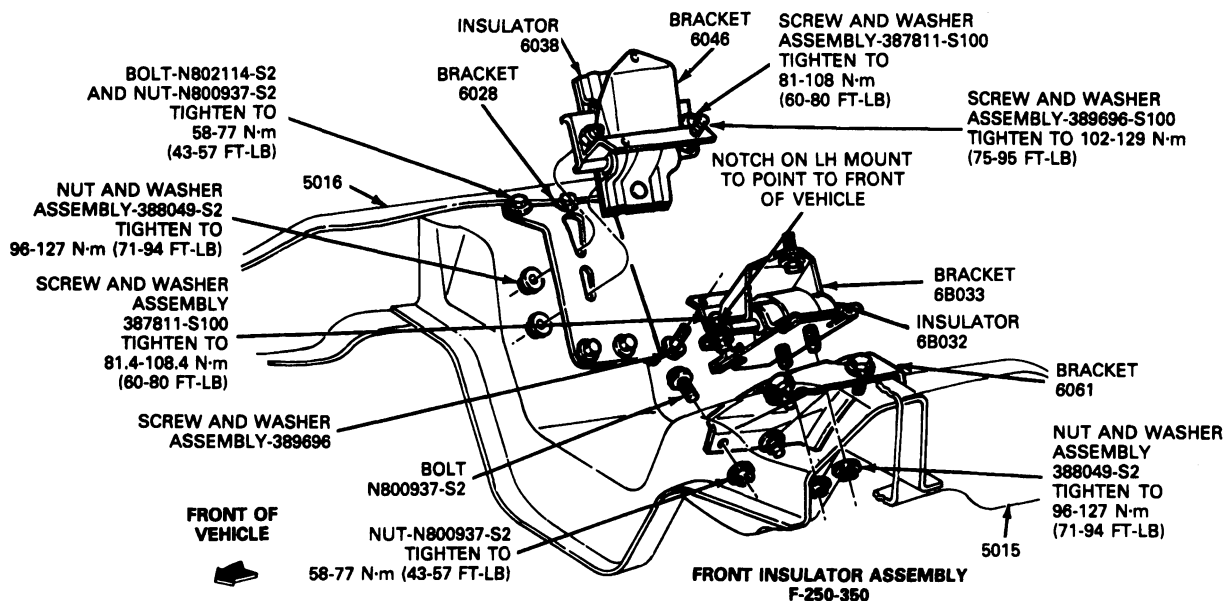
9. Remove insulator and bracket assemblies.

10. Remove insulator from bracket.

For installation, follow removal steps in reverse order. Tighten fan shroud bolts to 4-8 N·m (35-71 in·lb). Refer to illustration for insulator torque specifications.

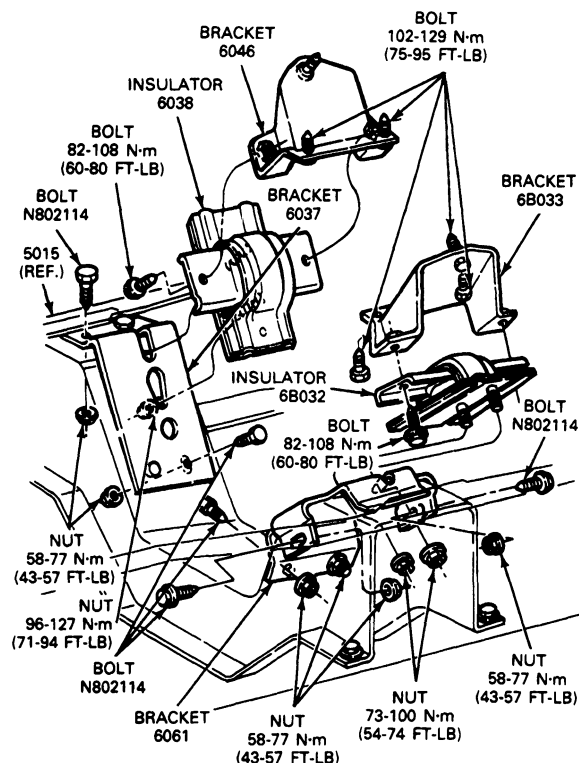
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

Engine Insulators, F-250-350



A7898-D

REMOVAL AND INSTALLATION (Continued)

Engine Insulators, F-Super Duty Commercial Chassis Vehicles

INSTALLATION - ENGINE MOUNTS FRONT

A11949-1A

E-250-350**Removal**

1. Disconnect battery ground cables from both batteries.
2. Remove the fan shroud attaching bolts and remove the shroud.
3. Loosen vacuum pump and remove vacuum pump drive belt.
4. Loosen alternator and remove alternator drive belt.
5. Disconnect alternator wiring harness from alternator.
6. Remove alternator adjusting bracket.
7. Remove alternator through-bolt and remove alternator from engine.
8. Remove fuel filter / fuel heater / water separator inlet line from fuel pump and fuel filter.
9. Discharge the air conditioning system, if so equipped. Remove air conditioner hoses. Remove air conditioner compressor and bracket, if so equipped. Refer to Section 12-03. Remove engine cover.
10. Remove air cleaner and install Intake Manifold Cover T83T-9424-A over air intake opening.

11. Remove and cap fuel filter / fuel heater / water separator to injection pump fuel line. Cap injection pump and fuel filter fittings.
12. Remove fuel filter / fuel heater / water separator return line hose.
13. Remove fuel filter / fuel heater / water separator bracket attaching bolts and remove filter and bracket as an assembly.
14. Remove kickdown rod from injection pump.
15. Raise vehicle.
16. Disconnect ground cables from lower front of engine.
17. Remove nuts attaching insulators to No. 1 crossmember.
18. Disconnect and remove transmission kickdown rod from transmission.
19. Lower vehicle.

NOTE: If engine has no lifting eye on right rear side, move left rear lifting eye to right side. Use a 3-inch bolt to attach eye to right side.

20. Install Rotunda Floor Crane 014-00071 and Lifting Brackets 014-00312 or equivalents to front of engine. Attach turn buckle to right rear lifting eye.
21. Raise engine until it contacts body.
22. Remove insulator and bracket assemblies.

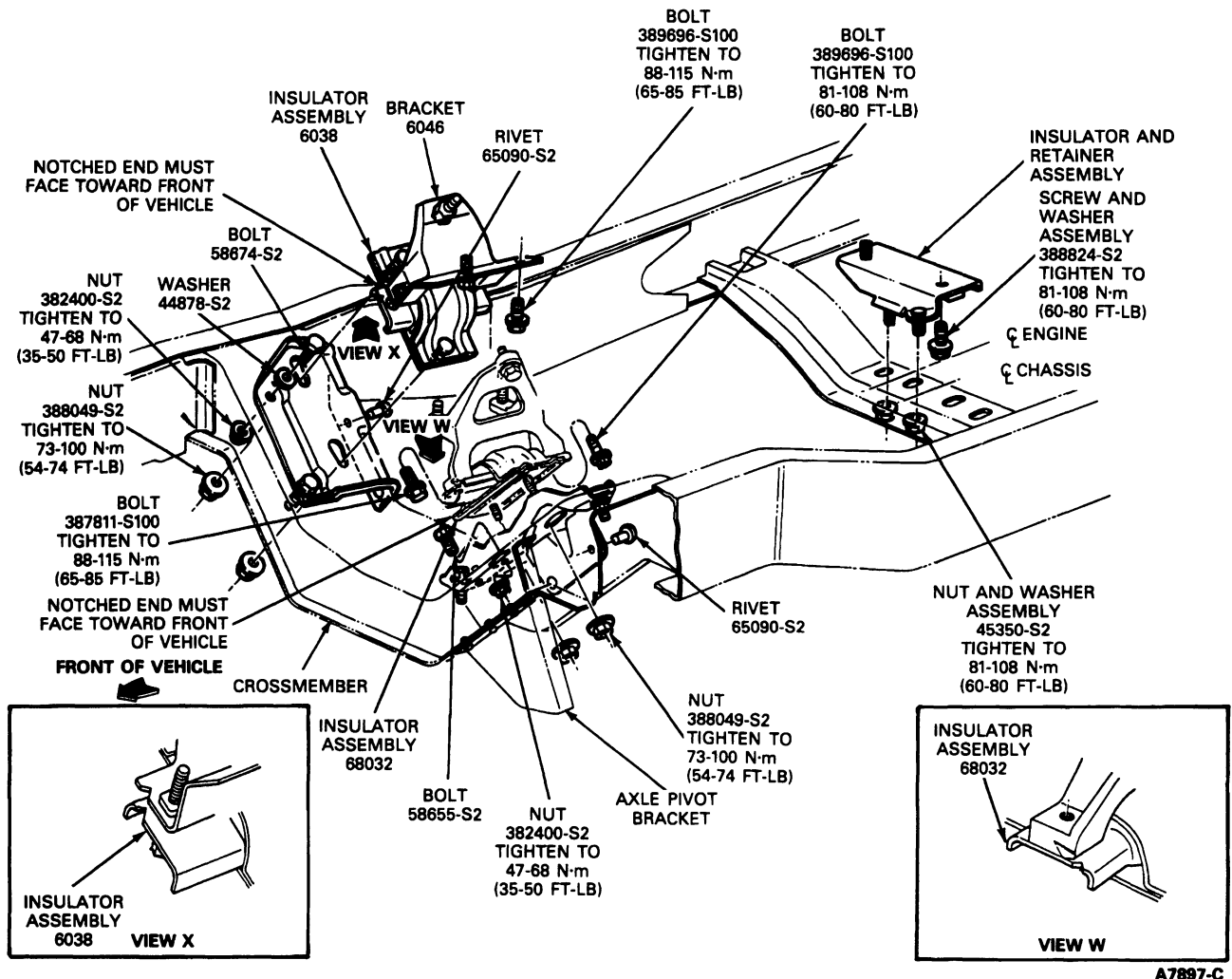
Installation

1. Install insulator to bracket and tighten to specifications.
2. Install insulator and bracket assembly onto engine and tighten to specifications.
3. Lower engine.
4. Remove turnbuckle from right rear lifting eye and remove lifting bracket from front of engine.
5. Transfer lifting eye from right side to left side if removed. Install original manifold bolts and tighten to specification.
6. Raise vehicle.
7. Install insulator to No. 1 crossmember with attaching nuts and tighten to specifications.
8. Install transmission kickdown rod and connect to transmission.
9. Install battery ground cables and tighten to specification.
10. Lower vehicle.
11. Install fuel filter / fuel heater / water separator and bracket assembly and tighten to 33-52 N-m (24-39 ft-lb).
12. Uncap and install fuel filter / fuel heater / water separator to injection pump fuel line.
13. Install fuel filter / fuel heater / water separator return hose and clamp.
14. Remove intake opening cover. Install air cleaner.

REMOVAL AND INSTALLATION (Continued)

15. Install air conditioner compressor and bracket, if so equipped, and tighten to 40-55 N·m (30-41 ft·lb). Install air conditioner hoses. Install air conditioner compressor drive belt. Refer to Section 12-03.
 16. Install fuel pump to fuel filter / fuel heater / water separator line and tighten to specification.
 17. Install alternator and alternator adjusting bracket.
 18. Install alternator drive belt.
 19. Install alternator wiring onto alternator.
 20. Install vacuum pump drive belt on alternator pulley.
 21. Adjust air conditioner compressor, alternator, and vacuum pump drive belts to specification. Refer to Section 03-05.
 22. Install fan and clutch assembly and tighten to 54-163 N·m (40-120 ft·lb) using Fan Clutch Holding Tool T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalents.
 23. Install fan shroud. Tighten bolts to 4-8 N·m (35-71 in·lb).
 24. Evacuate and charge air conditioning system, if so equipped. Refer to Section 12-03.
 25. Connect battery ground cables to both batteries.
- NOTE:** On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
26. Install engine cover.

CAUTION: Left-hand thread. Install by turning nut counter-clockwise.

Engine Insulators, E-250-350

REMOVAL AND INSTALLATION (Continued)

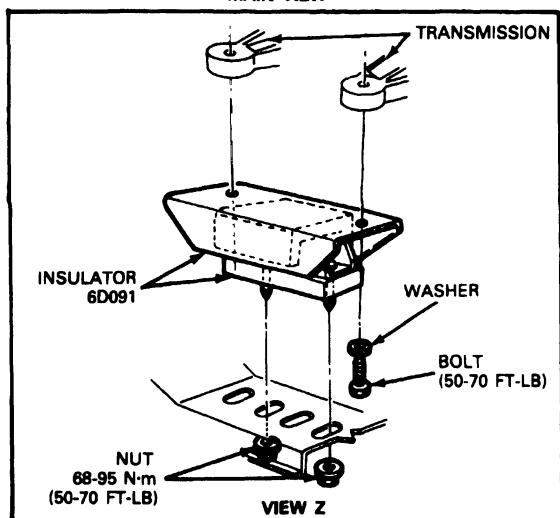
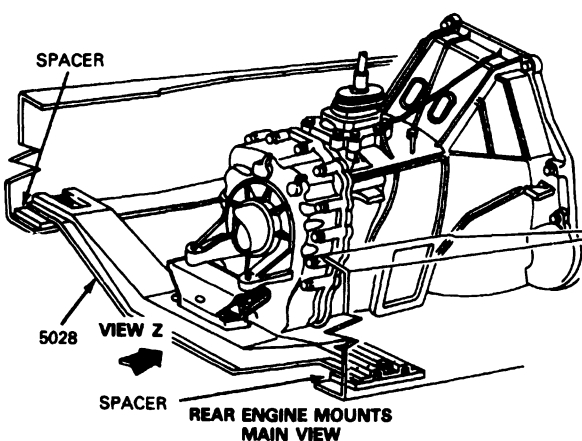
Engine Rear Insulator

Removal and Installation

1. Remove the insulator-to-support assembly bolt and locknut.
2. Remove the insulator-to-transmission housing bolts and lockwashers.
3. Raise the transmission with a floor jack and remove the insulator and retainer.

For installation, follow removal steps in reverse order. Tighten fasteners to specifications shown in illustration.

Engine Insulators, F-Series Motorhome and Commercial Chassis with 7.3L Diesel



A11950-1C

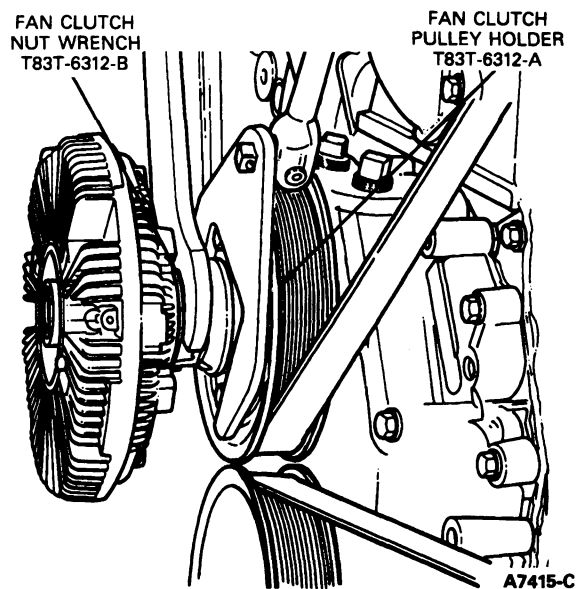
Water Pump

Removal

1. Disconnect battery ground cables from both batteries.
2. Drain cooling system.

3. Remove radiator fan shroud.
 4. Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.
- CAUTION: Left-hand thread: Remove by turning nut clockwise.**
5. Loosen power steering pump and air conditioner compressor. Remove drive belts.
 6. Loosen vacuum pump and remove drive belt.
 7. Loosen alternator and remove drive belt.
 8. Remove water pump pulley.
 9. Disconnect heater hose from water pump.
 10. Remove heater hose fitting from water pump.
 11. Remove alternator adjusting arm and adjusting arm bracket.
 12. Remove air conditioner compressor and position out of the way.
 13. Remove air conditioner compressor brackets.
 14. Remove power steering pump and bracket and position out of the way.
 15. Remove bolts attaching water pump to front cover and remove pump.

Removing Fan and Clutch Assembly



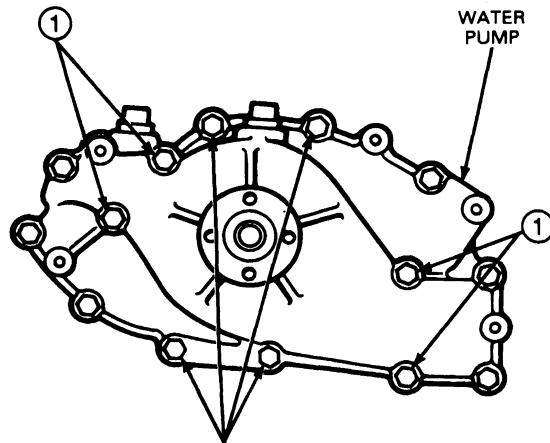
Installation

1. Clean water pump and engine front cover mating surfaces with suitable solvent. Clean bolt threads.

NOTE: Coat two top bolts and two bottom bolts with Aviation Permatex™ No. 3 or equivalent before installation. Install bolts within five minutes of sealer application. Make sure that correct length bolts are installed in correct holes.

REMOVAL AND INSTALLATION (Continued)

Water Pump



APPLY AVIATION PERMATEX™
NO. 3 OR EQUIVALENT
TO THESE BOLTS

① THESE BOLTS ARE 2 3/4-INCHES LONG.
ALL OTHERS ARE 1 1/2 INCHES LONG.

A7353-F

2. Install water pump with new gasket and tighten to 19 N·m (14 ft-lb).
 3. Install alternator adjusting arm bracket and tighten to 54-75 N·m (40-55 ft-lb).
 4. Install water pump pulley and tighten to standard torque specifications, see chart at end of this section.
 5. Coat heater hose fitting with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent and install in water pump. Tighten to 17-24 N·m (13-18 ft-lb).
 6. Connect heater hose to water pump and tighten clamp to specifications.
 7. Install power steering pump bracket and tighten to 54-68 N·m (40-50 ft-lb).
 8. Install power steering pump and drive belt.
 9. Install air conditioner compressor bracket and tighten attaching bolts to 40-55 N·m (30-41 ft-lb).
 10. Install air conditioner compressor and drive belt.
 11. Install alternator adjusting arm and alternator drive belt.
 12. Install vacuum pump drive belt.
 13. Adjust accessory drive belts to specification. Refer to Section 03-05.
 14. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B and tighten to 54-163 N·m (40-120 ft-lb).
- CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.**
15. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in-lb).
 16. Fill and bleed cooling system. Refer to Section 03-03.

17. Connect ground cables to both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

18. Run engine and check for coolant leaks.

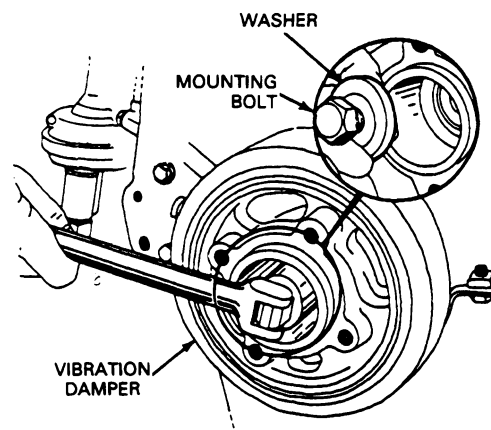
Crankshaft Vibration Damper

Removal

1. Disconnect ground cables from both batteries.
2. Remove radiator fan shroud.
3. Remove fan and clutch assembly as outlined using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B or equivalent.

CAUTION: Left-hand thread. Remove by turning nut clockwise.

4. Loosen and remove air conditioner compressor drive belt.
 5. Loosen and remove power steering pump drive belt.
 6. Loosen and remove alternator and vacuum pump drive belts.
 7. Raise vehicle.
 8. Remove crankshaft pulley.
 9. Remove bolt attaching damper to crankshaft.
- NOTE:** To prevent crankshaft rotation, use breaker bar for in vehicle removal or Flywheel Holding Tool T74P-6375-A for bench overhaul.
10. Install Crank / Cam Gear and Damper Remover T83T-6316-A and remove crankshaft damper.



A10727-1A

Installation

NOTE: A new front crankshaft seal should be installed whenever the crankshaft damper is removed.

REMOVAL AND INSTALLATION (Continued)

1. Lubricate the damper seal nose with clean engine oil, and install using Crank / Cam Gear and Damper Replacer T83T-6316-B.

NOTE: Add Silicone Rubber Sealant D6AZ-19562-AA or -BA (ESB-M4G92-A) or equivalent to engine side of washer (in area of keyway only) to prevent oil leakage past keyway.

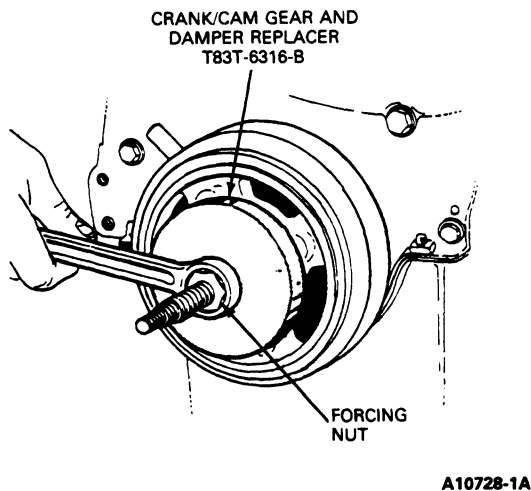
2. Install bolt attaching damper to crankshaft and tighten to 122 N·m (90 ft-lb).
3. Install crankshaft pulley and tighten to standard torque specifications, see chart at end of section.
4. Lower vehicle.
5. Install alternator, vacuum pump, power steering pump, and air conditioner compressor drive belts. Adjust to specification. Refer to Section 03-05.
6. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.

CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.

Tighten nut to 54-163 N·m (40-120 ft-lb).

7. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in-lb).
8. Connect ground cables to both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.



Front Crankshaft Oil Seal, In-Vehicle Replacement

NOTE: This procedure is for replacing front crankshaft oil seal without removing the front engine cover.

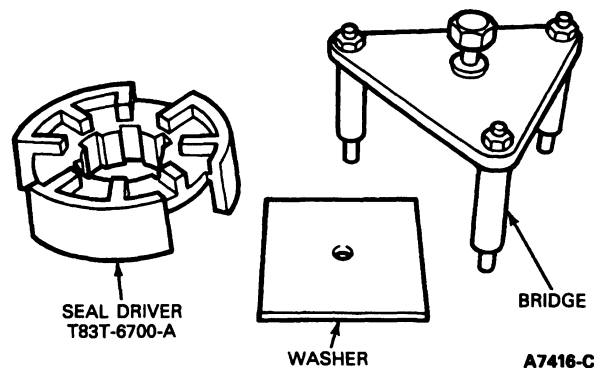
Removal

1. Disconnect battery ground cables from both batteries.
2. Remove radiator fan shroud.
3. Remove fan and clutch assembly as outlined.
CAUTION: Left-hand thread. Remove by turning nut clockwise.
4. Loosen and remove air conditioner compressor drive belt.
5. Loosen and remove power steering pump drive belt.
6. Loosen and remove alternator and vacuum pump drive belts.
7. Raise vehicle.
8. Remove crankshaft pulley.
9. Remove bolt attaching damper to crankshaft.
10. Install Crank / Cam Gear and Damper Remover T83T-6316-A and remove crankshaft vibration damper. To prevent crankshaft rotation install breaker bar into removal tool.
11. Pry out front oil seal from the front cover using a screwdriver.

CAUTION: Use care to prevent damage to the front cover or crankshaft. Bending front cover will break oil pan seal.

Installation

1. Coat new oil seal with Multi-Purpose grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent.
NOTE: It may be necessary to rotate crankshaft to align the damper key with seal installing tool.



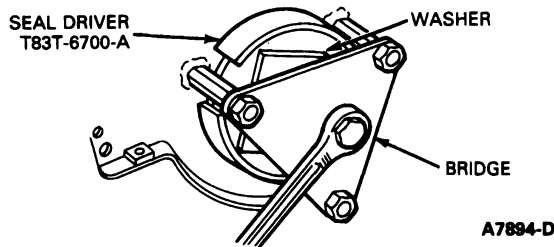
2. For engines without three weldnuts on front cover, place seal into Front Crank Seal Replacer T83T-6700-A and install over end of crankshaft. Install Crank / Cam Gear and Damper Replacer T83T-6316-B and tighten nut against washer and installation tool to force seal into front cover plate.

CAUTION: Use care to prevent bending front cover and breaking oil pan seal during oil seal installation.

REMOVAL AND INSTALLATION (Continued)

3. For engines with three weldnuts on front cover, place seal into seal driver, install over end of crankshaft, place washer on seal driver and attach bridge to weldnuts. Draw seal into front cover by rotating center screw clockwise.

NOTE: Seal is automatically installed at the proper depth when the tool bottoms on the front cover.



4. Clean grease from outside surfaces and apply a 3.2mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent around the outside diameter of the front seal and the edge of the front cover.

NOTE: When applying RTV rubber silicone sealant, always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to set-up and its sealing effectiveness may be reduced.

5. Lubricate the damper seal nose with clean engine oil and install crankshaft vibration damper using Crank / Cam Gear and Damper Replacer T83T-6316-B.
6. Add Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent to engine side of washer (in area of keyway only), to prevent oil leakage past keyway. Install bolt attaching vibration damper to crankshaft and tighten to specification.
7. Install crankshaft pulley and tighten to specification.
8. Lower vehicle.
9. Install alternator, vacuum pump, power steering pump, and air conditioner compressor drive belts. Adjust to specification. Refer to Section 03-05.
10. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B. Tighten nut to 54-163 N·m (40-120 ft·lb).

CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.

11. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in·lb).
12. Connect ground cables to both batteries.

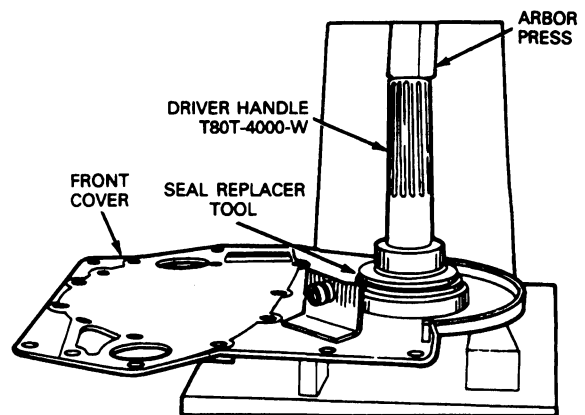
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

Engine Front Cover and Crankshaft Oil Seal

NOTE: Whenever the engine front cover is removed, the crankshaft front seal must also be replaced.

Removal

1. Disconnect ground cables from both batteries.
2. Drain cooling system.
3. Remove air cleaner and install intake air opening cap Intake Manifold Cover T83T-9424-A.
4. Remove water pump, as outlined in this section.
5. Remove injection pump, as outlined in this section.
6. Remove injection pump adapter, as outlined in this section.
7. Raise vehicle.
8. Remove crankshaft pulley and vibration damper, as outlined in this section.
9. Remove ground cables at front of engine.
10. Remove five bolts attaching front cover to engine block and oil pan.
11. Lower vehicle.
12. Remove bolts attaching engine front cover to engine block, and remove front cover.
13. Support engine front cover, and using an arbor press, Drive Handle T80T-4000-W and an 82.55mm (3-1/4-inch) diameter spacer, drive crankshaft seal out of front cover.

**Installation**

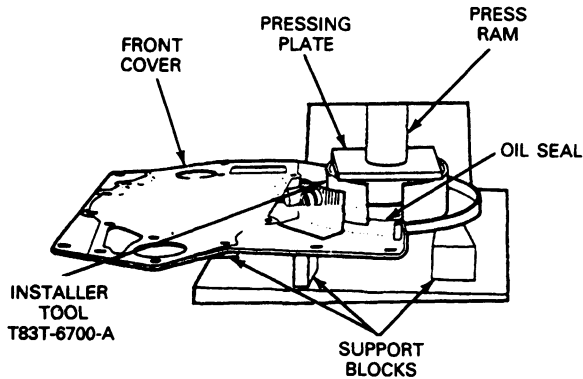
1. Remove old gasket material and clean engine block, engine front cover, and oil pan sealing surfaces with a suitable solvent and dry thoroughly.
2. Clean water pump sealing surface.
3. Coat new front crankshaft oil seal with Multi-Purpose Grease DOAZ-19584-AA (ESR-M1C159-A) or equivalent.

REMOVAL AND INSTALLATION (Continued)

4. Install new oil seal using Front Crank Seal Replacer T83T-6700-A, a suitable spacer, and an arbor press.

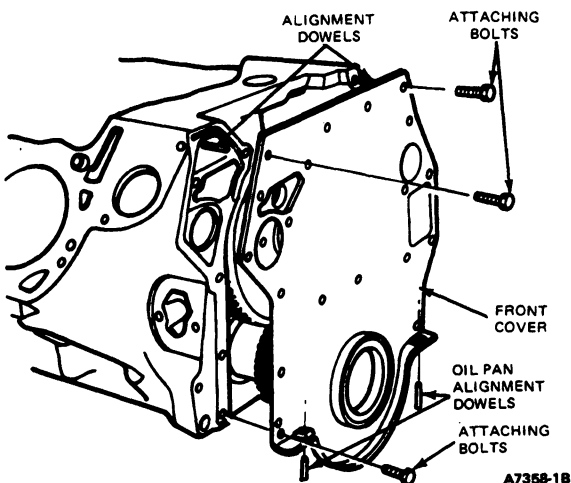
CAUTION: Support engine front cover.

Bottom out tool on front cover surface. Seal is automatically installed at proper depth.



A10729-1A

5. Clean outside surfaces of the front cover to remove any grease and apply a 3.2mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent around the outside diameter of the front seal and the edge of the front cover.
6. For in-vehicle repair, install fabricated alignment dowels on engine block and oil pan to align front cover and gaskets. For overhaul repair, install fabricated alignment dowels as shown.



A7358-1B

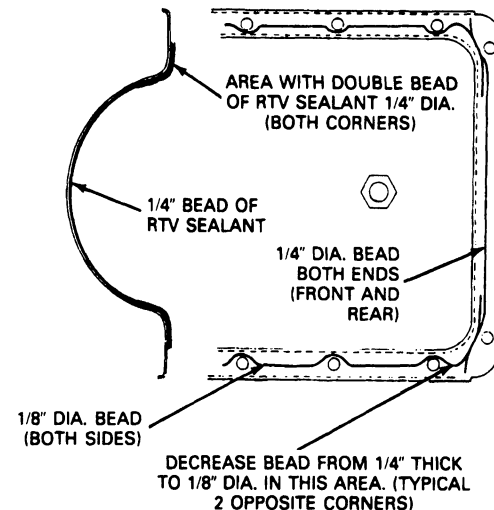
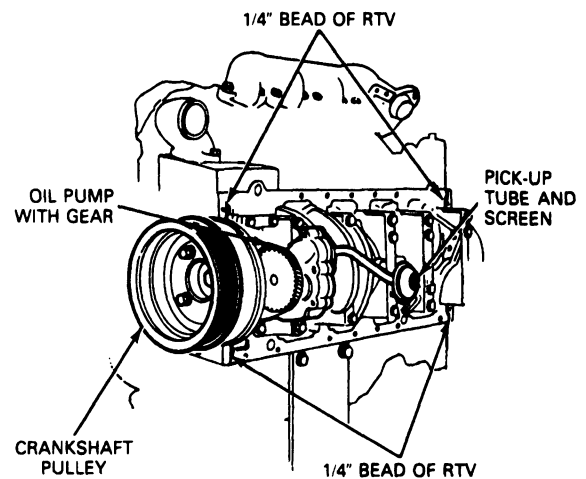
7. Apply Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent on engine block and front cover sealing surfaces.

8. Install gaskets on engine block.

NOTE: Silicone Rubber Sealant should be applied immediately prior to front cover installation. When applying Silicone Rubber Sealant, always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to set-up and sealing effectiveness may be reduced.

9. Apply a 3.2mm (1/8-inch) bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A) or equivalent to rear corners of oil pan and apply a 6.4mm (1/4-inch) bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A) or equivalent on oil pan as shown, for in-vehicle repair.

Front Cover RTV Sealant



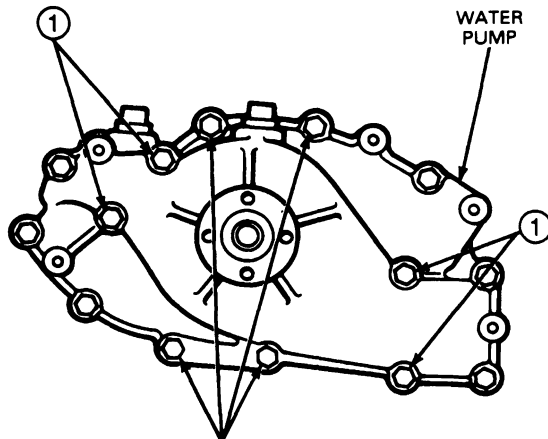
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10. Install engine front cover in position, on oil pan dowels first, and install three attaching bolts as shown previously.
11. For in-vehicle repair, remove engine front cover alignment dowels from engine and oil pan. Install and hand-tighten remaining front cover bolts.

REMOVAL AND INSTALLATION (Continued)

12. Install fabricated alignment dowels in engine block, if necessary.
13. Install water pump gasket on engine front cover alignment dowels.
14. Install water pump and hand tighten bolts.

NOTE: Apply Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent to four bolts as shown.

Water Pump

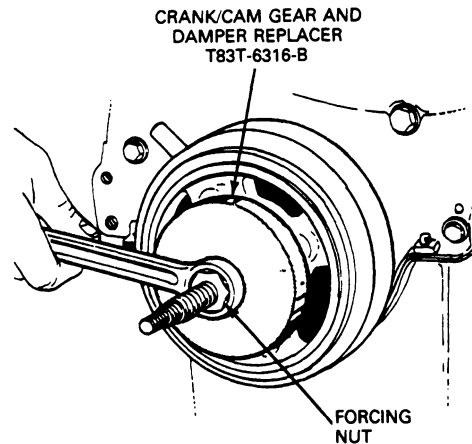
APPLY AVIATION PERMATEX™ NO. 3 OR EQUIVALENT TO THESE BOLTS

- ① THESE BOLTS ARE 2 3/4-INCHES LONG. ALL OTHERS ARE 1 1/2 INCHES LONG.

A7353-F

15. Remove alignment dowels and install two remaining attaching bolts.
Tighten all water pump bolts to 19 N·m (14 ft-lb).
16. Tighten engine front cover bolts to standard torque specifications, see chart at end of this section.
17. Install injection pump adapter, as outlined in this section.
18. Install injection pump, as outlined in this section.
19. Install heater hose fitting in pump using Pipe Sealant With Teflon® D8AZ-19554-A (ESG-M4G194-A) or equivalent.
20. Connect heater hose to water pump and tighten clamp to specification.
21. Raise vehicle.
22. Lubricate damper seal nose with clean engine oil and install crankshaft vibration damper, using Crank/Cam Gear and Damper Replacer T83T-6316-B.

NOTE: Add Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) to engine side of retaining bolt washer to prevent oil leakage past keyway.



A10728-1A

23. Install vibration damper-to-crankshaft attaching bolt and tighten to 122 N·m (90 ft-lb).
24. Install crankshaft pulley and tighten to standard torque specifications, see chart at end of this section.
25. Install both battery ground cables on front of engine.
26. Lower vehicle.
27. Install alternator adjusting arm bracket and tighten to 54-75 N·m (40-55 ft-lb).
28. Install water pump pulley and tighten to standard torque specification, see chart at end of this section.
29. Install power steering pump bracket and tighten to 54-68 N·m (40-50 ft-lb).
30. Install power steering pump and drive belt.
31. Install air conditioner compressor bracket and tighten to 40-55 N·m (30-41 ft-lb).
32. Install air conditioner compressor and drive belt.
33. Install alternator adjusting arm and install alternator and vacuum pump drive belts.
34. Adjust alternator, vacuum pump, power steering pump and air conditioner compressor drive belts to specification. Refer to Section 03-05.
35. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B. Tighten to 54-163 N·m (40-120 ft-lb).
36. Install radiator fan shroud. Tighten bolts to 4-8 N·m (35-71 in-lb).
37. Remove intake manifold cover. Install air cleaner. Refer to Section 03-12.
38. Connect ground cables to both batteries.
39. Fill and bleed cooling system. Refer to Section 03-03.
40. Operate engine and inspect for coolant and oil leaks.

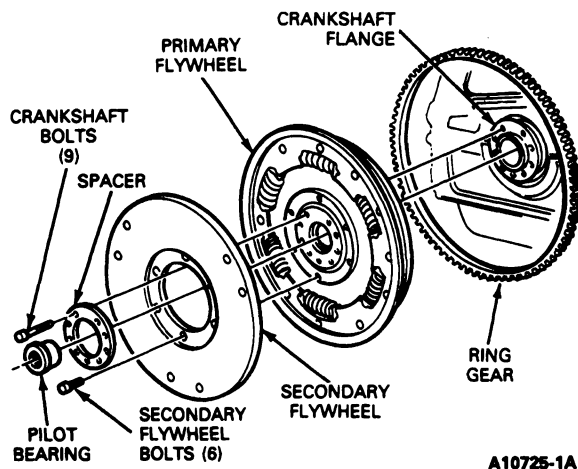
REMOVAL AND INSTALLATION (Continued)

Flywheel, Engine Rear Cover and Oil Seal

Removal

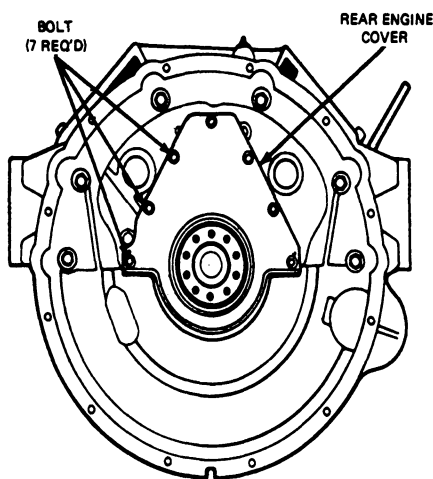
1. Remove transmission and integral clutch housing (manual transmission). Remove clutch and clutch housing, if so equipped. Refer to Group 07 or Group 08, in Body / Chassis / Electrical Manual.
2. Remove nine flywheel mounting bolts and spacer and remove flywheel.

Dual Mass Flywheel



A10725-1A

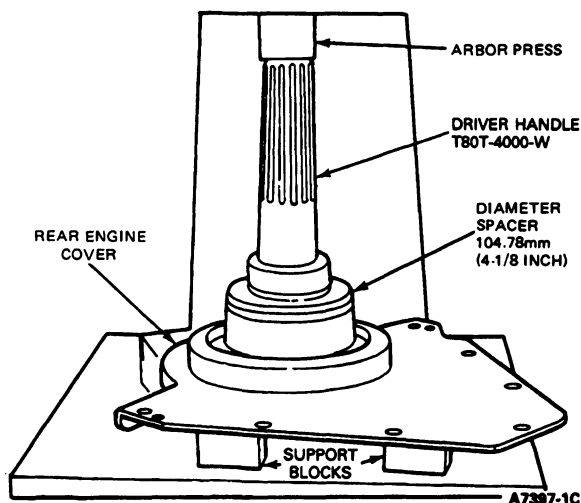
3. Remove bolts attaching rear engine cover to engine block and remove rear cover.



A7885-1A

4. Using an arbor press and a suitable spacer 104.78mm (4-1/8-inch) diameter, remove rear oil seal.

NOTE: Support rear cover.



A7387-1C

NOTE: If rear cover seal fails repeatedly, check rear cover bore concentricity as follows:

- Install rear cover to engine with oil seal removed.
- Mount a dial indicator (on swivel joint) onto the crankshaft flange. Position the dial indicator press against the inside diameter of the rear cover seal bore.
- Measure at four equally spaced locations.
- Rear cover seal bore will be connected to the crankshaft centerline in accordance with specifications.
- Replace rear cover if not within 0.05mm (0.020 inch).

Installation

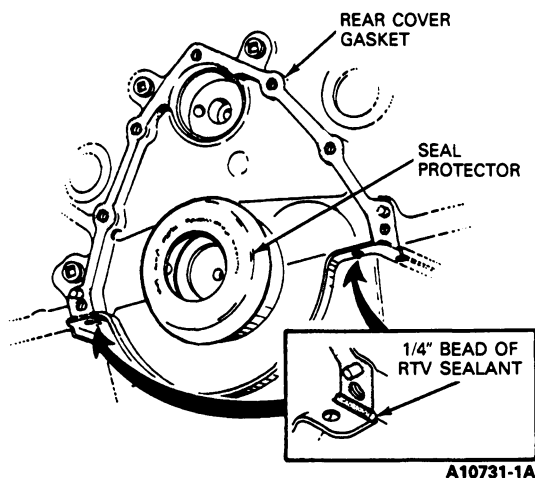
1. Clean rear cover and engine block gasket surfaces.
2. Remove old RTV sealant from oil pan to rear cover sealing surface on oil pan. Clean sealing surfaces with a suitable solvent, and dry thoroughly.
3. Coat rear engine cover seal bore inside diameter with Gasket and Trim Adhesive D7AZ-19B508-AA (ESR-M11P17-A) or equivalent. Using an arbor press and Rear Crankshaft Seal Replacer T83T-6701-A install new rear main oil seal.

NOTE: Seal must be installed from the engine block side of rear cover flush with seal bore inner surface.

4. Apply a 3.2mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent around the outside diameter of the rear seal and the edge of the rear cover.
5. Install Rear Crankshaft Seal Pilot T83T-6701-B onto crankshaft.

REMOVAL AND INSTALLATION (Continued)

6. Apply Gasket and Trim Adhesive D7AZ-19B508-AA (ESR-M11P17-A) or equivalent to engine block and rear cover gasket surfaces.
7. Install rear cover gasket to engine block.



8. For in-vehicle repair, apply a 6.35mm (1/4-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent at the corners of the oil pan and on oil pan sealing surface.

NOTE: When applying Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to set-up and sealing effectiveness may be reduced.

9. Push rear cover into position on engine block and install attaching bolts. Remove Seal Pilot T83T-6701-B. Tighten all bolts to standard torque specification, see chart at the end of this section.

NOTE: The dual mass flywheel may create an objectionable noise or vibration. This may occur because of loose flywheel bolts. Install new flywheel bolts with pre-applied adhesive (E7TZ-6379-B) to prevent the bolts from loosening. When installing these bolts for the first time, do not apply additional adhesive to the threads. Each time this new bolt or previous bolt (without pre-applied adhesive) is removed to service the flywheel, clean the bolt threads and apply Threadlock 262 (E2-19954-B) to the threads.

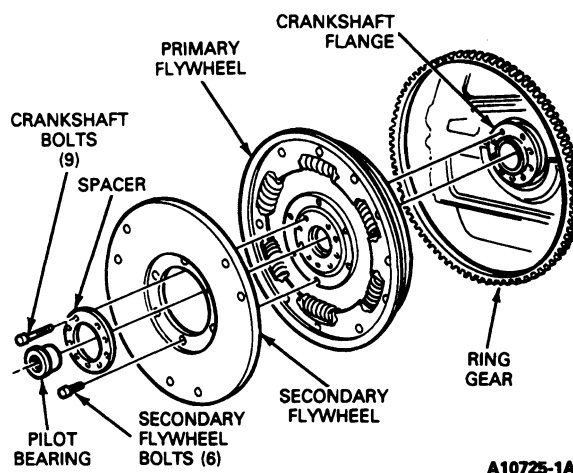
10. Position flywheel on crankshaft flange. Coat threads of flywheel attaching bolts with Perfect Seal Sealing Compound B5A-19554-A (ESE-M4G115-A) or equivalent and install spacer, bolts and washers (with flexplate, if so equipped). Tighten bolts to 64 N·m (47 ft·lb), alternating across from each other.
11. Install clutch, if so equipped. Refer to Group 08, in Body / Chassis / Electrical Manual.
12. Install transmission. Refer to Group 07 or Group 08 in Body / Chassis / Electrical Manual.
13. Run engine and check for oil leaks.

Secondary Flywheel

Removal

NOTE: The secondary flywheel inertia mass contains the clutch friction surface. Excessive clutch slipping can result in warpage or other surface distress which requires refacing or replacement of the secondary flywheel. Refer to Cleaning and Inspection in this section. The back side of the secondary flywheel contains a friction surface which is used in the internal torque limitation system of the dual mass flywheel assembly.

1. Remove the transmission, clutch pressure plate, and disc as outlined in Group 08 of the Body / Chassis / Electrical Manual.
2. Remove six bolts retaining the secondary flywheel to the primary flywheel assembly. Do not permit the flywheel to fall from the vehicle.
3. Using a screwdriver or other suitable tool, pry the secondary flywheel off of its mounting pilot. Do not drop.



Installation

1. Clean the clutch friction surface and torque limitation friction surface with a suitable commercial alcohol-based solvent to be sure that surfaces are free from any oil film.
2. Position secondary flywheel onto its mounting pilot on the primary flywheel assembly and align the six secondary flywheel attaching bolt holes with the six threaded holes of the primary flywheel assembly.
3. Coat threads of secondary flywheel attaching bolts with Ford Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A) or equivalent and install bolts. Tighten bolts to specification, alternating across from each other.
4. Install the clutch pressure plate, disc, and transmission as outlined in Group 08 of the Body / Chassis / Electrical Manual.

REMOVAL AND INSTALLATION (Continued)

Flywheel Ring Gear

Removal

1. Remove transmission. Remove the clutch housing. Refer to Group 07 and Group 08 in the Body / Chassis / Electrical Manual.
2. Remove flywheel as outlined.
3. To replace a damaged or worn ring gear, heat the ring gear with a blow torch on the engine side of the gear, and knock it off the flywheel. **Do not hit the flywheel when removing the ring gear.**

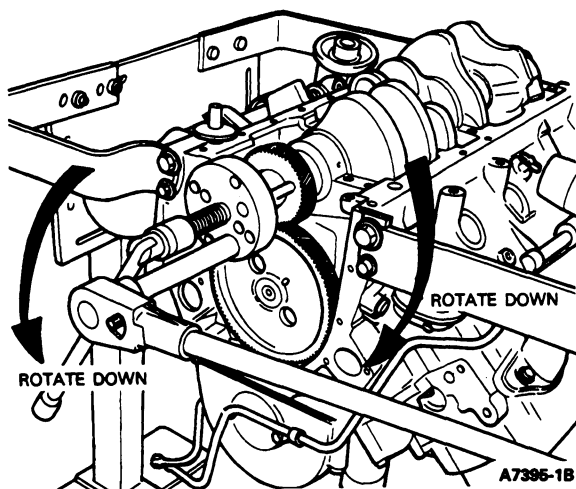
Installation

1. Heat the new ring gear evenly until the gear expands enough to slip onto the flywheel. Make sure the gear is seated properly against the shoulder. **Do not heat any portion of the gear to a temperature higher than 278°C (500°F). If this limit is exceeded, the hardness will be removed from the ring gear teeth.**
2. Install flywheel as outlined.
3. Install clutch housing and transmission. Refer to Group 08 in the Body / Chassis / Electrical Manual.

Crankshaft Drive Gear

Removal

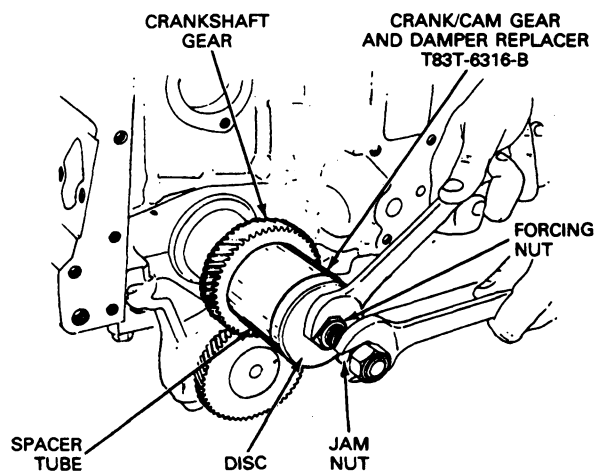
1. Remove engine front cover, as outlined in this section.
2. Install Crank / Cam Gear and Damper Remover T83T-6316-A and using a breaker bar (in-vehicle procedure) to prevent crankshaft rotation or Flywheel Holding Tool T74P-6375-A (bench procedure) or equivalent, remove crankshaft gear.



Installation

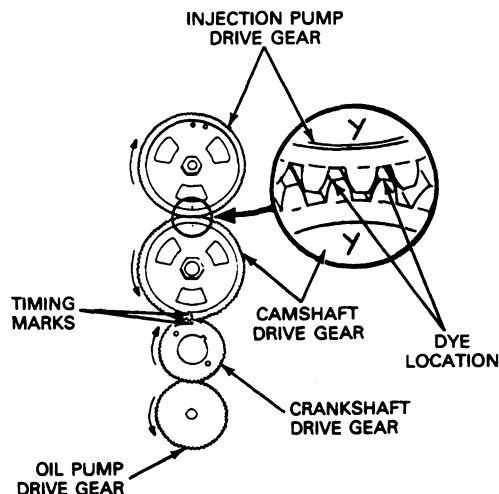
1. Install crankshaft gear using Crank / Cam Gear and Damper Replacer T83T-6316-B aligning crankshaft drive gear timing mark with crankshaft drive gear timing mark.

NOTE: Gear may be heated to 149-177°C (300-350°F) for ease of installation. Heat in oven. Do not use torch.



A10732-1A

Aligning Timing Marks



A10733-1A

2. Install engine front cover as outlined in this section.

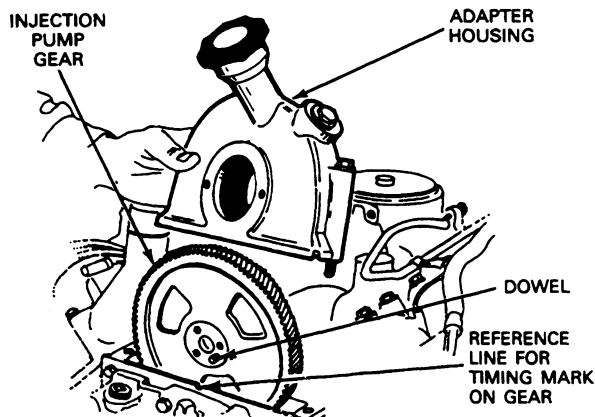
Injection Pump Drive Gear and Gear Cover

Removal

1. Disconnect ground cables from both batteries.
2. Remove engine cover (Econoline only).
3. Remove air cleaner and install intake opening cover, Intake Manifold Cover T83T-9424-A.

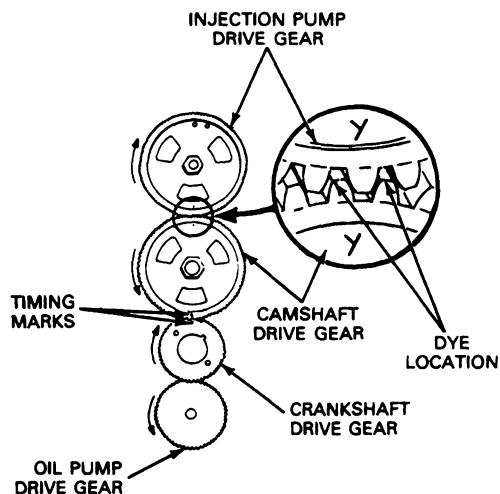
REMOVAL AND INSTALLATION (Continued)

4. Remove injection pump as described in this section.
 5. Remove bolts attaching injection pump drive gear cover to engine block, and remove cover.
- NOTE: Do not remove drive gear yet.

Drive Gear Cover

A10734-1A

6. Remove glow plugs with Glow Plug Socket D83T-6002-A or equivalent to facilitate turning engine over by hand.
 7. Turn engine over by hand to TDC (top dead center), compression stroke of No. 1 piston.
- NOTE: To determine that No. 1 piston is at TDC (compression stroke), position injection pump drive gear dowel at the four o'clock position. The scribe line in vibration damper should be at TDC.
- NOTE: To aid aligning the timing marks, the pump drive gear and the camshaft gear are marked with "Y" timing marks. The crankshaft and camshaft gears are marked with "o" (dot) alignment marks. With engine at TDC compression for No. 1 cylinder, the "Y" marks should be aligned.



A10733-1A

CAUTION: Do not remove injection pump gear without performing the following procedure.

8. Slide injection pump gear back (do not remove) to expose top of camshaft gear when looking down into the front cover. In addition to the "Y", the gear teeth adjacent to the "Y" on the camshaft gear are permanently dyed.
9. Remove injection pump drive gear.

Installation

1. Clean all gasket and sealing surfaces with a suitable solvent and dry thoroughly.
- NOTE: To determine that No. 1 piston is at TDC of compression stroke, position injection pump drive gear dowel at the four o'clock position. The scribe line in vibration damper should be at TDC.
2. With drawn line on drive gear at six o'clock position, install gear and align all drive gear timing marks.

CAUTION: Use extreme care to avoid disturbing injection pump drive gear, once it is in position.

3. Apply a 3.16mm (1/8 inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent along bottom surface of injection pump drive gear cover.
- NOTE: When applying Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent always use the bead size specified and join the components within 15 minutes of application. After 15 minutes, sealant begins to set-up and sealing effectiveness may be reduced.
4. Install injection pump drive gear cover and tighten retaining bolts to 19 N·m (14 ft-lb). Apply Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent to bolt threads before assembly.

NOTE: With injection pump drive gear cover installed, the injection pump drive gear cannot "jump" timing.

5. Remove intake manifold cover. Install air cleaner, refer to Section 03-12.
 6. Install ground cables to both batteries.
- NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
7. Run engine and check for oil, fuel and coolant leaks.

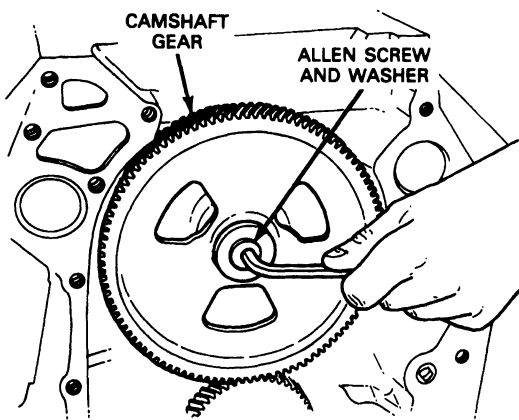
WARNING: KEEP EYES AND HANDS AWAY FROM NOZZLE SPRAY. FUEL SPRAYING FROM THE NOZZLE UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.

REMOVAL AND INSTALLATION (Continued)

8. If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.
9. Install engine cover (E-250-350 only).

Camshaft Drive Gear, Fuel Pump Cam, Spacer and Thrust Plate**Removal**

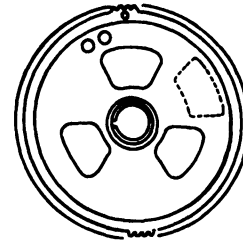
1. Remove engine front cover, as outlined in this section.
2. Remove camshaft Allen screw and washer.



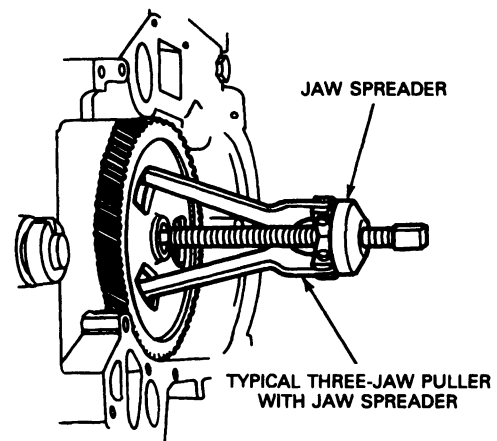
A10896-B

3. Install three-jaw gear puller and remove gear.

**USE THREE-JAW PRESSURE
SCREW PULLER (WITH
JAW SPREADER) TO
REMOVE THIS GEAR**

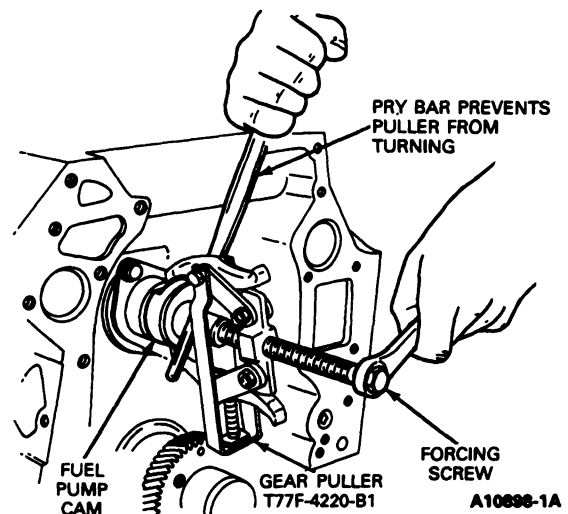


**NEW CAM GEAR WITH
COUNTERWEIGHT LUG
AND GEAR PULLER HOLES
REMOVED**



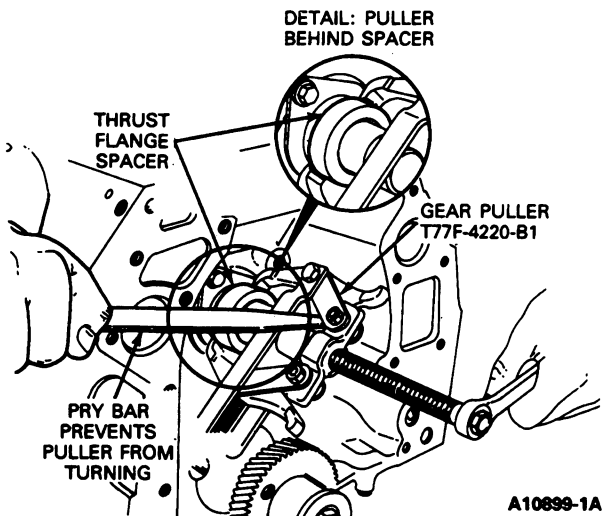
A16242-A

4. If necessary, remove fuel supply pump as outlined in this section.
5. Install Gear Puller T77F-4220-B1 and remove fuel pump cam and thrust flange spacer, if necessary.



A10896-1A

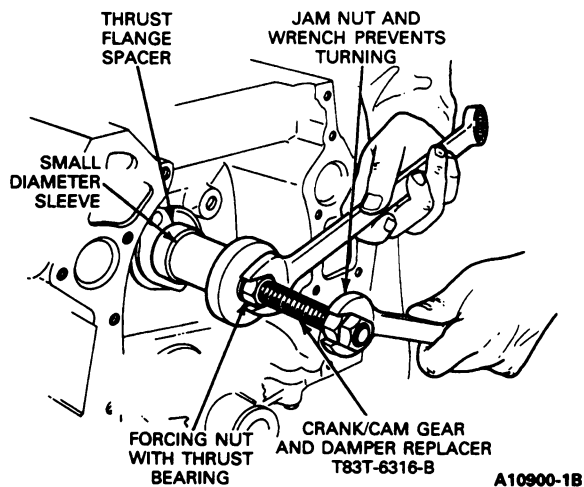
REMOVAL AND INSTALLATION (Continued)



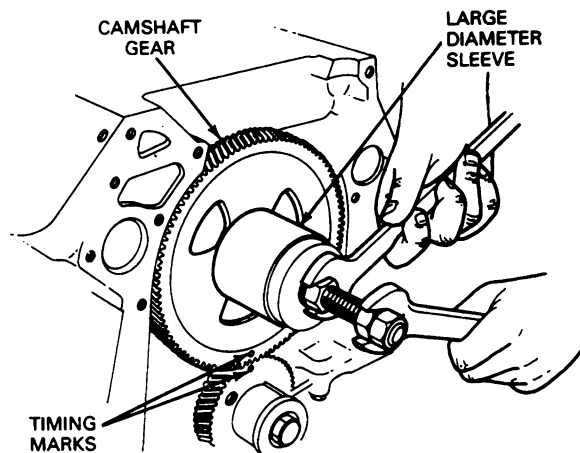
6. Remove bolts attaching thrust plate. Remove thrust plate, if necessary.

Installation

1. Install new thrust plate, if removed, and tighten to specification.
NOTE: Replace fuel supply pump cam if nicked, scored, or otherwise damaged. If fuel supply pump cam is replaced, replace fuel supply pump.
2. Install spacer and fuel supply pump cam against camshaft thrust flange using Crank / Cam Gear and Damper Replacer T83T-6316-B if removed.



3. Install camshaft drive gear against fuel supply pump cam, aligning timing mark with mark on crankshaft drive gear, using Crank / Cam Gear and Damper Replacer T83T-6316-B.

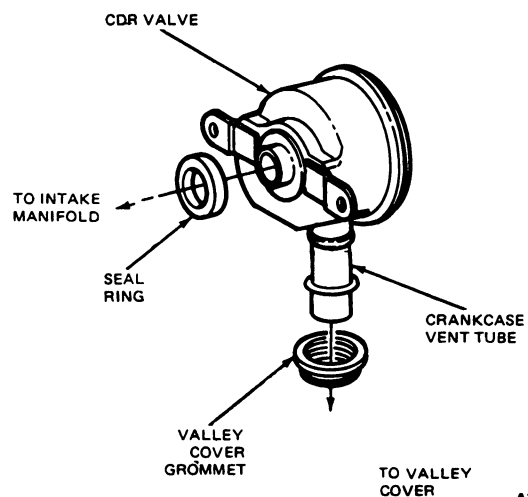


A11901-1A

4. Install camshaft Allen screw and tighten to 20 N·m (15 ft-lb).
5. Install fuel supply pump as outlined in this section.
6. Install new crankshaft oil seal in engine front cover, as outlined.
7. Install engine front cover, as outlined.

Crankcase Depression Regulator (CDR)**Removal and Installation**

1. Remove air cleaner and install Intake Manifold Cover T83T-9424-A onto intake manifold opening.
2. Remove two bolts attaching CDR valve to intake manifold and remove valve.

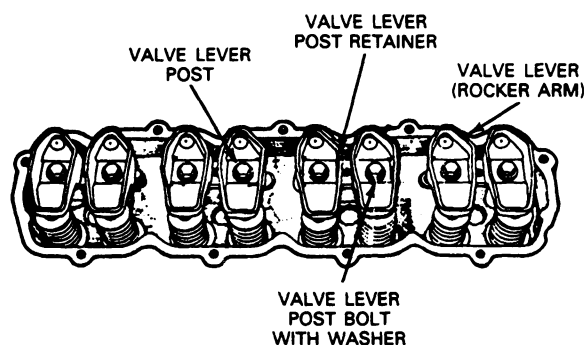


A7362-1B

For installation, follow removal procedures in reverse order.

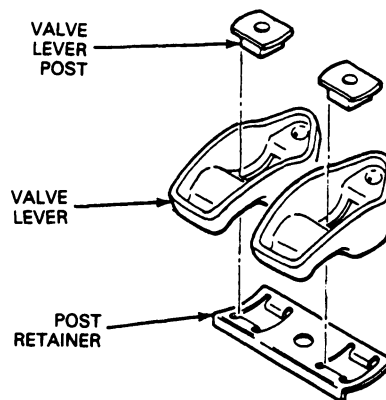
REMOVAL AND INSTALLATION (Continued)**Valve Cover, Rocker Arm, and Push Rod****Removal**

1. Disconnect ground cables from both batteries.
2. On Econoline, remove fan shroud.
3. Remove engine cover (Econoline only).
NOTE: Perform Steps 4 through 9 on Econoline, right side only.
4. Remove engine oil dipstick tube fasteners and remove dipstick, tube assembly and valve cover bracket.
5. Remove transmission filler tube fasteners and remove filler tube and dipstick.
6. Raise vehicle.
7. Remove nuts attaching right engine mount insulator to frame.
8. Slightly raise right side of the engine until fuel filter header touches vehicle sheet metal. Install suitable wood block between insulator and frame. Lower engine on block.
9. Lower vehicle.
10. Remove valve cover attaching screws and remove covers.
11. Remove valve rocker arm post mounting bolts.



A10735-1A

12. Remove valve rocker arms and posts in order and identify so they are returned to their original positions.
NOTE: It is not necessary to disassemble the rocker arms from their pedestal assemblies to inspect them. Inspect rocker arms by rotating to the maximum position and view the post area from the underside.
13. Remove push rods in order and identify so they are returned to their original positions.



A10736-1A

Installation

1. Install push rods in their original positions, making sure they are fully seated in tappet push rod seats.
NOTE: Install copper colored end of push rod toward rocker arm.
2. Install valve rocker arms and posts in their original positions. Apply Multi-Purpose grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips.
3. Install valve rocker arm post attaching bolts as follows:
 - a. Turn engine over by hand until timing mark is at 11:00 o'clock position as viewed from front of engine.
 - b. Install all rocker arm post attaching bolts, and tighten to 27 N·m (20 ft-lb).
4. Clean valve covers with clean solvent and install new gaskets.
5. Install valve covers on cylinder heads. Tighten attaching screws to 8 N·m (6 ft-lb).
6. Raise vehicle.
7. Raise engine, remove wood block and lower engine onto No. 1 crossmember, if required.
8. Install insulator attaching washers and nuts and tighten to specification, if required.
9. Lower vehicle.
10. Install transmission filler tube and tighten to specification. Install transmission oil dipstick, if required.
11. Install engine oil dipstick tube and valve cover bracket. Tighten fasteners to specification. Install engine oil dipstick.
12. Install radiator fan shroud halves, if required. Refer to Section 03-03.

REMOVAL AND INSTALLATION (Continued)

13. Install ground cables to both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

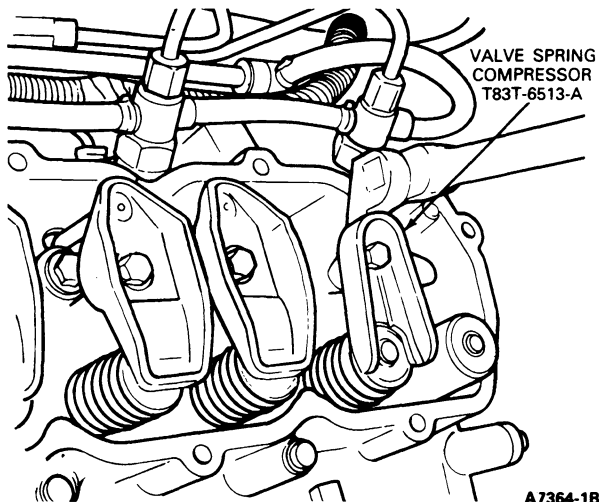
14. Run engine and inspect for oil leaks.

Valve Spring, Retainer and Stem Seal

Broken valve springs or damaged valve stem seals and retainers may be replaced without removing the cylinder head, provided damage to the valve or valve seat has not occurred. Refer to the following procedure.

Removal

1. Remove the required valve rocker arm(s).
2. Remove glow plug(s) with Glow Plug Socket D83T-6002-A or equivalent.
3. Install an air line with the adapter from Rotunda Compression Tester 014-00701 or equivalent into the glow plug hole and turn on the air supply.
4. Install Spring Compressor T83T-6513-A as shown. Compress valve spring and remove retainer locks, oil shield spring retainer, valve spring and damper spring.



NOTE: It may be necessary to strike valve stem end with a plastic tipped hammer to loosen valve retainer locks.

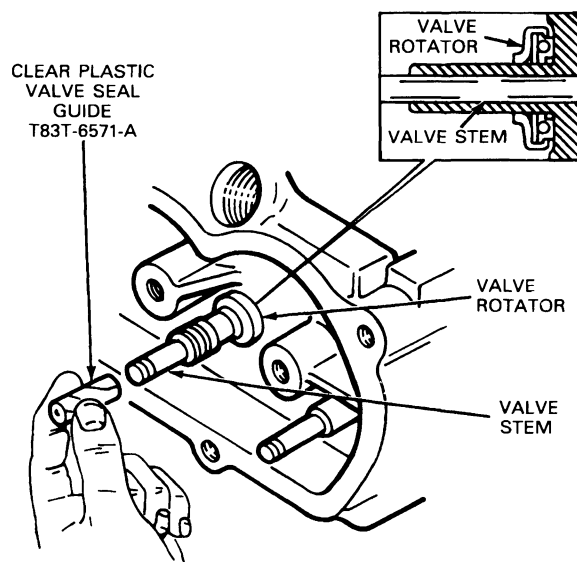
5. Remove valve stem seal and valve rotators.
6. Air pressure will force the piston to bottom of the cylinder and any removal of air pressure will allow valve(s) to fall into cylinder. A rubber band, tape or string wrapped around end of valve stem will prevent this condition and will still allow enough travel to check the valve for binding.

Installation

1. Inspect cylinder head and valve assemblies, as outlined. Inspect the valve stem for damage. Rotate the valve and check valve stem tip for eccentric movement during rotation. Move valve up and down through normal travel in valve guide and check stem for binds. If valve has been damaged, it will be necessary to remove cylinder head for repairs. Inspect valve retainer locks for excessive wear, and replace in pairs, as necessary.

NOTE: When installing a new valve, always use new retainer locks.

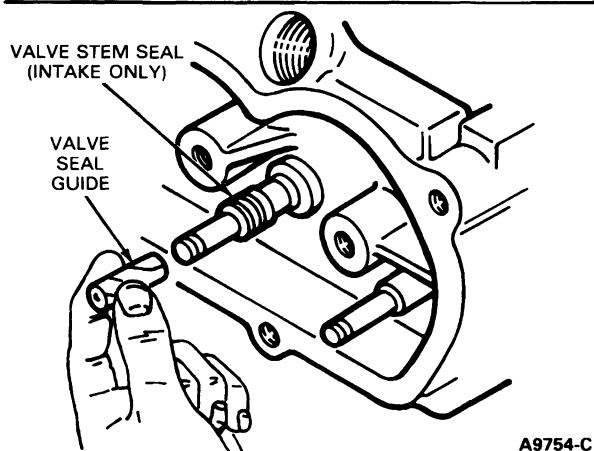
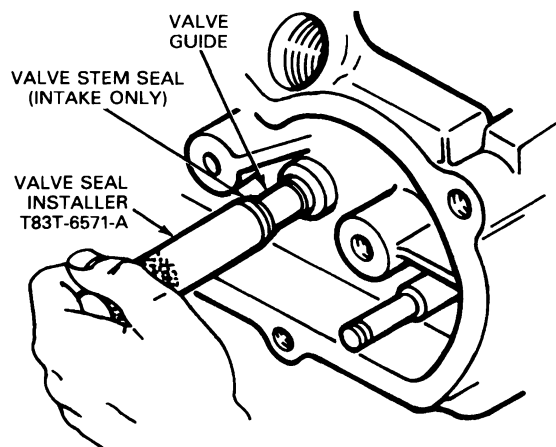
2. If condition of valve proved satisfactory, hold valve in closed position and pressurize cylinder by applying compressed air to adapter installed in glow plug hole.
3. Lubricate valve stem with recommended engine oil.
4. Install valve rotators as shown.



CAUTION: Apply only steady hand pressure on Valve Stem Seal Replacer T83T-6571-A until the seal bottoms squarely on the valve guide.

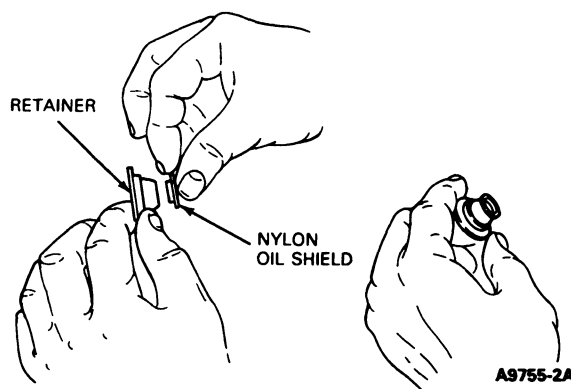
REMOVAL AND INSTALLATION (Continued)

5. For the intake valves only, install valve stem seals by installing the clear plastic valve seal guide. Install the valve stem seal by hand until it rests on the end of the valve guide. Use Valve Stem Seal Replacer T83T-6571-A to align the seal over the end of the valve guide as shown.



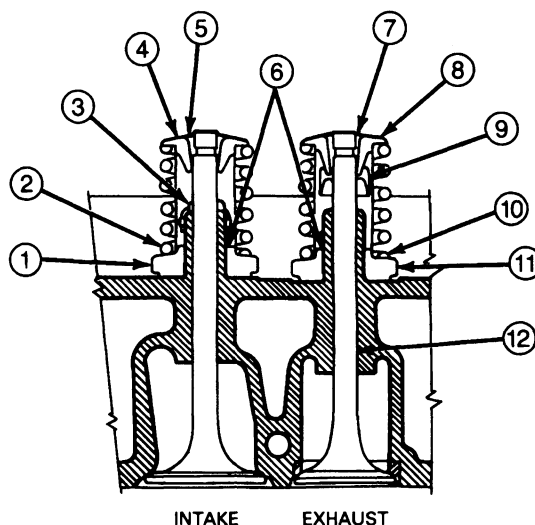
CAUTION: If the nylon oil shield is not properly installed in the valve spring retainer, it will float and cause excessive oil consumption.

6. Remove the plastic valve seal guide. Install the nylon oil shield into the valve spring retainer, applying pressure on shield until it snaps into place.



NOTE: Starting with engine number 520429, intake valve oil shield has been eliminated for both production and service gasket sets. Also, a new, larger oil shield is supplied for exhaust valves.

NOTE: Intake and exhaust valve stem oil shields are different. The intake valve oil shield is much smaller than the exhaust valve oil shield. These oil shields are not interchangeable.



A15993-A

Item	Part Number	Description
1	6K533	Valve Rotator
2	6513	Spring with Damper
3	6571	Valve Stem Seal (Intake Only)
4	6514	Retainer
5	6518	Retainer Lock
6	6510	Valve Guide
7	6514	Retainer Lock
8	6518	Retainer
9	6517	Oil Shield (Exhaust Only)
10	6513	Spring with Damper

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
11	6K533	Valve Rotator
12	—	Valve Guide Bore

7. Place spring in position over valve and install valve spring retainer assembly. Compress valve spring and install valve spring retainer locks. Verify that the locks are correctly seated. Remove valve spring compressor.
8. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to tips of valve stem and push rods.
9. Install required rocker arm(s) and push rod(s) following instructions under Rocker Arm Installation.
10. Install glow plugs using Glow Plug Socket D83T-6002-A or equivalent and tighten to 16 N·m (12 ft·lb).

Fuel Supply Pump**Removal**

1. Loosen threaded connections with proper size wrench (flare nut wrench preferred) and tighten snugly. Do not remove lines at this time.
2. Loosen mounting bolts one to two turns. Apply force with hand to loosen fuel pump if gasket is stuck. Rotate engine, by "nudging" starter, until fuel pump cam lobe is at low position. At this position, spring tension against fuel pump bolts will be greatly reduced.

WARNING: USE CARE TO PREVENT COMBUSTION OF SPILLED FUEL.

3. Disconnect fuel supply pump inlet, outlet and fuel return line.
4. Remove fuel pump attaching bolts. Remove pump and gasket. Discard old gasket.

Installation

1. Remove all fuel pump gasket material from engine and from fuel supply pump if installing original pump.

NOTE: Cam must be at low position before attempting to install fuel supply pump. If it is difficult to start the mounting bolts due to spring action of the fuel pump, turn crankshaft by hand 360 degrees to relocate camshaft lobe. Then, proceed with fuel supply pump installation. Install with lever on bottom side of cam.

2. Install attaching bolts into fuel supply pump and install a new gasket onto bolts. Position fuel supply pump to mounting pad. Turn attaching bolts alternately and evenly. Refer to Standard Torque Specification Chart at the end of this section.
3. Install fuel outlet line. Start fitting by hand to avoid crossthreading. Tighten to 20-24 N·m (15-18 ft·lb).
4. Install inlet line and tighten hose clamp to specification.
5. Start engine and observe all connections for fuel leaks for two minutes.
6. Stop engine and check all fuel supply pump fuel line connections. Check for oil leaks at pump mounting pad.

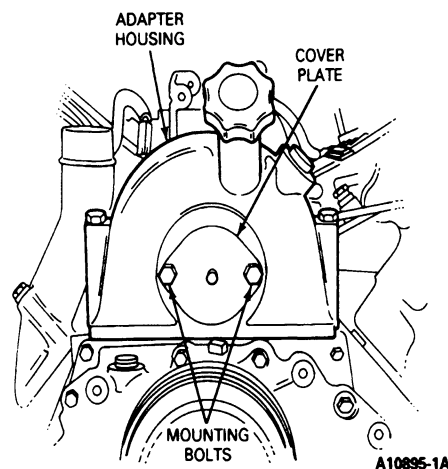
Injection Pump

NOTE: Before removing any fuel lines, clean exterior with clean fuel oil or solvent to prevent entry of dirt into engine when fuel lines are removed.

CAUTION: Do not wash or steam clean engine while engine is running or still hot from running. Serious damage to injection pump could occur.

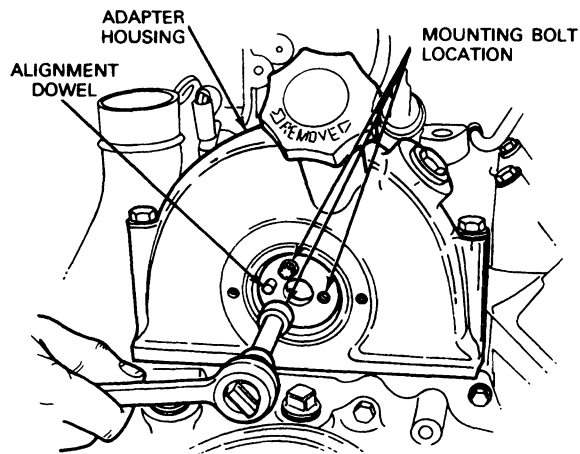
Removal

1. Disconnect battery ground cables from both batteries.
2. Remove engine cover on Econoline.
3. Remove adapter housing cover plate by removing two retaining bolts.



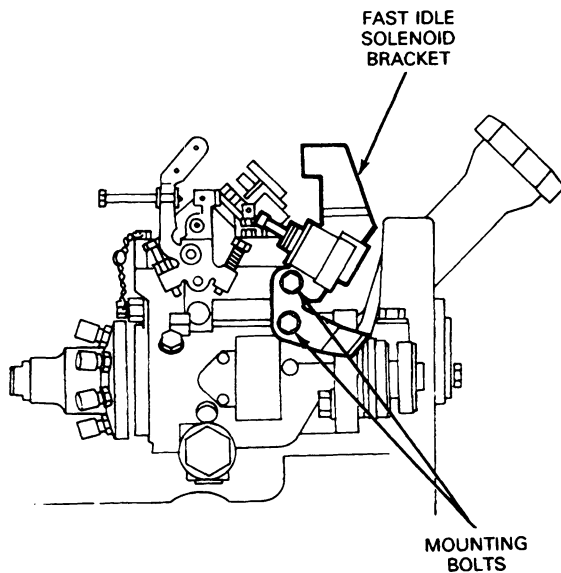
REMOVAL AND INSTALLATION (Continued)

4. Remove bolts attaching injection pump to drive gear.



A11903-1B

5. Disconnect electrical connectors to injection pump.
6. Remove fast idle solenoid bracket assembly to provide access to injection pump mounting nuts.



RIGHT SIDE VIEW

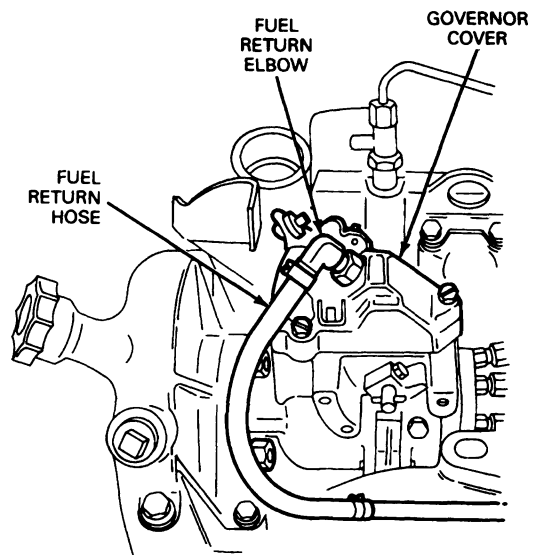
A11904-1A

7. Disconnect accelerator cable and speed control cable from throttle lever, if so equipped.

8. Remove air cleaner and install intake opening cover, using Intake Manifold Cover T83T-9424-A.
9. Remove accelerator cable bracket (with cables attached) from intake manifold and position out of the way.

NOTE: All fuel lines and fittings must be capped using Fuel System Protective Cap Set T83T-9395-A to prevent fuel contamination.

10. On Econoline, disconnect fuel inlet line from the fuel filter. Disconnect fuel return line from fuel filter. Remove fuel filter bracket attaching bolts and remove fuel filter and bracket as an assembly.
11. Remove fuel return hose and clip from the 90 degree elbow at the governor cover. Cap opening at governor cover elbow.



A11905-1A

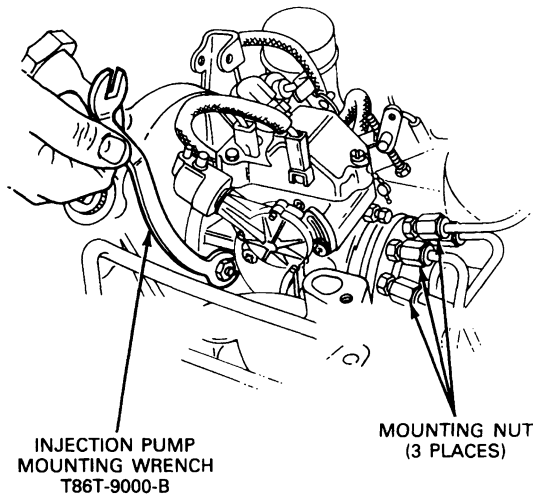
12. Remove fuel filter-to-injection pump fuel line and cap fittings.

NOTE: It is not necessary to remove injection lines from injection pump to remove injection pump. If lines are to be removed, loosen injection line fittings at injection pump before removing it from engine.

13. Remove fuel injection lines from nozzles and cap lines and nozzles.

REMOVAL AND INSTALLATION (Continued)

14. Remove three nuts attaching injection pump to injection pump drive gear cover using Injection Pump Mounting Wrench T86T-9000-B.

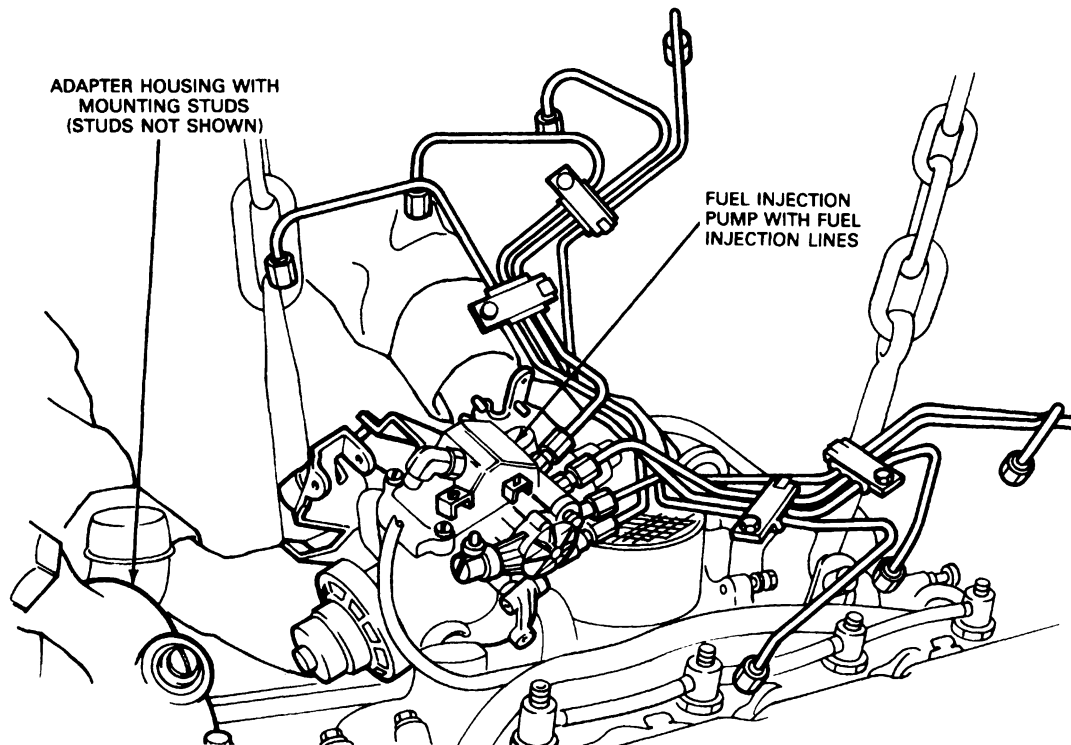


A11906-B

15. If injection pump is to be replaced, loosen injection line retaining clips and injection nozzle fuel lines with Fuel Line Nut Wrench T83T-9396-A. Cap all fittings at this time with Fuel System Protective Cap Set T83T-9395. Do not install injection nozzle fuel lines until new pump is installed in engine.

CAUTION: Do not carry injection pump by injection nozzle fuel lines as this could cause lines to bend or crimp.

16. On F-Series vehicles, lift injection pump, with nozzle lines attached, up and out of engine compartment.

Injection Pump Removal, 7.3L Diesel Engine, F-Series

A11907-28

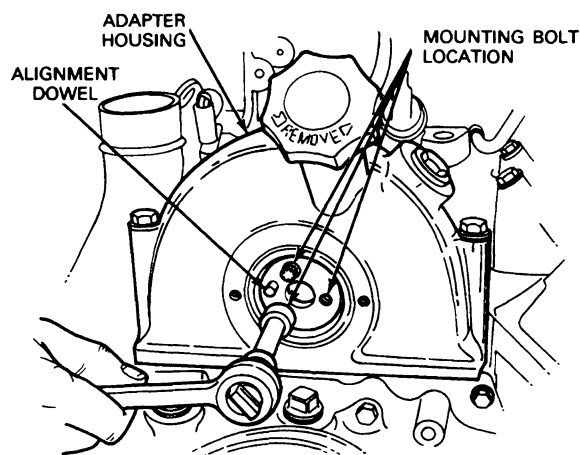
REMOVAL AND INSTALLATION (Continued)

17. On Econoline, remove injection pump through passenger compartment.

NOTE: Use care to avoid spilling diesel fuel in passenger compartment.

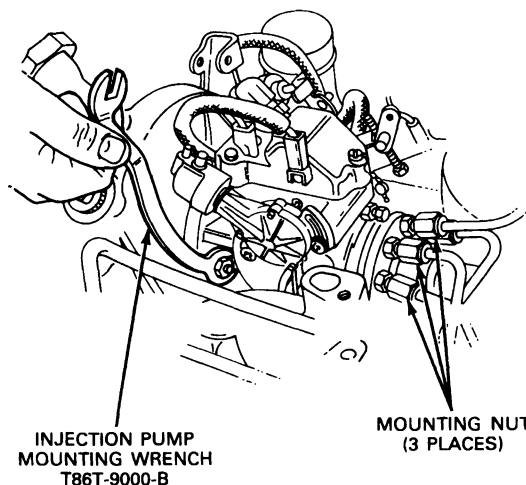
Installation

1. Install new O-ring onto drive gear end of injection pump.
2. On F-Series vehicles, move injection pump down and into position.
3. On Econoline, install injection pump from passenger compartment.
NOTE: Use care to avoid spilling diesel fuel in passenger compartment.
4. Position alignment dowel on injection pump into alignment hole on drive gear. If necessary, rotate pump drive shaft to align drive slot prior to installation.



A11903-1B

5. Install bolts attaching injection pump to drive gear and tighten to 34 N·m (25 ft·lb).
6. Install nuts attaching injection pump to adapter. Align scribe lines on injection pump flange and injection pump adapter. Tighten nuts to 35 N·m (26 ft·lb) using injection pump mount wrench T86T-9000-B.



A11906-B

7. If injection nozzle fuel lines were removed from injection pump, install using Fuel Line Nut Wrench T83T-9396-A and tighten to 30 N·m (22 ft·lb).
8. Remove caps from nozzles and fuel lines. Install fuel line nuts onto nozzles and tighten to 30 N·m (22 ft·lb) using Fuel Line Nut Wrench Tool T83T-9396-A.
9. Connect fuel inlet line from filter and fuel return line to injection pump and tighten nuts to 20-24 N·m (15-18 ft·lb).
10. Install injection pump fitting adapter with a new O-ring.
11. Clean old sealant from injection pump elbow threads using clean solvent, and dry thoroughly. Start elbow into injection pump adapter, and then apply a light coating of Pipe Sealant With Teflon® D8AZ-19554-A (ESG-M4G 194-A) or equivalent on elbow threads.
12. Tighten elbow in injection pump adapter to a minimum of 8 N·m (6 ft·lb). Then tighten further, if necessary, to align elbow with injection pump fuel inlet line, but do not exceed 360 degrees of rotation or 13 N·m (10 ft·lb).
13. Remove caps and connect fuel filter-to-injection pump fuel line and tighten to specification listed at the end of this section.
14. On Econoline, install fuel filter and bracket as an assembly and tighten bolts to 33-52 N·m (24-39 ft·lb). Install fuel filter return line and tighten clamp to specifications. Install fuel filter inlet fuel line and tighten to 20-24 N·m (15-18 ft·lb).
15. Install accelerator cable bracket to intake manifold and tighten to 16-23 N·m (12-17 ft·lb).
16. Remove intake manifold cover and install air cleaner. Refer to Section 03-12.
17. Connect accelerator and speed control cable, if so equipped, to throttle lever.

REMOVAL AND INSTALLATION (Continued)

18. Install fast idle solenoid bracket assembly and tighten to specification.
19. Install electrical connectors on injection pump.
20. Clean adapter housing cover plate sealing surfaces.
21. Apply a 3.2mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent in adapter housing grooves.

NOTE: When applying Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to set-up and sealing effectiveness may be reduced.

22. Connect ground cables to both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

23. Run engine and check for fuel leaks.

WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM PARTIALLY OPENED CONNECTION UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.

24. If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.

25. Check and adjust injection pump timing as described in the Powertrain Control/Emissions Diagnosis Manual.⁴

Injection Nozzle Fuel Lines**Removal**

NOTE: Before removing any fuel lines, clean exterior of each nozzle assembly and surrounding area with solvent to prevent entry of dirt into fuel system when fuel lines are removed. Blow dry with compressed air.

1. Disconnect ground cables from both batteries.
2. On Econoline, remove engine cover.
3. Remove air cleaner and cap intake manifold opening with Intake Manifold Cover T83T-9424-A.
4. Disconnect accelerator cable and speed control cable, if so equipped, from injection pump.
5. Remove accelerator cable bracket from intake manifold and position out of the way with cable(s) attached.

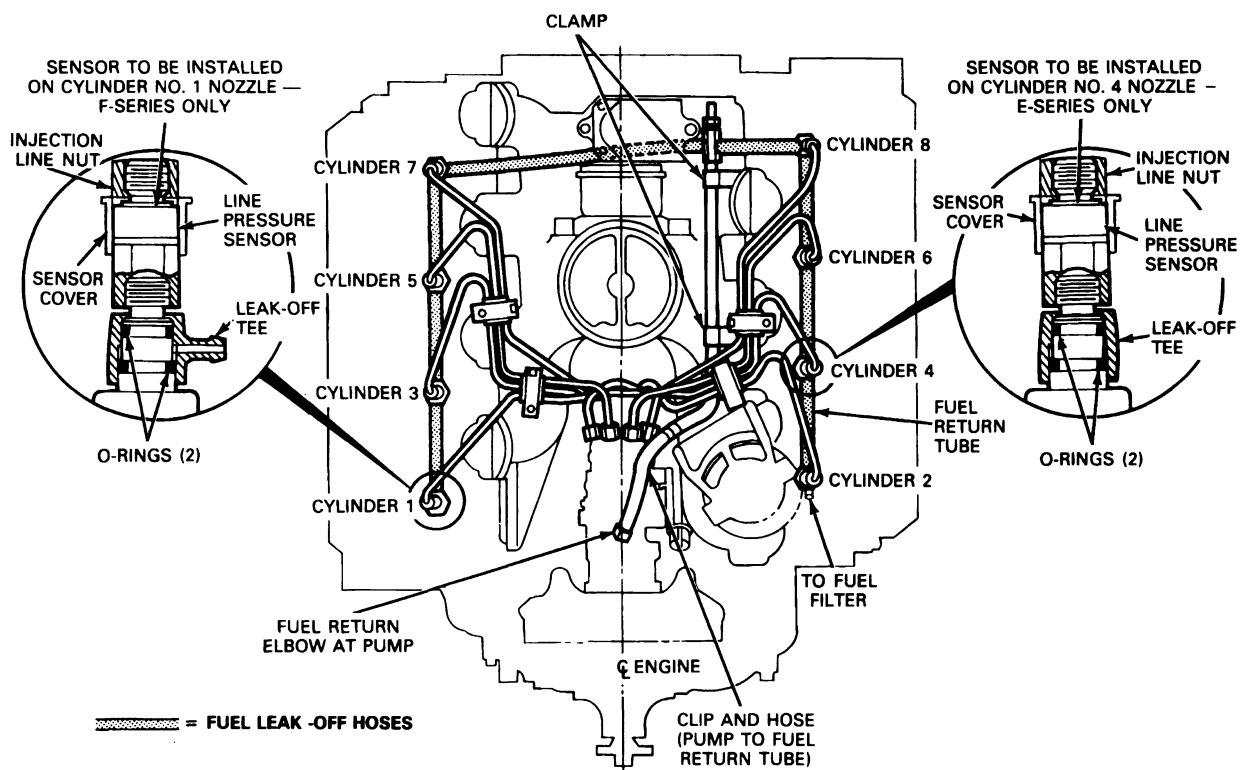
NOTE: To prevent fuel system contamination, cap all fuel lines and fittings with Fuel System Protection Cap Set T83T-9395-A.

6. Disconnect fuel line from fuel filter to injection pump and cap all fittings.
7. Disconnect and cap nozzle fuel lines at nozzles.
8. Remove fuel line clamps from fuel lines to be removed.

⁴ Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

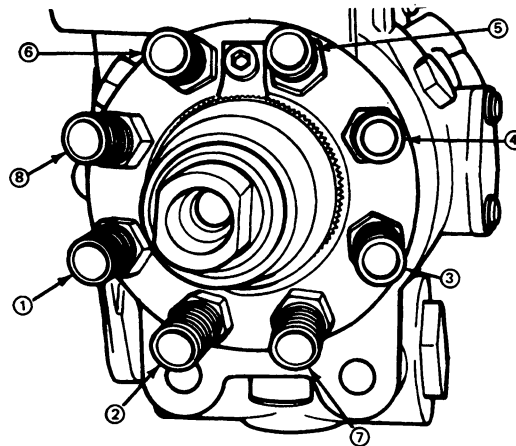
Fuel Line Routing and Installation



A11908-C

9. Remove and cap injection pump inlet elbow.
10. Remove and cap inlet fitting adapter.
11. Remove injection nozzle lines, one at a time, from injection pump using Fuel Line Nut Wrench T83T-9396-A.

NOTE: Fuel lines must be removed following this sequence: 5-6-4-8-3-1-7-2. Install caps on each end of each fuel line and pump fitting as it is removed and identify each fuel line accordingly.



CYLINDER NUMBER

A7370-1A

Installation

1. Install fuel lines on injection pump using Fuel Line Nut Wrench T83T-9396-A one at a time, and tighten to 30 N·m (22 ft·lb).

NOTE: Fuel lines must be installed in the following sequence: 2-7-1-3-8-4-6-5.

REMOVAL AND INSTALLATION (Continued)

2. Clean old sealant from injection pump elbow, using clean solvent, and dry thoroughly.
3. Apply a light coating of Pipe Sealant With Teflon® D8AZ-19554-A (ESG-M4G 194-A) or equivalent on elbow threads.
4. Install elbow in injection pump adapter and tighten to a minimum of 8 N·m (6 ft-lb). Tighten further, if necessary, to align elbow with injection pump fuel inlet line, but do not exceed 360 degrees of rotation or 13 N·m (10 ft-lb).
5. Remove caps from fuel lines and connect lines to nozzles. Tighten to 30 N·m (22 ft-lb) using Fuel Line Nut Wrench T83T-9396-A or equivalent.
6. Uncap and connect fuel line from fuel filter to injection pump and tighten to 30 N·m (22 ft-lb).
7. Install fuel line retaining clamps and tighten to specification.
8. Install accelerator cable bracket onto intake manifold and tighten to 16-23 N·m (15-18 ft-lb).
9. Connect accelerator and speed control cable, if so equipped, to injection pump throttle lever.
10. Remove intake manifold cover, and install air cleaner. Refer to Section 03-12.
11. On Econoline, install engine cover.
12. Connect ground cables to both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

13. Run engine and check for fuel leaks.

WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM PARTIALLY OPENED CONNECTION UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.

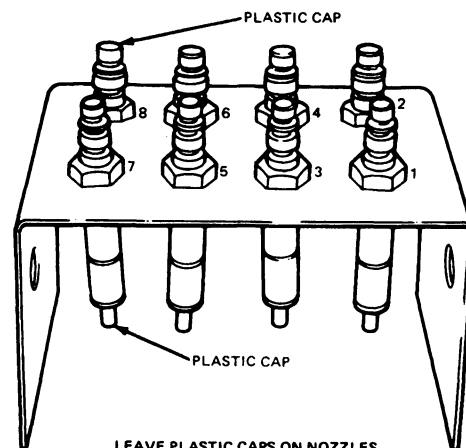
14. If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.

NOTE: On F-Series, remove and cap line sensor on No. 1 cylinder to permit removal of fuel leak-off tees. On E-Series, remove and cap line sensor on No. 4 cylinder to permit removal of fuel leak-off tee.

1. Disconnect nozzle fuel inlet (high pressure) and fuel leak-off tees from each nozzle assembly and position out of the way. **Cover open ends of fuel inlet lines and nozzles to prevent entry of dirt with Fuel System Protective Cap Set T83T-9395-A.**
2. Remove fuel leak-off lines as an assembly as follows.
 - a. Remove pump to fuel return tube hose at fuel return elbow. Cap elbow at pump. Disconnect hose (from leak-off tee to fuel filter) at leak-off tee.
 - b. Loosen two fuel return tube retaining clamps, one at intake manifold and one at engine lifting eye. Remove fuel return hose clamp at CDR valve bracket.
 - c. With clamps removed, remove return lines and tees as an assembly by lifting tees off nozzles.
3. Remove injection nozzles by turning counterclockwise. Pull nozzle assembly with copper washer from engine. **Be careful not to strike nozzle tip against any hard surface during removal. Cover nozzle assembly fuel inlet opening and nozzle tip with plastic cap, Fuel System Protective Cap Set T83T-9395-A.**

NOTE: Remove copper injector nozzle gasket from nozzle bore with O-Ring T7 1P-19703-C if not attached to nozzle tip.

4. Place nozzle assemblies in a fabricated holder as they are removed from the heads. The holder should be marked with numbers corresponding to the cylinder numbering of the engine. Use of this holder permits nozzle installation into original location in the cylinder heads.



A7371-1A

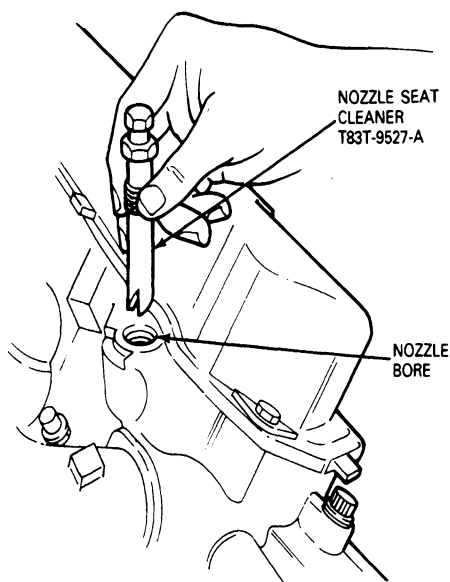
Injection Nozzles**Removal**

NOTE: Before removing nozzle assemblies, clean exterior of each nozzle assembly and the surrounding area with solvent to prevent entry of dirt into engine when nozzle assemblies are removed. Also, clean fuel inlet and fuel leak-off piping connections. Blow dry with compressed air.

REMOVAL AND INSTALLATION (Continued)

Installation

1. Thoroughly clean nozzle bore in cylinder head before reinserting nozzle assembly with Nozzle Seat Cleaner T83T-9527-A. Pay particular attention to seating surface, in order that no small particles of metal or carbon will cause assembly to be cocked or permit blow-by of combustion gases. Blow out particles with compressed air.



A11909-1A

2. Remove protective cap and install a new copper gasket on nozzle assembly with a small dab of Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent.

NOTE: Anti-seize compound or equivalent should be used on nozzle threads to aid installation and future removal.

CAUTION: Be careful that nozzle tip does not strike against recess wall.

3. Install nozzle assembly into cylinder head nozzle bore.
 4. Tighten nozzle assembly to 47 N·m (35 ft-lb).
 5. Remove protective caps from nozzle assemblies and fuel lines.
 6. Install leak-off tees and lines as an assembly by lowering onto nozzles. Connect clip and hose to fuel return elbow at pump. Install line to retaining clamps.
- NOTE: Install two new O-ring seals for each fuel return tee.
7. Connect high pressure fuel line(s) and tighten to specification using Fuel Line Nut Wrench T83T-9396-A.
 8. Start engine.

9. If necessary, purge high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from connection.

WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM PARTIALLY OPENED CONNECTION UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.

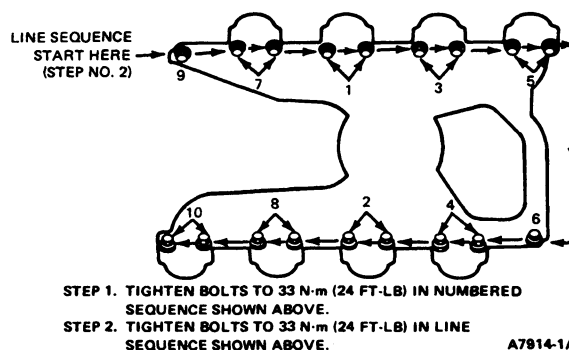
10. Check for fuel leakage at high-pressure connections.

Intake Manifold, Valley Pan and Tappets

Removal

1. Disconnect ground cables from both batteries.
 2. On Econoline, remove engine cover.
 3. Remove air cleaner and install intake manifold cover using Intake Manifold Cover T83T-9424-A.
 4. On Econoline, disconnect fuel inlet line from the fuel filter. Disconnect fuel return line from fuel filter. Remove fuel filter bracket attaching bolts and reverse fuel filter and bracket as an assembly.
 5. Remove injection pump, as outlined.
 6. On F-Series, remove fuel return hoses from No. 7 and No. 8 (rear) nozzles and remove return hose to fuel tank.
 7. Remove glow plug harness and controller.
- NOTE: Remove engine wiring harness ground cable from back of left cylinder head.
8. Remove bolts attaching intake manifold to cylinder heads and remove manifold.

Intake Manifold Attaching Bolts Tightening Sequence

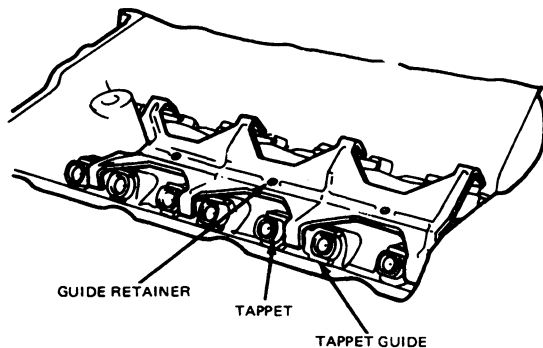


9. Remove CDR tube and grommet from valley pan.
10. Remove bolts attaching valley pan strap to front of engine block, and remove strap.

REMOVAL AND INSTALLATION (Continued)

11. Remove valley pan drain plug and remove valley pan.
12. If tappets are being serviced, remove valve covers, rocker arms and push rods, as outlined in this section.
13. Remove tappet guide retainer.

NOTE: Tappets should be kept in order so they can be installed in their original position. Inspect and test each tappet separately to prevent intermixing the internal parts.

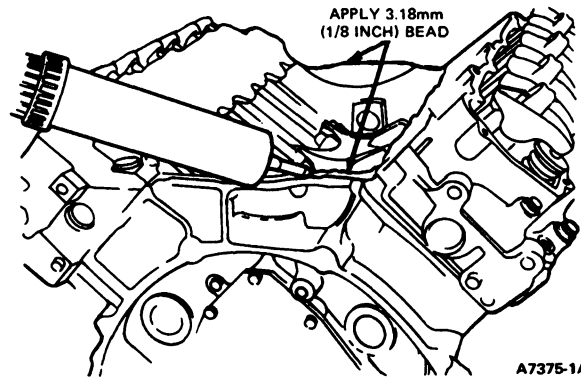


A7374-1A

Installation

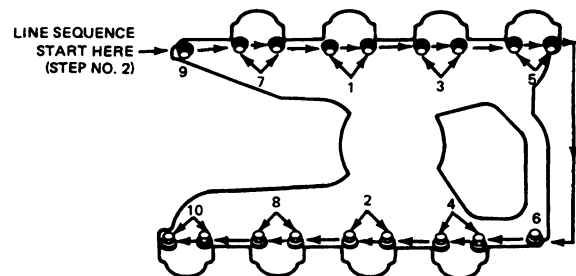
1. Lubricate tappets and bores with recommended quality engine oil and install tappets in their original positions.
2. Install tappet guides.
3. Install tappet guide retainer and tighten to specifications.
4. Position push rods, copper colored ends toward rocker arms, into their respective tappets making sure they are seated fully in push rod seats.
5. Install rocker arms and valve covers with new gaskets, as outlined.
6. Clean cylinder block gasket surfaces of any old Silicone Rubber Sealant or oil. Apply a 3.18mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent to each end of the cylinder block.

NOTE: When applying Silicone Rubber Sealant always use the bead size specified and join the components within 15 minutes of application. After 15 minutes the sealant begins to set-up and sealing effectiveness may be reduced.

Applying Silicone Rubber Sealant

A7375-1A

7. Install new valley pan.
8. Install valley pan drain plug.
9. Install CDR tube and new grommet into valley pan.
10. Install new O-ring and new back-up ring on CDR valve.
11. Install valley pan strap onto front of valley pan and tighten to specification in Standard Torque Chart.
12. Install intake manifold and tighten to 33 N-m (24 ft-lb), using the two-step method shown.



STEP 1. TIGHTEN BOLTS TO 33 N-m (24 FT-LB) IN NUMBERED SEQUENCE SHOWN ABOVE.

STEP 2. TIGHTEN BOLTS TO 33 N-m (24 FT-LB) IN LINE SEQUENCE SHOWN ABOVE.

A7914-1A

13. Install engine wiring harness on engine.

NOTE: Connect engine wiring harness ground wire to rear of left cylinder head and tighten to specification.

14. Install glow plug controller and harness.
15. On Econoline, install fuel filter and bracket as an assembly and tighten bolts to 33-52 N-m (24-39 ft-lb). Install fuel filter return line and tighten clamp to specifications. Install fuel filter inlet fuel line and tighten to specifications.
16. Install injection pump, as outlined.
17. Connect fuel tank return hose and No. 7 and No. 8 nozzle fuel return hoses.
18. Remove intake manifold cover and install air cleaner.
19. Install engine cover on Econoline.

REMOVAL AND INSTALLATION (Continued)

20. Connect ground cables to both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

21. Run engine. Check for oil and fuel leaks.

WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM PARTIALLY OPENED CONNECTION UNDER HIGH PRESSURE OPENED CONNECTION UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.

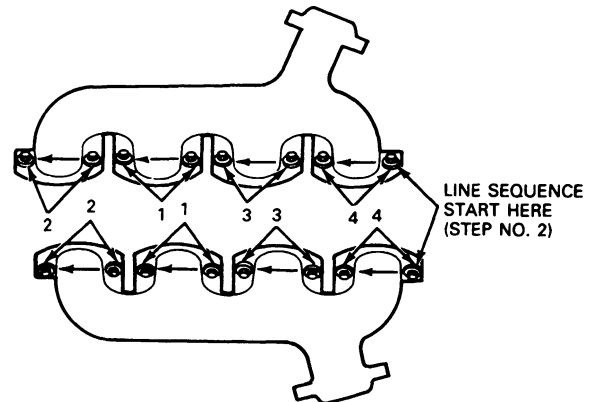
22. If necessary, purge nozzle high-pressure fuel lines of air by loosening connector one-half to one turn and cranking engine until bubble-free fuel flows from the connection.

Exhaust Manifolds**F-Series****Removal**

1. Disconnect ground cables from both batteries.
2. Raise vehicle.
3. Disconnect muffler inlet pipe from exhaust manifolds.
4. If right exhaust manifold is to be removed, lower vehicle at this time. If left exhaust manifold is to be removed, leave hoist up.
5. Remove exhaust manifold attaching bolts and manifold.

Installation

1. Clean mounting surfaces.
2. Apply anti-seize compound on exhaust manifold bolt threads and install left manifold with new gasket.
3. Tighten bolts to 47 N·m (35 ft-lb) using the two-step method shown. Raise vehicle.
4. If right exhaust manifold is being installed, raise vehicle at this time, and repeat installation Steps 2 and 3.

Exhaust Manifold Tightening Sequence

STEP1. TIGHTEN BOLTS TO 47 N·m (35 FT-LB), IN NUMBERED SEQUENCE SHOWN ABOVE.

STEP2. TIGHTEN BOLTS TO 47 N·m (35 FT-LB), IN LINE SEQUENCE SHOWN ABOVE.

A7912-1B

5. Connect muffler inlet pipe to manifolds and tighten to specification. Refer to Section 09-00.
6. Lower vehicle.
7. Connect battery ground cables to both batteries.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
8. Run engine and check for exhaust leaks.

Econoline**Removal**

1. Open hood. Remove engine cover.
2. Disconnect battery ground cables from both batteries.
3. For right manifold only, remove radiator fan shroud halves. Refer to Section 03-03.
4. For right manifold only, remove engine oil dipstick tube fasteners. Remove dipstick and tube.
5. For right manifold only, remove transmission filler tube fasteners. Remove filler tube and dipstick.
6. Raise vehicle.
7. For right manifold only, remove nuts attaching right engine mount insulator to frame.
8. For right manifold only, slightly raise right side of the engine until fuel filter header touches vehicle sheet metal. Install suitable wood block between insulator and frame. Lower engine on block.
9. Remove muffler inlet pipe from exhaust manifolds.
10. Lower vehicle.
11. Remove bolts and manifold.

Installation

1. Apply anti-seize compound to manifold retaining bolts. Install manifold with new gasket.

REMOVAL AND INSTALLATION (Continued)

2. Tighten bolts to 47 N-m (35 ft-lb) using the two-step method shown previously for F-Series.
3. Raise vehicle.
4. For right manifold only, raise engine, remove wood block and lower engine onto No. 1 crossmember.
5. Install insulator attaching washers and nuts. Refer to Insulator Installation in this section.
6. Install muffler inlet pipe to exhaust manifolds and tighten to specification. Refer to Section 09-00.
7. Lower vehicle.
8. For right manifold, install transmission filler tube and tighten to specification. Install transmission oil dipstick.
9. Install engine oil dipstick tube and tighten fasteners to specification. Install engine oil dipstick.
10. For right manifold, install radiator fan shroud. Tighten bolts to 4-8 N-m (35-71 in-lb).
11. Connect ground cables to both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

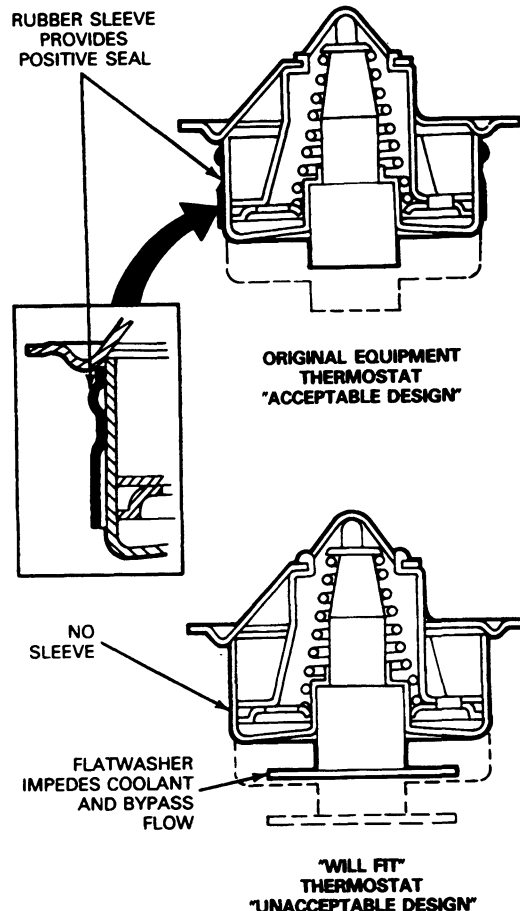
12. Run engine and check for exhaust leaks.
13. Install engine cover and close hood.

Thermostat

CAUTION: The specified thermostat does not contain an internal bypass, since the by-pass is located in the cylinder block. Whenever the thermostat is replaced, it is mandatory that only Motorcraft E5TZ-8575-C or Navistar 1807945-C1 thermostat be installed.

CAUTION: Do not attempt to repair the thermostat. It should be replaced if it is not operating properly.

Check the thermostat before installing it, following the procedure described in this section.

Thermostat Design (Acceptable vs. Unacceptable)

A11910-1A

Removal

1. Disconnect ground cables from both batteries.
2. Drain coolant from radiator until coolant level is below thermostat.
3. Loosen and remove alternator and vacuum pump drive belts.
4. Remove alternator. Position alternator out of the way.
5. Remove vacuum pump and bracket. Position pump out of the way.
6. Remove all but the lowest alternator / vacuum pump mounting casting bolt. Loosen the lowest bolt and pivot the alternator / vacuum pump casting outboard.
7. Remove the water outlet housing attaching bolts. Bend the radiator upper hose upward and remove the thermostat and gasket.
8. Inspect thermostat as outlined in this section.

REMOVAL AND INSTALLATION (Continued)**Installation**

1. Clean the water outlet housing gasket surfaces. Coat a new outlet housing gasket with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent. Position the water outlet housing gasket on intake manifold opening.
2. Install thermostat in crankcase opening with the copper pellet or element toward engine and the thermostat flange positioned in the recess. If thermostat is improperly installed, it will cause a restricted flow of coolant.
3. Position the water outlet housing against the crankcase. Install and tighten the attaching bolts to 27 N·m (20 ft-lb).
4. Reposition the alternator / vacuum pump casting. Install attaching bolts.
5. Install vacuum pump with bracket and tighten to specification. Refer to Section 03-05.
6. Install alternator and drive belt.
7. Install vacuum pump drive belt.
8. Adjust alternator and vacuum pump drive belts to specification. Refer to Section 03-05.
9. Fill and bleed the cooling system. Refer to Section 03-03.
10. Connect ground cables to both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN REVVING ENGINE.

11. Operate the engine until normal operating temperature is reached, then check the coolant level. Inspect cooling system for leaks.

Cylinder Heads

NOTE: Right side described; left side similar. Refer to Section 03-05 for differences in accessory drive for left side of engine.

Removal

1. Disconnect ground cables from both batteries.
2. Drain cooling system.
3. Remove radiator fan shroud. Refer to Section 03-03.

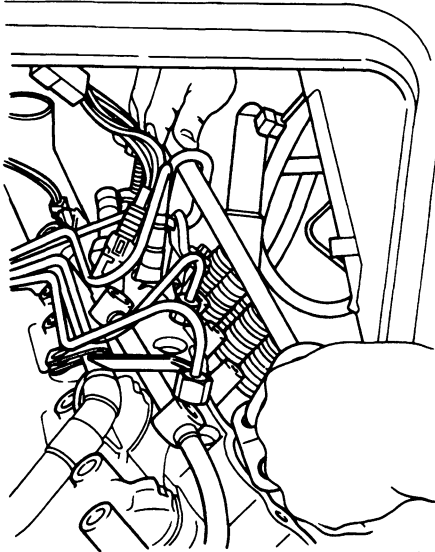
4. Remove radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.

CAUTION: Left-hand thread. Remove by turning nut clockwise.

5. Disconnect alternator wiring from alternator. Disconnect wiring harness electric connector from top of fuel filter / fuel heater / water separator.
6. Remove alternator adjusting bolt and pivot bolt. Remove alternator.
7. Remove vacuum pump adjusting bolt and pivot bolt. Remove vacuum pump.
8. Remove fuel filter inlet, outlet and return lines. Cap lines and fittings with Fuel System Protection Cap Set T83T-9395-A.
9. Remove alternator and vacuum pump mounting bracket. Refer to Section 03-05. On F-Series vehicles, remove fuel filter bracket with filter attached (right side only).
10. Remove heater hose from cylinder head.
11. Remove injection pump, as outlined.
12. Remove intake manifold and valley cover, as outlined.
13. Raise vehicle.
14. Disconnect muffler inlet pipe from exhaust manifolds.
15. Remove bolt attaching transmission oil dipstick tube to cylinder head (right side only).
16. Lower vehicle.
17. Remove engine oil dipstick tube-fasteners (right side only).
18. Remove right-hand exhaust manifold, as outlined.
19. Remove engine oil dipstick, dipstick tube and O-ring (right side only).
20. Remove valve cover, rocker arms and push rods, as outlined.
21. Remove nozzles and glow plugs, as outlined.
22. Remove bolts attaching cylinder head to engine block.
23. Attach Engine Lifting Brackets T70P-6000 to each end of cylinder head.
24. For F-Series, install lifting sling to lifting eyes and carefully lift cylinder head out of engine compartment.

REMOVAL AND INSTALLATION (Continued)

25. For Econoline, install suitable bar through rings on lifting eyes. With an assistant, carefully lift cylinder head and remove.



CAUTION: Pre-combustion chamber inserts may fall out of cylinder head upon removal.

26. Remove head gasket carefully to prevent damage to cylinder head locating dowel sleeves.

Installation

NOTE: New cylinder head assemblies are interchangeable from one cylinder bank to another. Used cylinder heads should be installed into their original positions using new gaskets. Cylinder head gaskets are interchangeable.

1. Clean gasket surface. Remove all burrs or scratches with an oil stone.
2. Check for warpage or cracks. Replace head if warped or cracked.

NOTE: Cylinder heads are not to be resurfaced.

3. Position new cylinder head gasket on engine block using locating dowels. Install gasket with silver stamped "This Side Up" facing installer.

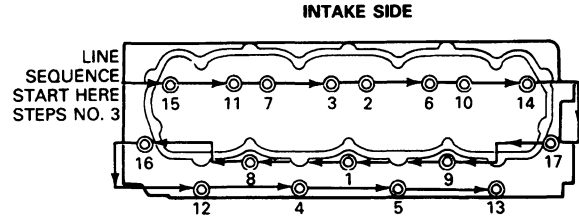
CAUTION: Use care when installing cylinder head to prevent prechambers from falling into cylinder bores. Do not slide cylinder head across gasket. Sliding head may damage seals and result in coolant or oil leakage.

4. On F-Series, attach lifting sling and brackets to cylinder head. On E-Series, position bar through rings on lifting eyes. Carefully lower cylinder head onto engine block.

5. Lightly lubricate cylinder head bolt threads and mating surfaces of bolt heads and washers with engine oil.

CAUTION: Do not use anti-seize compounds, grease or any other lubricant except engine oil. Other lubricants have an adverse effect on torque value.

6. Install cylinder head retaining bolts and washers. Tighten to specifications as shown.



- STEP 1.** TIGHTEN BOLTS TO 88 N·m (65 FT-LB) IN NUMBERED SEQUENCE SHOWN ABOVE.
STEP 2. TIGHTEN BOLTS TO 115 N·m (85 FT-LB) IN NUMBERED SEQUENCE SHOWN ABOVE.
STEP 3. TIGHTEN BOLTS TO 136 N·m (100 FT-LB) IN LINE SEQUENCE SHOWN ABOVE.
STEP 4. REPEAT STEP NO. 3.

A7913-1C

7. Install push rods, copper colored ends toward rocker arms, making sure push rods are fully seated into tappets.
8. Install valve rocker arms and posts in their original positions. Apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to valve stem tips.
9. Install valve rocker arm post attaching bolts as follows:
 - a. Turn engine over by hand until timing mark is at 11:00 o'clock position as viewed from front of engine.
 - b. Install all rocker arm post attaching bolts, and tighten to 27 N·m (20 ft-lb).
10. Clean valve covers with clean solvent and install new gaskets.
11. Install valve covers on cylinder heads. Tighten attaching screws to 8 N·m (6 ft-lb).
12. Install valley pan and intake manifold, as outlined in this section.
13. Install injection pump, as outlined in this section.
14. Connect heater hose to cylinder head and tighten clamp to specification. Refer to Section 03-03.
15. Install fuel filter / fuel heater / water separator with bracket (F-Series, right side only), and / or alternator and vacuum pump bracket and tighten to specification. Refer to Section 03-05.
16. Remove protective caps and install fuel filter inlet, outlet and return lines. Tighten to specifications.
17. Loosely install engine oil dipstick tube and O-ring into cylinder block (right side only).

REMOVAL AND INSTALLATION (Continued)

18. Raise vehicle.
19. Install right exhaust manifold, as outlined. Install fasteners holding engine oil dipstick tube in position.
20. Install bolt attaching transmission oil dipstick to cylinder block and tighten to specification (right side only).
21. Connect muffler inlet pipe to exhaust manifolds and tighten to specification. Refer to Section 09-00.
22. Lower vehicle.
23. Install vacuum pump.
24. Install alternator and drive belt.
25. Install vacuum pump and drive belt.
26. Adjust alternator and vacuum pump drive belts to specifications. Refer to Section 03-05.
27. Connect alternator wiring harness. Connect wiring harness top of fuel filter / fuel heater / water expansion.
28. Remove intake manifold cover and install air cleaner.
29. Connect ground cables to both batteries.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
30. Refill and bleed cooling system. Refer to Section 03-03.
WARNING: KEEP EYES AND HANDS AWAY FROM FUEL SPRAY. FUEL SPRAYING FROM THE PARTIALLY OPENED CONNECTOR UNDER HIGH PRESSURE CAN PENETRATE THE SKIN AND CAUSE INFECTION. MEDICAL ATTENTION SHOULD BE PROVIDED IMMEDIATELY IN THE EVENT OF SKIN PENETRATION.
31. Run engine and check for fuel, coolant and exhaust leaks.
32. If necessary, purge high-pressure fuel lines of air by loosening connector one half to one turn and cranking engine until bubble-free fuel flows from connection.
33. Install radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.
CAUTION: Left-hand thread. Tighten by turning nut counterclockwise.

34. Install radiator fan shroud.

Engine Oil Filter**Removal**

1. Raise vehicle.
2. Remove oil filter, using a suitable oil filter wrench.

Installation

1. Clean gasket mating surface on oil filter flange.
2. Lightly coat sealing gasket with clean engine oil.
3. Install oil filter until seal contacts filter flange and tighten 1-1/4 to 2 additional turns.
4. Lower vehicle.
5. Check engine oil level, and add as required.
6. Run engine and check for oil leaks.

Engine Oil Cooler

CAUTION: Do not start the engine after a debris-generated failure without replacing the oil cooler bundle. Debris cannot be filtered before entering the oil cooler since the filter is downstream of the cooler.

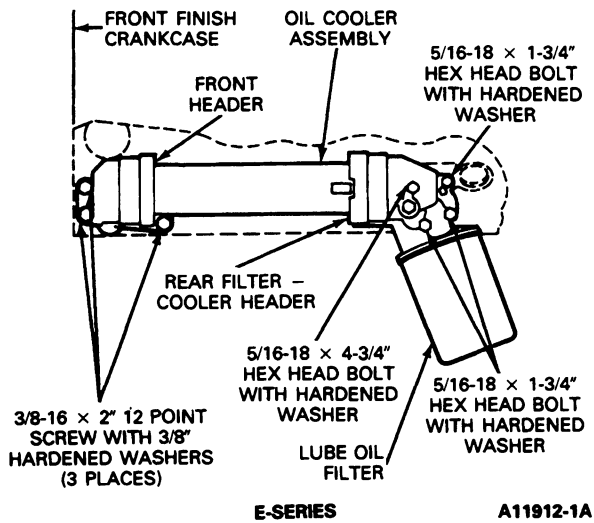
NOTE: If necessary, refer to Oil Cooler Internal Leakage Test and perform as outlined in this section.

Removal

1. Disconnect ground cables from both batteries.
2. Drain cooling system.
3. Remove radiator fan shroud.
4. Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.
CAUTION: Left-hand thread. Remove by turning nut clockwise.
5. Raise vehicle.
6. Drain engine oil and remove oil filter. Do not install drain plug.
7. Remove nut attaching left engine mount insulator to frame. Slightly raise left side of the engine and install a 25mm (one inch) wood block between insulator and frame. Lower engine on block (F-Series only).
8. Remove bolts attaching oil cooler to engine block and remove engine oil cooler.

REMOVAL AND INSTALLATION (Continued)

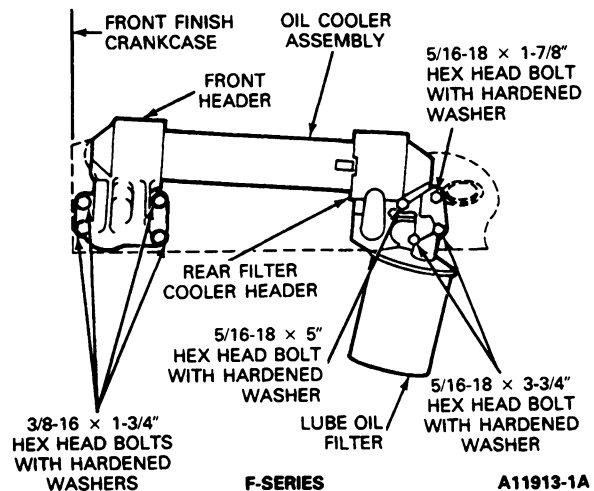
Oil Cooler Installation, E-Series



E-SERIES

A11912-1A

Oil Cooler Installation, F-Series



F-SERIES

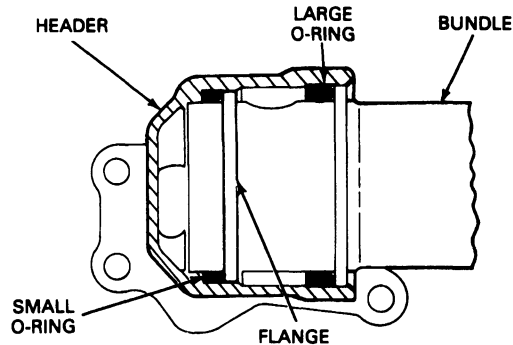
A11913-1A

Installation

1. Assemble cooler and headers; refer to Disassembly and Assembly. Install engine oil cooler assembly with new gaskets. Refer to Specifications, Standard Torque chart, at the end of this section.

NOTE: Four O-rings are used on all oil coolers (F-Series and E-Series).

CAUTION: The inner O-ring must be installed on the header (not on the bundle) to avoid cutting the inner O-ring during assembly.



NOTE:
INSTALL THE LARGE O-RING ON THE OIL COOLER BUNDLE FIRST, THEN INSTALL THE SMALL O-RING ON THE COOLER BUNDLE.

A8704-C

2. Raise engine, remove wood block and lower engine onto No. 1 crossmember (F-Series only).
3. Install insulator attaching washer and nut. Tighten to specification (F-Series only).
4. Lubricate oil filter gasket and install new oil filter until seal contacts filter flange. Tighten filter 1-1/4 to 2 additional turns. Install drain plug and tighten to specification.
5. Prime the entire engine lubricating system to fill the oil cooler, oil filter and cylinder block galleries with the specified type and grade of oil.
NOTE: Priming the lubricating system will minimize the possibility of scuffing or heat build-up during initial engine operation, which could lead to immediate or low mileage failure.
6. Lower vehicle.
7. Check the engine oil level and fill as necessary with the specified type and grade of oil.
8. Fill and bleed the cooling system. Refer to Section 03-03.
9. Install fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.

CAUTION: Left-hand thread. Turn nut counterclockwise to tighten.

Tighten nut to 54-163 N·m (40-120 ft·lb).

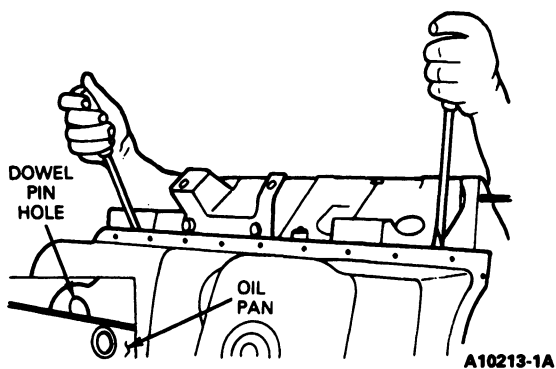
10. Install radiator fan shroud.
11. Connect ground cables at both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

12. Run engine and check for oil and coolant leaks.

REMOVAL AND INSTALLATION (Continued)**Oil Pan, Oil Pump and Oil Pick-Up Tube****Removal**

1. Disconnect ground cables from both batteries.
2. Remove engine oil level dipstick.
3. Remove air cleaner and intake tube and intake opening using Intake Manifold Cover T83T-9424-A.
4. Remove fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B. Position the fan out of the way, in the fan shroud.
CAUTION: Left-hand thread. Remove by turning nut counterclockwise.
5. Drain cooling system.
6. Disconnect the upper lower radiator hoses.
7. Disconnect power steering return hose from pump. Plug hose and pump to prevent contamination of the system.
8. Disconnect alternator and air conditioner compressor wiring harness and fuel line heater connector from alternator. Position the harness away from the engine.
9. Raise vehicle.
10. Disconnect and plug transmission oil cooler lines from radiator, if so equipped.
11. Disconnect and plug fuel pump inlet fuel hose.
12. Drain crankcase and remove oil filter.
13. Disconnect muffler inlet pipe from exhaust manifolds.
14. Disconnect muffler inlet pipe at muffler flange, disconnect the hanger bracket at the frame rail and remove inlet pipe.



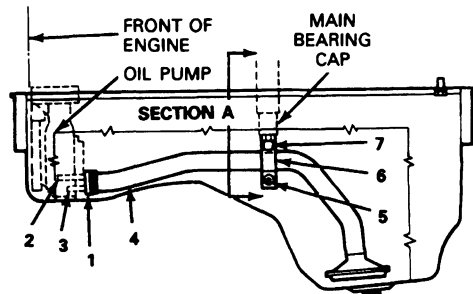
15. Remove upper inlet pipe mounting stud from right exhaust manifold.
16. Remove bolt attaching transmission oil filler tube to engine block and remove tube.
17. Remove nuts and washers attaching engine insulators to No. 1 crossmember.
18. Remove the two bolts securing the shift linkage bell crank to the transmission (automatic transmission). Let the linkage hang freely.
19. Lower vehicle.
20. On Econoline, install Rotunda Engine Floor Crane 014-0007 1 and lifting brackets or equivalent to front of engine. Raise engine until transmission housing contacts body.
On F-Series, install lifting sling to lifting eyes on intake manifold and raise engine until transmission housing contacts body.
21. Install wood blocks (approximately 2-3 / 4 inches left side, 2 inches right side) between engine insulators and crossmember.
22. Lower engine onto blocks to support the engine.
23. Raise vehicle.
24. Remove flywheel inspection plate.
25. Position fuel pump inlet line at rear of No. 1 crossmember. Remove transmission oil cooler lines, if so equipped, and position out of way.
26. On F-Series, remove oil pan retaining bolts and oil pan.
27. Remove oil pump and pickup tube.
28. On Econoline, remove oil pan retaining bolts and lower pan onto front crossmember.
29. Remove oil pump and pickup tube retaining bolts and lower into oil pan.
30. Remove oil pan from vehicle. It may be necessary to turn crankshaft so pan has clearance to come out.
31. Lift oil pump out of oil pan.

Installation

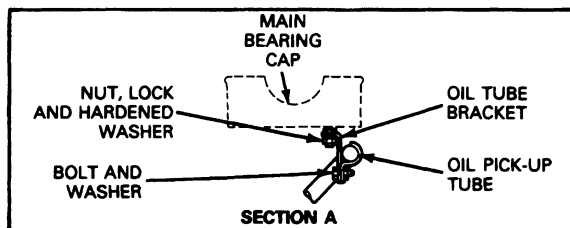
1. Remove old gasket material. Clean mating surfaces of oil pan, engine block and front and rear covers with a suitable solvent and dry thoroughly.

REMOVAL AND INSTALLATION (Continued)

2. Clean mating surfaces of oil pickup tube. Inspect for cracks, and assemble to oil pump with new gasket, if removed. Refer to Specifications, Standard Torque chart.



1. OIL PICK-UP TUBE MOUNTING GASKET
2. 5/16"-18 x 2" BOLT AND 5/16" HARDENED WASHER
3. 5/16"-18 x 1-1/2" BOLT AND 5/16" HARDENED WASHER
4. OIL PICK-UP TUBE ASSEMBLY
5. 5/16"-18 x 0.930 BOLT W/WASHER
6. OIL TUBE BRACKET
7. 5/16"-18 NUT AND 5/16" LOCK AND HARDENED WASHERS

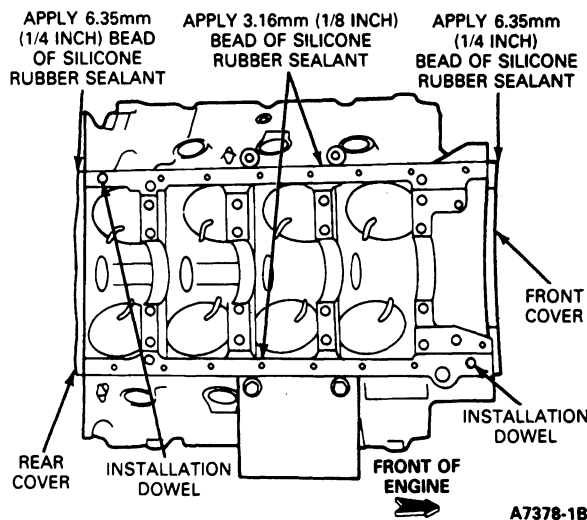


A11914-1A

NOTE: Prime oil pump with recommended engine oil. Rotate pump drive gear to distribute oil within pump body.

3. On F-Series, install oil pump and tighten bolts to specification listed at the end of this section, if removed.
4. On Econoline place oil pump and pick-up tube in oil pan.
5. Place oil pan in position on No. 1 crossmember.
6. Install oil pump and pick-up tube and tighten to specifications (Econoline only).
7. Apply a 3.16mm (1/8-inch) bead of Silicone Rubber Sealant D6AZ-19562-BA (ESB-M4G92-A) or equivalent on side rails of engine block oil pan mating surface and on ends of engine oil pan mating surface on front and rear covers, and in mating corners.

NOTE: When applying Silicone Rubber Sealant always use the bead size specified and join the components within 15 minutes of application. After 15 minutes, sealant begins to set-up and sealing effectiveness may be reduced.



A7378-1B

8. Install locally fabricated oil pan installation dowels in position.
9. Position oil pan onto engine and install attaching bolts.
10. Remove oil pan locating dowels and install two remaining oil pan bolts. Tighten all oil pan retaining bolts. Refer to Specifications, Standard Torque chart at the end of this section.
11. Lower transmission and install the transmission mount retaining nuts. Tighten nuts to 96-128 N·m (70-94 ft-lb).
12. Install flywheel inspection plate and tighten to specifications.
13. Lower vehicle.
14. Raise engine and remove wooden engine support blocks.
15. Lower engine onto No. 1 crossmember and remove lifting sling.
16. Raise vehicle.
17. Position the automatic transmission filler tube (with a new O-ring) and install the retaining bolts. Tighten bolt to specifications. Refer to appropriate section in Group 07, Transmissions.
18. Install nuts and washers attaching engine insulators to No. 1 crossmember and tighten to specifications.
19. On automatic transmission-equipped vehicles, position the shift linkage bell crank to the transmission and tighten the bolts to 27-40 N·m (20-30 ft-lb).
20. Install upper muffler inlet pipe mounting stud on right exhaust manifold.
21. Position muffler inlet pipe and hanger in vehicle and connect muffler inlet pipe to muffler flange, using a new gasket, and tighten to specification.
22. Connect muffler inlet pipe to exhaust manifolds and tighten to specification. Tighten hanger bracket nuts to appropriate specifications. Refer to Section 09-00.

REMOVAL AND INSTALLATION (Continued)

23. Install oil pan drain plug and new oil filter. Tighten plug to 37 N·m (27 ft-lb).
24. Connect fuel pump inlet line to fuel pump and tighten to specification.
NOTE: Make sure fuel line clip is installed in No. 1 crossmember.
25. Connect transmission oil cooler lines, if so equipped, and tighten to specification. Refer to appropriate section in Group 07, Transmissions.
26. Lower vehicle.
27. Connect alternator and air conditioner compressor wiring harness to alternator and compressor. Connect wiring harness to top of fuel filter / fuel heater / water separator.
28. Connect power steering return hose to power steering pump.
29. Connect upper and lower radiator hoses and tighten clamps to 2-3 N·m (18-27 in-lb) double wire clamp; 3-4 N·m (27-35 in-lb) screw clamp.
30. Install radiator fan and clutch assembly using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B and tighten to 54-163 N·m (40-120 ft-lb).
CAUTION: Left-hand thread. Install by turning nut counterclockwise.
31. Remove intake manifold cover, and install air cleaner and intake tube. Refer to Section 03-12.
32. Install engine oil and transmission oil dipsticks.
33. Refill and bleed cooling system. Refer to Section 03-03.
34. Fill crankcase with specified quantity and viscosity of engine oil.
35. Connect ground cables to both batteries.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
36. Run engine and check for oil, fuel and coolant leaks.
37. Check power steering fluid and add, if necessary.

Pistons and Connecting Rods

CAUTION: Do not use a power wrench for removing or installing connecting rod bolts, nuts and washers. Power wrench usage will cause seizure of connecting rod bolt or nut threads.

Removal

1. Remove engine from vehicle and place on an engine stand as outlined in this section, remove injection pump, intake manifold, cylinder heads, oil pan, and oil pump as outlined.

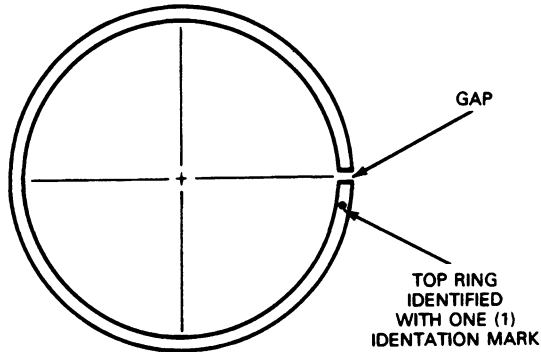
2. Remove any ridges and / or deposits from upper end of cylinder bores as follows:
 - a. Turn crankshaft until piston to be removed is at the bottom of its travel. Place a cloth on piston head to collect cuttings. Remove any ridge and / or deposits from upper end of cylinder bores. Remove cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturer.
CAUTION: Never cut into ring travel area. Maximum cylinder ridge cutter depth is 0.79mm (0.031 inch).
3. Mark all connecting rods and caps to permit installation into original positions.
4. Turn crankshaft until connecting rod being removed is down before dead center (BDC).
5. Remove connecting rod nuts and cap.
6. Install Connecting Rod Installation Guides D83T-6136-A or equivalent onto connecting rod bolts.
7. Push connecting rod and piston assembly out top of cylinder with handle end of a hammer. **Avoid damage to cooling jets, crankshaft journal or cylinder wall when removing piston and rod.**
8. Remove bearing inserts from connecting rod and cap, if required.
9. Install cap onto connecting rod from which it was removed.

Installation

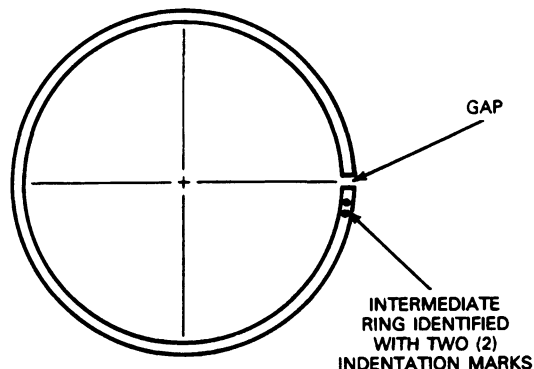
1. Remove cylinder wall glaze if new piston rings are to be installed. Follow instructions of the tool manufacturer. Cylinder bores must be cleaned with a soap and water solution after deglazing or honing. Dry and oil cylinder walls immediately after cleaning as outlined. Use proper size ring installer tool.
2. Oil piston rings, pistons, and cylinder walls with specified engine oil. **Be sure to install pistons in same cylinders from which they were removed, or to which they were fitted. Connecting rods and bearing caps must be numbered 1, 3, 5, 7, in left bank, beginning at front of engine. The numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with a new cylinder number.**
3. Make sure ring gaps (oil ring spacer-A, oil ring-B, compression ring-C) are properly spaced around circumference of piston. Piston rings are identified by indents as shown.

REMOVAL AND INSTALLATION (Continued)

Ring Identification



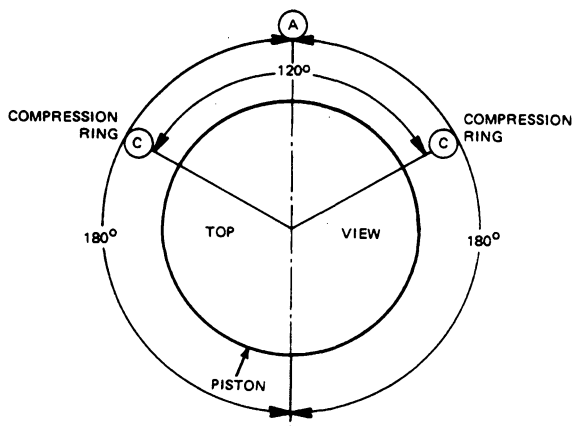
TOP COMPRESSION RING



INTERMEDIATE COMPRESSION RING

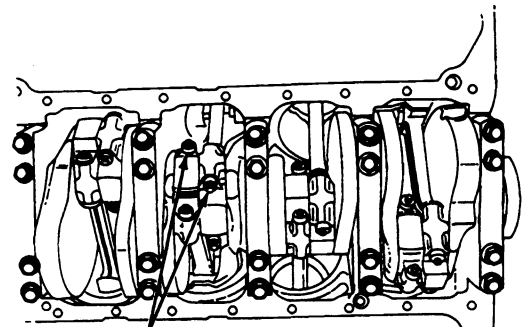
A11915-1A

Piston Ring Spacing



A7304-1B

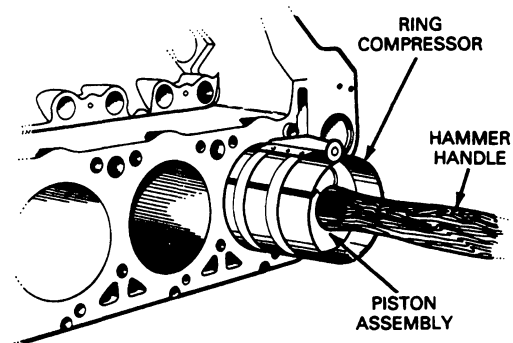
4. Turn crankshaft throw to position shown.



CONNECTING RODS POSITIONED FOR REMOVAL

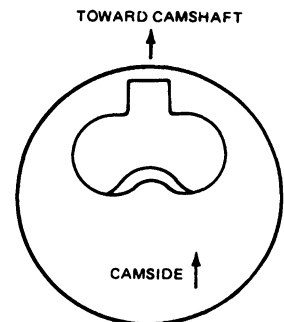
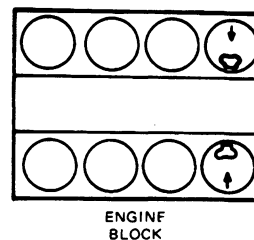
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5. Install connecting rod upper bearing. Install Connecting Rod Installation Guides D83T-6136-A or equivalent. Before installing, make sure that large chamfer on connecting rod faces crankshaft check (facing toward front on engine on right bank rods, and toward rear of engine on left bank rods). Install Piston Ring Compressor D81L-6002-C or equivalent onto piston and push piston in with a hammer handle until it is slightly below top of cylinder. Guide connecting rods to avoid damaging cooling jets and crankshaft journals. **Install piston with arrow and eyebrows on piston head toward camshaft.**



A10681-1A

Piston Orientation



A7379-1C

6. Push piston downward until connecting rod bearing seats on crankshaft journal. Remove protective sleeves and install lower bearing and cap.

REMOVAL AND INSTALLATION (Continued)

7. Check clearance of each bearing and connecting rod side clearance following procedure described under Main and Connecting Rod Bearings.
8. Apply a light coat of specified engine oil to journals and bearings.
NOTE: Lightly coat bolt threads with oil before installing.
9. Install connecting rod cap and bearing. Tighten connecting rod nuts alternately to 52 N·m (38 ft-lb). Tighten nuts to 69 N·m (51 ft-lb).

Crankshaft**Removal**

1. With engine removed from vehicle and placed on an engine stand, as outlined in this section, remove injection pump and adapter, engine front and rear covers, oil pan, oil pump and pick up, as outlined.
2. Mark all bearing caps (main and connecting rod) to permit installation into their original locations.
CAUTION: Use care to avoid damage to crankshaft journal, cooling jets and cylinder wall when moving piston assembly.
3. Turn crankshaft until connecting rod from which cap is being removed is down before dead center (BDC) and remove bearing cap. Install Connecting Rod Installation Guides D83T-6136-A or equivalent and push connecting rod and piston assembly up into cylinder. Remove rod and piston from cylinder. Remove guides and install bearing cap. Repeat this procedure until all connecting rods are removed.
4. Remove main bearing caps. Main bearing caps are numbered from front of engine.
5. Install Engine Lifting Brackets T70P-6000 to crankshaft and lift crankshaft out of block so that thrust bearing surfaces are not damaged. **Handle crankshaft with care to avoid possible fracture or damage to finished surfaces.**

Crankshaft Repair

Clean all parts with cleaning solvent, dry with compressed air, and inspect bearings for wear and evidence of uneven bearing support. If such evidence is present, examine bearing caps and supporting surfaces or crankcase for high spots and burrs.

Inspect crankshaft journals for scoring, burning and cracking. Measure diameter of each journal using a micrometer. Check dimensions obtained against specifications listed at the end of this section. Measure each journal at two points, one at right angles to other, in order to show any evidence of out-of-round. Move micrometer over entire width of journal.

Crankshafts must not be straightened. Even slight straightening with complete absence of cracks will endanger the high strength built into the shaft.

Bearing failures can cause overheating of crankshaft journals and a reduction of hardness. When this occurs, the crankshaft strength may be unacceptably reduced. Whenever bluing is found on the journal or fillet area, the crankshaft must be replaced.

Crankshaft Grinding

An induction-hardened fillet and journal crankshaft can be reground similar to any precision crankshaft.

Crankshafts should be ground at a qualified machine shop, experienced in grinding induction hardened crankshafts. Crankshafts should be magnifluxed after grinding to make sure that there are no surface cracks.

Grinding Limits

Maximum allowable taper on crankpins (rod journals) and main journals is .013mm (.0005 inch) per 25.4mm (1 inch) of length. Crankpins and journals must be polished from 508 Micro-mm (20 Micro-inch) maximum to 127 Micro-mm (5 Micro-inch) minimum, and must not be over 0.003mm (0.0001 inch) out of round.

The main journal fillet radii should be 3.07-3.226mm (.121-.127 inch) with the crankpins (rod journals) fillet radii held at 3.05mm (.120 inch).

The third main journal controls crankshaft end thrust and provides initial location of crankshaft in relation to crankcase. For this reason the width of the third journal must be 28.766-28.841mm (1.1325-1.1355 inches).

Fitting Main or Connecting Rod Bearings With Plastigage**Main Bearings**

NOTE: Be sure bearing inserts, bearing bore and mating surfaces are clean. Foreign material under inserts will distort bearing and cause incorrect readings and subsequent bearing failure.

To obtain an accurate reading using plastigage method of checking, all bearing caps must be in place and tightened to 101 N·m (75 ft-lb); then to 129 N·m (95 ft-lb).

1. Remove one bearing cap and insert. Leave remaining caps tight while checking fit of bearing.
2. Wipe oil from all contact surfaces such as crankshaft journal, bearing insert, bearing caps, etc.
3. Place piece of Plastigage D81L-6002-B or equivalent across full width of bearing surface on crankshaft journal (or bearing cap insert) approximately 6.35mm (1/4 inch) off center. Install bearing cap and tighten cap bolt to specification.

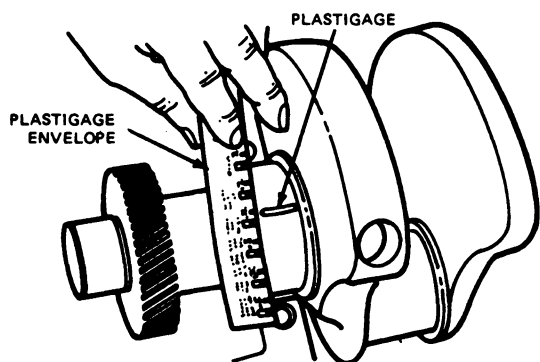
NOTE: Lightly coat bolt threads with oil before installing.

NOTE: Do not turn crankshaft while making check with plastigage.

4. Remove bearing cap and insert.

REMOVAL AND INSTALLATION (Continued)

5. Do not disturb plastigage. Using plastigage envelope, measure widest point of plastigage. Reading indicates bearing clearance in thousandths of an inch.



A7383-1A

6. Crankshaft must be reground and undersize bearings installed if the bearing clearance is not within specifications.
7. Use Dial Indicator with Bracketry TOOL-4201-C or equivalent to check end play as outlined in Section 03-00.

Connecting Rod Bearings

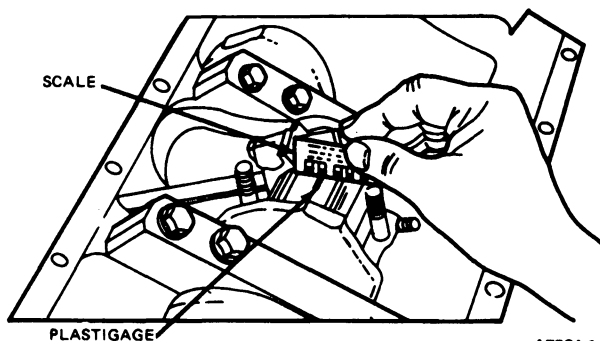
NOTE: Make sure bearing inserts, bearing bore and mating surfaces on connecting rod and cap are clean. Foreign material under inserts will distort bearing and cause incorrect readings and subsequent bearing failure.

1. Remove bearing cap and wipe oil from face of bearing insert and exposed portion of crankshaft journal.
2. Place a piece of Plastigage Tool D81L-6002-B or equivalent on bearing surface across full width of bearing about 6.35mm (1/4 inch) off center.
3. Install cap and tighten 101 N·m (75 ft-lb); then 129 N·m (95 ft-lb).

NOTE: Lightly coat bolt threads with oil before installing.

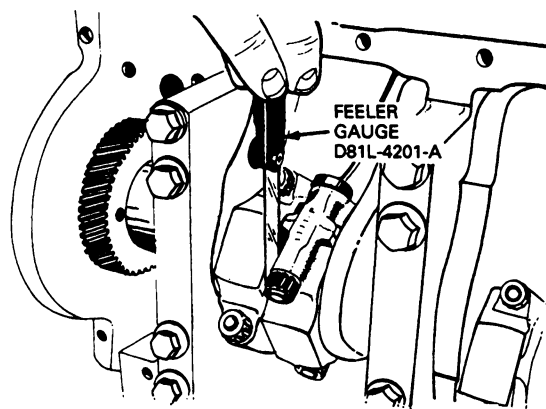
NOTE: Do not turn crankshaft while plastigage is in place.

4. Remove bearing cap and use plastigage scale to measure widest point of plastigage. Reading indicates bearing clearance in thousandths of an inch. The opposite side of the scale indicates bearing clearance in tenths of millimeters.



A7384-1A

5. Crankshaft must be reground and undersize bearings installed if bearing clearance is not within specifications.
6. Check connecting rod end clearance using Feeler Gauge D81L-4201-A or equivalent as shown. Excessive clearance may require replacement of rods or shaft. Check should be made to make certain specified running clearance exists. Lack of clearance could indicate damaged rod or rod bearing out of position.



A10679-1A

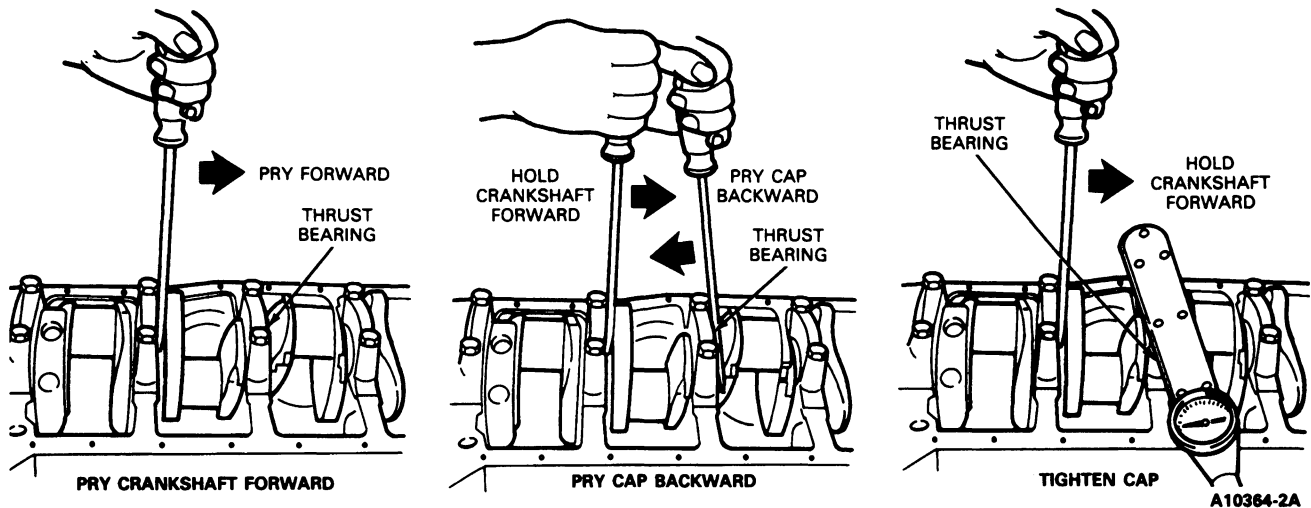
Installation

1. Remove main bearing inserts from block and bearing caps.
2. Clean mating surfaces of block and main bearing caps.
3. Remove connecting rod bearing inserts from connecting rods and caps.
4. Install correct undersize bearings if crankshaft main bearing journals have been refinished to a definite undersize. Make sure bearing inserts and bearing bores are clean. Foreign material under inserts will distort bearings and cause failure.
5. Place upper main bearing inserts with tangs fitting in slots, and oil holes into position in bores. Do not install thrust bearing (No. 3 main bearing) at this time.
6. Install lower main bearing inserts into bearing caps.

REMOVAL AND INSTALLATION (Continued)

7. Carefully lower crankshaft into place. **Handle crankshaft with care to avoid possible fracture or damage to finished surfaces.** If necessary refer to Cleaning and Inspection.
8. Remove lifting eyes.
9. Install upper No. 3 main bearing (thrust flanges and oil hole) by rolling main bearing into saddle.
10. Check clearance of each main bearing following procedure under Fitting Main and Connecting Rod Bearings.
11. Apply specified engine oil to journals and bearings.
12. Install all bearing caps, except thrust bearing cap (No. 3 bearing). **Be sure that main bearing caps are installed in their original locations.** Tighten bearing cap bolts to 101 N-m (75 ft-lb); then to 129 N-m (95 ft-lb).
13. Install thrust bearing cap with bolts finger-tight.
14. Pry crankshaft forward against thrust surface of upper half of bearing.
15. Hold crankshaft forward and pry thrust bearing cap to rear. This will align thrust surfaces of both halves of bearing.
16. Retain forward pressure on crankshaft. Tighten cap bolts to specification.
17. Force crankshaft toward rear of engine.
18. Check crankshaft end play as outlined in this section.

Aligning Thrust Bearing Cap, Typical



Camshaft

Removal

1. Remove engine from vehicle as outlined in this section.
2. With engine placed on an engine stand, remove injection pump and adapter, intake manifold and tappets, engine front cover and fuel supply pump as outlined in this section.
3. Remove camshaft drive gear, fuel supply pump cam, spacer and thrust plate from the camshaft as outlined in this section.
CAUTION: Use care to avoid damaging camshaft bearings.
4. Remove camshaft.

Camshaft Repair

Remove light scuffs, scores or nicks from camshaft machined surfaces with smooth oil stone marks.

Installation

Coat camshaft lobes with Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent and lubricate journals with specified engine oil before installation.

1. Oil camshaft journals and apply Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent to lobes. Carefully slide camshaft through bearings. If tools are available, a handle may be fabricated for easier installation of camshaft by connecting the Puller Screw Extension from Camshaft Bearing Set T65L-6250-A into suitable camshaft installation adapter. This assembly is then connected onto the end of the camshaft prior to installation. Remove the handle assembly when camshaft is properly seated in the bearings. Install new camshaft thrust plate onto cylinder block and tighten to specification listed at the end of this section.

REMOVAL AND INSTALLATION (Continued)

2. Install spacer and fuel pump cam against camshaft thrust flange using Crank / Cam Gear and Damper Replacer T83T-6316-B.
3. Install camshaft drive gear against fuel pump cam, aligning timing mark with timing mark on crankshaft drivegear using Crank / Cam Gear and Damper Replacer T83T-6316-B.
4. Install camshaft Allen screw and tighten to 20 N·m (15 ft-lb).
5. Install fuel supply pump, as outlined in this section.
6. Install new crankshaft oil seal in engine front cover as outlined in this section.
7. Install engine front cover as outlined in this section.
8. Install water pump as outlined in this section.
9. Install injection pump adapter as outlined in this section.
10. Lubricate tappets and bores with specified engine oil and install tappets in their original positions.
11. Install tappet guides.
12. Install tappet guide retainer and tighten to specification listed at the end of this section.
13. Position push rods, copper colored ends toward rocker arms, into their respective tappets making sure they are seated fully in push rod seats.
14. Install rocker arms and valve covers with new gaskets as outlined.
15. Install intake manifold as outlined in this section.
16. Install injection pump as outlined in this section.
17. Install engine into vehicle as outlined in this section.

Camshaft Bearings

The bearings are interchangeable from one bore to another except for the front bearing which is wider than the others.

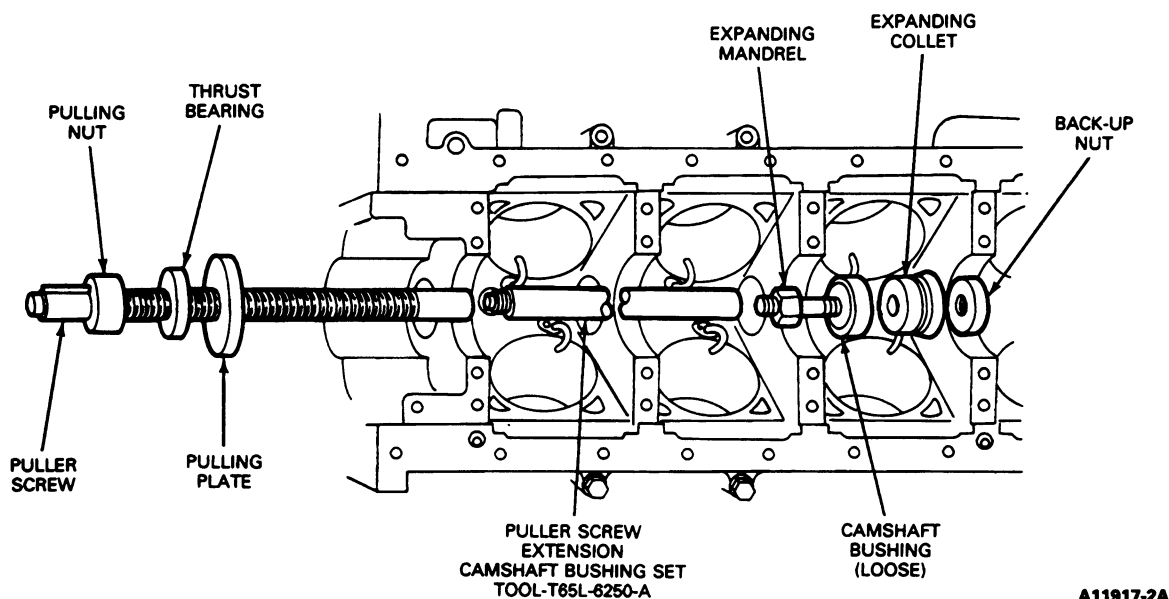
Removal

1. Remove engine from vehicle as outlined in this section. Mount engine stand using Rotunda Engine Stand Mounting Adapter 014-00306 or equivalent.

2. Remove camshaft, flywheel and crankshaft, following appropriate procedures in this section. Push pistons to top of cylinders.

CAUTION: Use care when pushing pistons to top of cylinders to prevent damage to piston cooling jets. Using Connecting Rod Installation Guides D83T-6136-A or equivalent protect connecting rod bolts.

3. Using Camshaft Bearing Set T65L-6250-A select proper size expanding collet and backup nut and assemble on expanding mandrel. With expanding collet collapsed, install collet assembly in camshaft bearing, and tighten back-up nut on expanding mandrel until collet fits camshaft bearing.

Camshaft Bearing Replacement, Typical

REMOVAL AND INSTALLATION (Continued)

4. Assemble puller screw and extension, if necessary, as shown and install on expanding mandrel. Wrap a cloth around threads of puller screw to protect front bearing or journal. Tighten pulling nut against thrust bearing and pulling plate to remove camshaft bearing. Be sure to hold wrench on end of puller screw to prevent it from turning.
5. Repeat procedure for each bearing. To remove front bearing, install puller screw from rear of cylinder block.

Installation

1. Position new bearings at bearing bores with oil holes aligned, and press in place with Camshaft Bearing Set T65L-6250-A shown under Removal. Be sure to center pulling plate and puller screw to avoid damage to bearing. **Failure to use correct expanding collet can cause severe bearing damage. Be sure front bearing is installed the specified distance below front face of cylinder block.**
2. Install camshaft, crankshaft, flywheel and related parts, as outlined. It is not necessary to check connecting and main bearing clearances as a part of camshaft bearing replacement.
3. Install engine into vehicle as outlined in this section.

Core Plugs

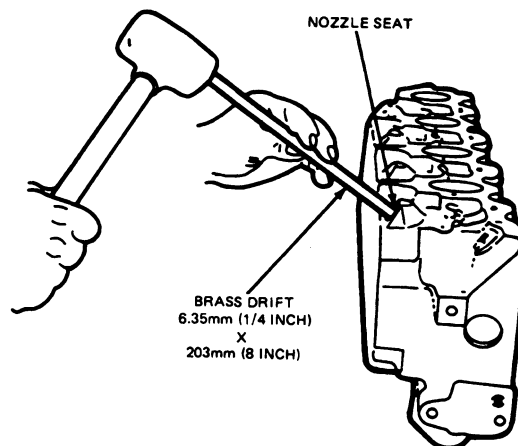
Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

DISASSEMBLY AND ASSEMBLY

Cylinder Head Assembly

Disassembly

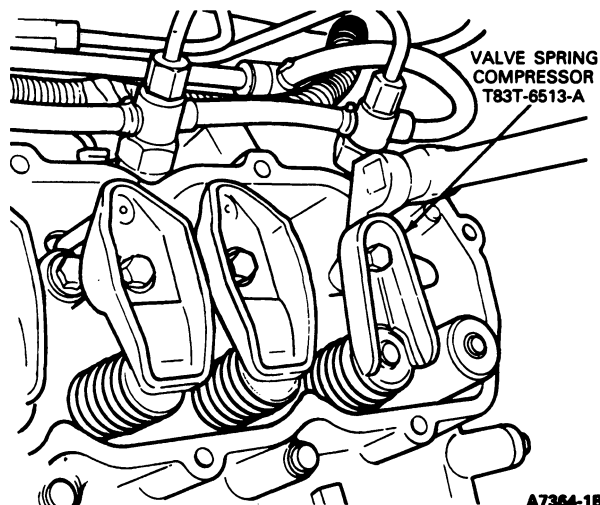
1. Remove precombustion chamber inserts using a 6.35mm x 203mm (1/4-inch x 8-inch) brass drift and suitable hammer.



A7376-1A

2. Place cylinder head in suitable holding fixture.
NOTE: Be careful not to damage the cylinder head gasket surface.
3. Install Valve Spring Compressor T83T-6513-A and compress valve spring and remove valve keeper.

NOTE: It may be necessary to strike valve stem end with a light, soft hammer to loosen valve keepers.



A7364-1B

4. Release spring compressor and remove spring retainer, valve spring and damper assembly.
NOTE: Keep valves and their related parts together so they may be installed in their original positions. Refer to Valve Spring, Retainer and Stem Seal in this section.
5. Remove valve seal, valve rotators and valves.
NOTE: Remove any burrs from valve stem before removing valves to prevent damage to the valve bore.

DISASSEMBLY AND ASSEMBLY (Continued)

Valve Guides

Removal and Installation

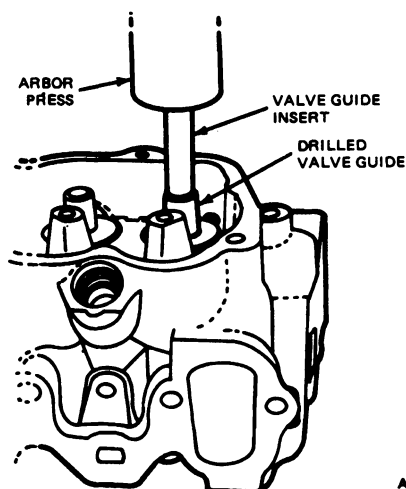
Excessive guide clearance prevents adequate cooling of valve through guide and allows valve to tilt or tip which may cause valve breakage at high engine speed. These conditions prevent good seating and promote leakage past valve face. If valve guides are either larger than specified or damaged, use suitable valve guide tools and follow manufacturer's instructions. Install as follows:

1. Remove cylinder head and valve as outlined in this section.
2. Drill out valve guide.
3. Ream drilled guide bore for recommended insert sleeve.

NOTE: Before installing inserts they should be thoroughly chilled with dry ice or other means to facilitate their installation in the cylinder head.

4. Chill repair insert in dry ice. Carefully press insert into bore.

NOTE: When installing repair insert, be careful not to burr inside diameter of insert.



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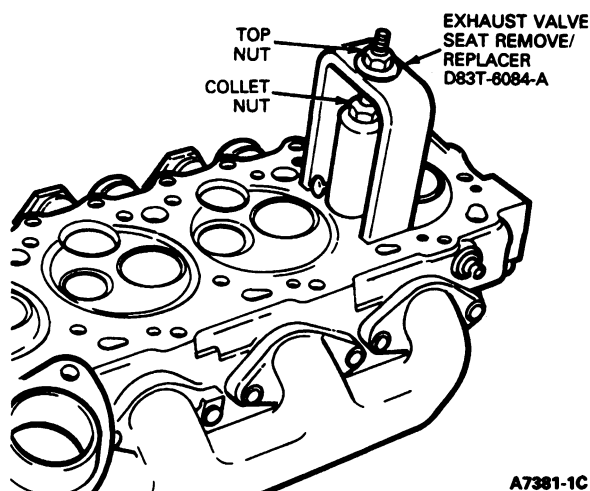
5. Finish insert with recommended size reamers to specified valve guide diameter. Always re-face valve seat after valve guide has been reamed, and use suitable scraper to break sharp corner (inside diameter) at top of valve guide.
6. Install valve(s) in cylinder head and install cylinder head as outlined in this section.

Valve Seats

Prior to seat reconditioning, clean seats and inspect for cracks, burning or other damage. Inspect exhaust seat inserts for looseness.

Exhaust Seats, Removal

1. Use Exhaust Valve Seat Remover / Replacer D83T-6084-A or equivalent to remove damaged or loose seats. Position removal collet into insert and rotate collet nut clockwise to expand collet jaws under lip of seat insert.



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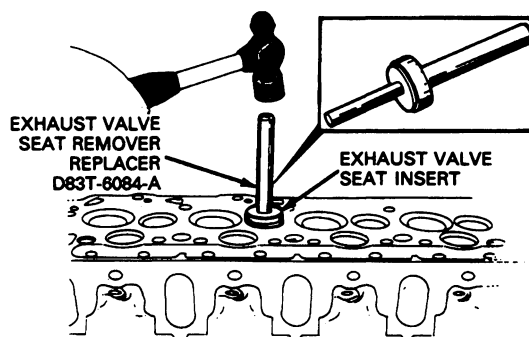
2. Rotate top nut clockwise to remove insert.

NOTE: If an oversize seat insert is required, the cylinder head should be sent out to a qualified machine shop for insert counterbore procedure.

Valve seat inserts supplied for service are standard size, .015 inch oversize and .030 inch oversize.

Exhaust Seats, Installation

1. Install valve seat using Exhaust Valve Seat Remover / Replacer D83T-6084-A or equivalent and a hammer.



A10680-1A

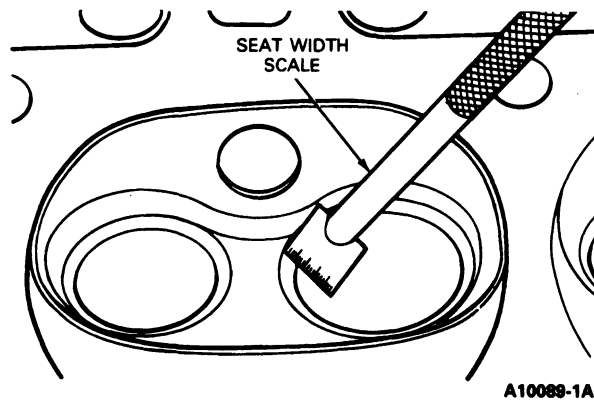
Refacing Valve Seats

Refacing of valve seat should be closely coordinated with refacing of valve face so that finished seat and valve face will be concentric and specified interference fit will be maintained. This is important so that valve and seat will have a compression tight fit. Make sure that valve seat grinding wheels are properly dressed.

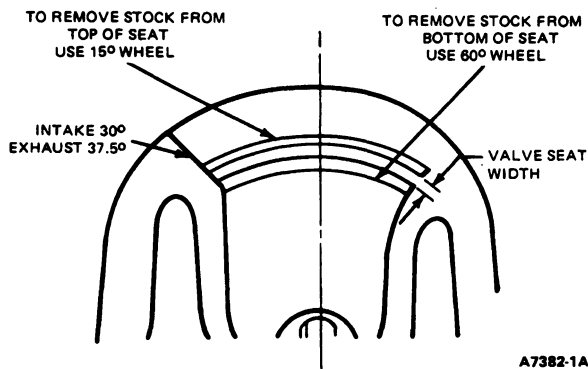
Grind valve seats to specification listed at the end of this section. Remove only enough stock to clean up pits and grooves or to correct valve seat runout. After seat has been refaced, use seat width scale or machinist's scale to measure seat width. Narrow seat if necessary to bring it within specification. Refer to specifications listed at the end of this section.

DISASSEMBLY AND ASSEMBLY (Continued)

If valve seat width exceeds maximum limit, remove enough stock from top edge and / or bottom edge of seat to reduce width to specification.



Use a 60 degree angle grinding wheel to remove stock from bottom of seats (raise seats) and use a 15 degree angle wheel to remove stock from top of seats (lower seats).



Finished valve seat should contact approximate center of valve face. It is good practice to determine where valve seat contacts face. To do this, coat seat with Prussian blue and set valve in place. Rotate valve with light pressure. If blue is transferred to center of valve face, contact is satisfactory. If blue is transferred to top edge of valve face, lower valve seat. If blue is transferred to bottom edge of valve face, raise valve seat. **Fit of valve and seat should never be lapped out with lapping compounds.**

Valves

Inspect valve for evidence of burning, warping, scuffing or bending. Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged, if face runout cannot be corrected by refinishing, or if stem clearance exceeds specifications. Refer to specification.

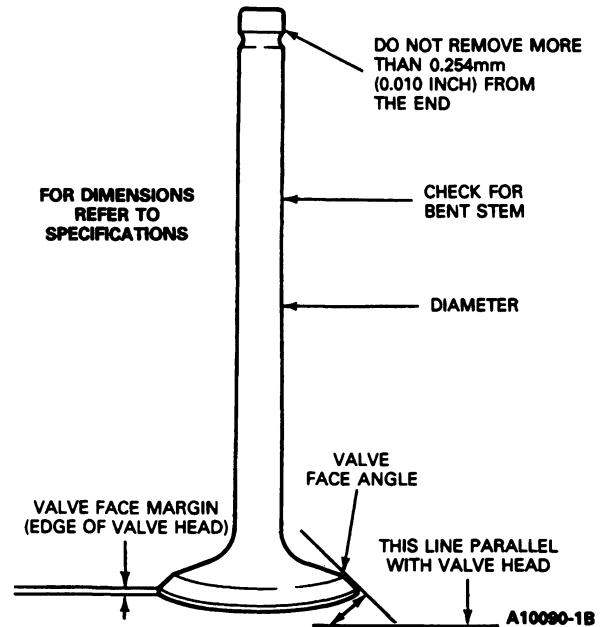
Discard any worn or damaged valve train parts.

Refacing Valves

The valve refacing operation should be closely coordinated with valve seat refacing operations so that finished angles of valve face of valve seat will be to specifications and provide a compression tight fit. Be sure that valve grinding wheels are properly dressed.

If valve face runout is excessive and / or to remove pits and grooves, reface valves to specification. Remove only enough stock to correct runout or to clean up pits and grooves. If edge of intake valve head is less than 2.84mm (0.112 inch) thick after grinding, replace valve as valve will run too hot in engine. If edge of exhaust valve head is less than 1.35mm (0.053 inch) thick after grinding replace valve. **Interference fit of valve and seat should not be lapped out.**

Critical Valve Dimensions



Remove all grooves or score marks from end of valve stem, and chamfer it as necessary. **Do not remove more than 0.254mm (0.010 inch) from end of valve stem.**

If valve and / or valve seat has been refaced, it will be necessary to check clearance between rocker arm pad and valve stem tip with valve train assembly installed in engine.

Assembly

1. Clean and inspect cylinder head and valves, as outlined.
NOTE: To avoid erroneous readings, remove precombustion chamber inserts prior to inspection of cylinder head gasket surface.
2. Clean and inspect cylinder head gasket surface for cracks and flatness, as outlined.
3. Install valves, springs, retainers and stem seals, as outlined.
4. Clean and inspect prechambers and ports for cracks. Install or replace prechambers as necessary. Refer to Overhaul, Cylinder Head Assembly in this section.

DISASSEMBLY AND ASSEMBLY (Continued)

5. Apply a light coating of Steering Linkage Lube D4AZ-19590-A (ESA-M1C92-A) or equivalent to mounting edge of prechamber and install prechamber into head. Lightly tap with plastic-tipped hammer, if necessary.
6. Clean and inspect engine block head gasket surface for cracks and flatness.

Cylinder Assembly**Disassembly**

1. Mount the engine on a work stand using Rotunda Engine Stand Mounting Adapters 014-00306 or equivalent and remove all parts not furnished with new cylinder assembly. Follow applicable Removal and Installation procedures in this section.
2. Remove four cylinder head locating dowels and block drain plugs.
3. Remove old cylinder assembly from work stand.

Assembly

1. Clean gasket and seal surfaces of all serviceable parts and assemblies with a suitable solvent and dry thoroughly.
2. Position new cylinder assembly on a work stand and install cylinder head locating dowels and block drain plugs.
3. Transfer all serviceable parts removed from original cylinder assembly, following procedures described under Removal and Installation in this section.
4. Check all assembly clearances. Make sure that clearances are in accordance with specifications listed at the end of this section. Service as necessary.

Cylinder Block

Before replacing a cylinder block, determine if it is repairable. If so, make the necessary repairs, following procedures outlined.

Disassembly

1. Mount old engine in a work stand using Rotunda Engine Stand Mounting Adapters 014-00306 or equivalent. Completely disassemble engine following procedures described under Removal and Installation in this section.
2. Ridge-ream cylinder bores before removing piston assemblies.
3. Remove cylinder head locating dowels and block drain plugs.

Refinishing Cylinder Walls

1. To refinish cylinder walls, obtain a "flexhone" for a 4-inch bore engine with a 120 grit rating (no color code). This type of hone looks like a wire brush with carbide balls on the ends of the bristles. Obtain a full 12-ounce container of Ford Rust Penetrant and Inhibitor D7AZ-19A501-AA (ESR-M99C56-A) or equivalent. This spray contains colloidal graphite and has a black appearance. Obtain an electric or air-powered drill motor with adjustable speed. A speed of about 100 rpm is required. If this is not available, **REPAIR WILL NOT BE SUCCESSFUL.**

NOTE: It is NOT necessary to remove crankshaft, however, it is good practice to oil the rod journals and wrap them in a shop towel with tape.

2. Spray cylinder wall and hone cylinder wall for about three seconds while stroking up and down twice a second. Remove the hone (ALWAYS REMOVE WITH HONE ROTATING), and wipe a portion of cylinder wall. Inspect the crosshatch pattern comparing it to the neighboring (untouched) cylinder. The crosshatch angle should be 120 to 135 degrees.

NOTE: Comparison with a "virgin" bore is the best check, provided the engine has not been repaired before. If the pattern is "flatter" than called for, increase stroke speed or slow down rotation speed. The hone will not damage the piston cooling jet and honing to the very bottom of the cylinder is not required as the piston ring travel stops well short of the bottom of the bore. The hone must be partly removed from the block at the top of each stroke.

Continue honing the cylinder (after adjusting your technique to get required 120 to 135 degrees crosshatch) for 10 to 15 seconds, while an assistant continuously sprays the graphite spray at the cylinder well. Do not spend more than 15 seconds (25 strokes) per bore. Wipe cylinder bore clean and inspect. The bore should have a satin-like sheen with a clearly identified crosshatch pattern of 120 to 135 degrees. Compare with a virgin bore to confirm correct angle. Repeat for remaining cylinders.

3. Wash all cylinders with mild soap and water (like dishwashing solution). Air dry with shop air and immediately oil cylinder walls to prevent corrosion.

Repairing Engine Casting Holes and Porosities

Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

Assembly

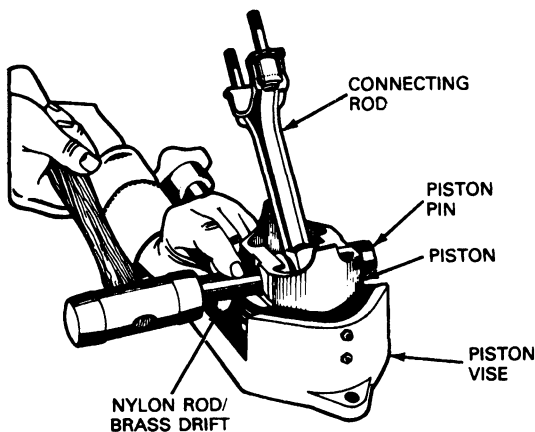
1. Clean gasket and seal surfaces of all serviceable parts and assemblies with a suitable solvent and dry thoroughly.
2. Position new cylinder block in a work stand and install cylinder head locating dowels and block drain plugs.

DISASSEMBLY AND ASSEMBLY (Continued)

3. Transfer all serviceable parts removed from original cylinder block following procedures described under Removal and Installation in this section.
4. Check all assembly clearances. Make sure that clearances are in accordance with Specifications at the end of this section. Service as necessary.

Piston and Connecting Rod Assembly**Disassembly**

1. Remove bearing inserts from connecting rod and cap.
2. Mark pistons to assure assembly with same rod and installation into cylinders from which they were removed.
3. To disassemble connecting rod from piston and piston pin assembly, remove piston pin retainers from each end of pin using snap ring pliers.
4. After placing piston in vise, drive pin from assembly using drift and hammer or equivalent, or brass drift and plastic-tipped hammer.



A10676-1A

5. After pin is removed, separate piston from connecting rod. Remove all old rings from piston. Clean and inspect components as described in this section.

Fitting Pistons

Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

NOTE: Piston cooling jets must be removed before glaze breaking cylinders. Cooling jets are reusable.

CAUTION: Special "patch" bolts are used to install piston cooling jets. These bolts are included with new cooling jets. **DO NOT** use standard bolts.

Fitting Piston Pins

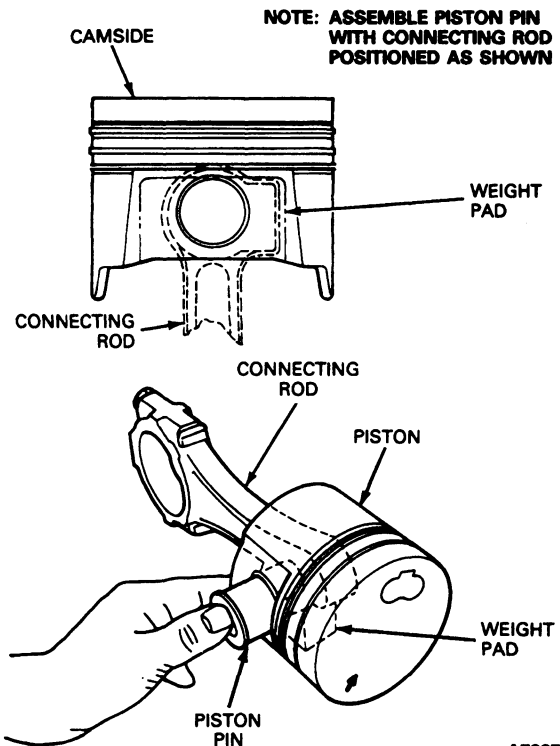
Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

Fitting Rings

Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

Assembly

1. To assemble piston to connecting rod, position rod into piston so that connecting rod weight pad and large chamfered side is located against crankshaft face and top of piston's arrow faces camside.

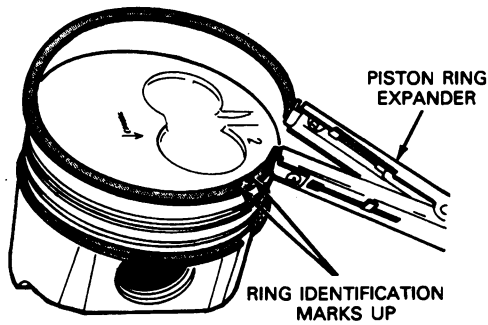


A7387-1B

2. Lubricate piston pin with specified engine oil. Align rod bore and piston bore and insert piston pin. Push piston pin with thumb and install retainer snap rings. Make sure that retainer rings seat fully in their grooves.
3. After checking piston ring end gap, assemble rings onto pistons to which they were fitted by using a suitable ring expander tool. This type of tool is recommended to avoid over-expansion of rings, and also to expand rings to a true circle to avoid distortion.

DISASSEMBLY AND ASSEMBLY (Continued)

4. Check ring side clearance as outlined.



**IMPORTANT: INSTALL IN ORDER:
OIL CONTROL RING,
2ND COMPRESSION RING AND
TOP COMPRESSION RING.
SPACE RING GAPS 120° APART.**

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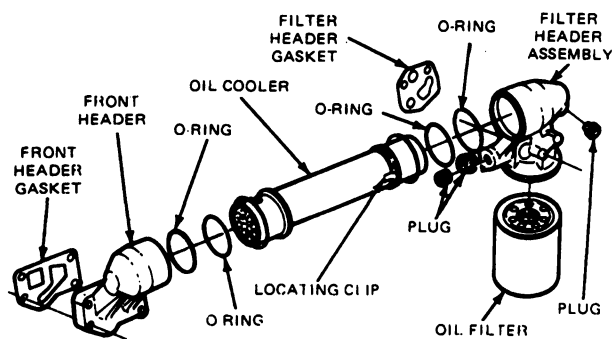
Oil Cooler

If oil is found in the cooling system, or coolant found in the oil, the oil cooler should be checked for leakage as outlined.

If oil cooler O-rings are leaking, remove oil cooler as outlined. Disassemble and repair as follows.

Disassembly

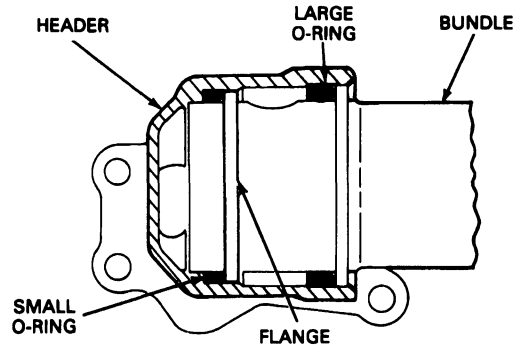
1. Gently rap front and oil filter headers to loosen O-rings. Twist oil cooler apart.
2. Clean oil cooler, front header and filter header thoroughly in suitable solvent. The oil cooler should be thoroughly flushed and drained to remove all residue within it.



A7422-1B

Assembly

1. Use new O-rings when assembling oil cooler. Lubricate all O-ring mating surfaces and O-rings prior to assembly with clean engine oil.
2. Install the large O-rings on the oil cooler bundle first, then install the small O-rings on the cooler bundle.



**NOTE:
INSTALL THE LARGE O-RING ON THE OIL
COOLER BUNDLE FIRST, THEN INSTALL THE SMALL
O-RING ON THE COOLER BUNDLE.**

A8704-C

3. Press assembly together making sure locating clips align in slots and header is not cocked.
4. Test oil cooler assembly, as outlined before installing on engine.

ADJUSTMENTS

Refer to Powertrain Control/Emissions Diagnosis Manual ⁵ for adjustment procedures.

⁵ Can be purchased as a separate item.

CLEANING AND INSPECTION

Crankcase Depression Regulator (CDR)

Refer to Truck Pre-Delivery, Maintenance and Lubrication Manual for the correct mileage interval for maintenance. Service following procedures described in this section.

Valve Rocker Arm Assembly

Cleaning

Clean all parts thoroughly.

Inspection

Inspect pad at valve end of rocker arms for indications of scuffing or abnormal wear. If pad is grooved, replace rocker arm. **Do not attempt to true this surface by grinding.** Check fulcrum and spherical pushrod seats for excessive wear, cracks, nicks or burrs. Inspect fulcrum seat of rocker arm post for excessive wear.

Push Rods

Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

Cylinder Heads

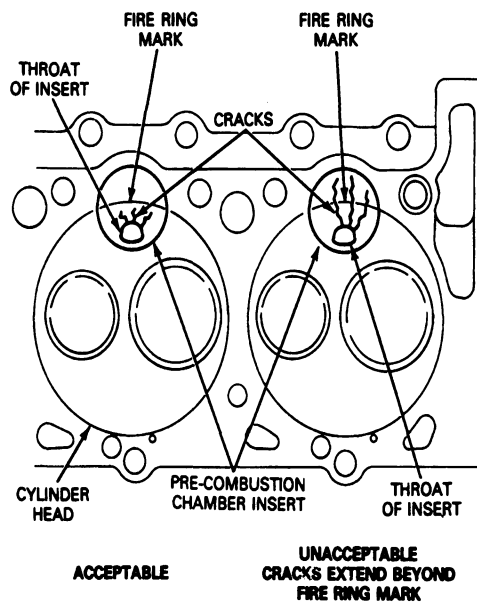
Cleaning

With valves installed to protect the seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. **Be careful not to damage cylinder head gasket surface.** After valves are removed, clean valve guide bores with a valve guide cleaning tool. Use cleaning solvent to remove dirt, grease and other deposits; clean all bolt holes; ensure valve seats, gasket surfaces and oil return passages are clean. Clean all valve assembly components using a suitable solvent and dry thoroughly.

Inspection

1. Examine cylinder head for cracks in combustion chambers, intake and exhaust valve ports, and around intake valve seats. Inspect exhaust valve seat inserts for looseness burned or cracked condition. Inspect gasket and sealing surfaces for scratches or mars which may cause leakage after assembly.

NOTE: Precup insert cracking is acceptable from the throat of the precombustion chamber. The cracking becomes unacceptable if the cracks extend beyond the fire ring. Acceptable and unacceptable precup cracks are illustrated. Replace unacceptable precombustion chambers.

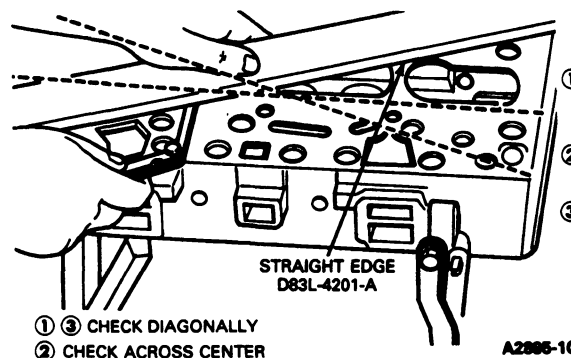


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2. Using a straightedge and a 0.15mm (0.006 inch) feeler gauge, check cylinder head gasket surface for warpage.

Replace cylinder head if it is cracked or warped.

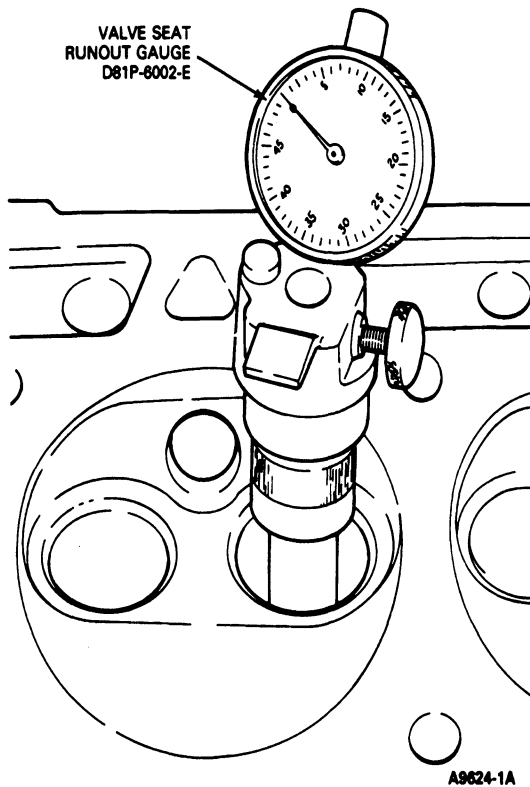
NOTE: Cylinder heads cannot be resurfaced.



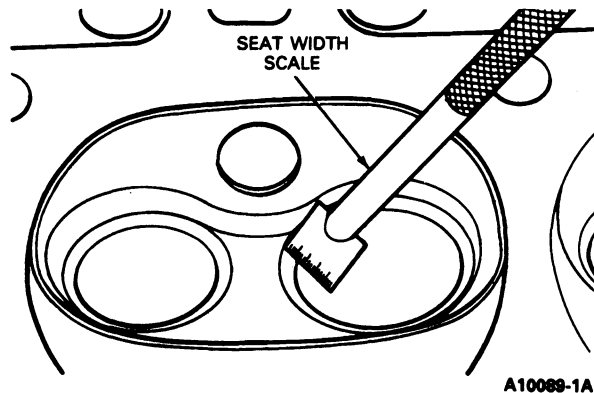
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CLEANING AND INSPECTION (Continued)

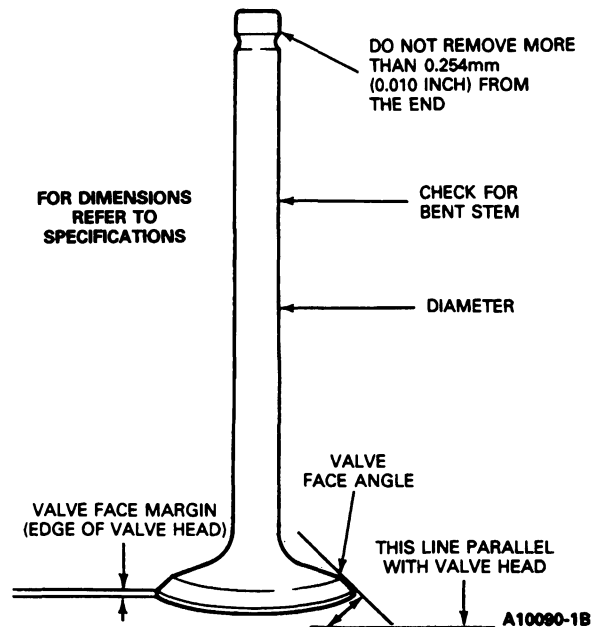
3. Check valve seat runout with suitable valve seat runout gauge. Follow instructions of gauge manufacturer. If runout exceeds service limit, reface valve and valve seat.



4. Measure valve seat width. Reface valve seat(s) as outlined in this section if width is not within specifications.

**Valves****Visual Inspection**

Critical inspection points and tolerances of valve are illustrated. Refer to Specifications at the end of this section for service limits. Remove all carbon from valve stems and valve heads using a fine wire brush or buffing wheel.



Inspect valve face and edge of valve head for pits, grooves or scores. Inspect stem for a bent condition and end of stem for grooves or scores. Check valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

Visually inspect valve springs, valve spring retainers, locks and sleeves and discard any damaged parts.

Inspect valve keepers for excessive wear and replace in pairs as required. When installing a new valve, always use new valve keepers.

Valve Face Runout

Check valve face runout. It should not exceed specifications listed at the end of this section. If runout exceeds service limit, valve should be replaced or refaced as described under Refacing Valves.

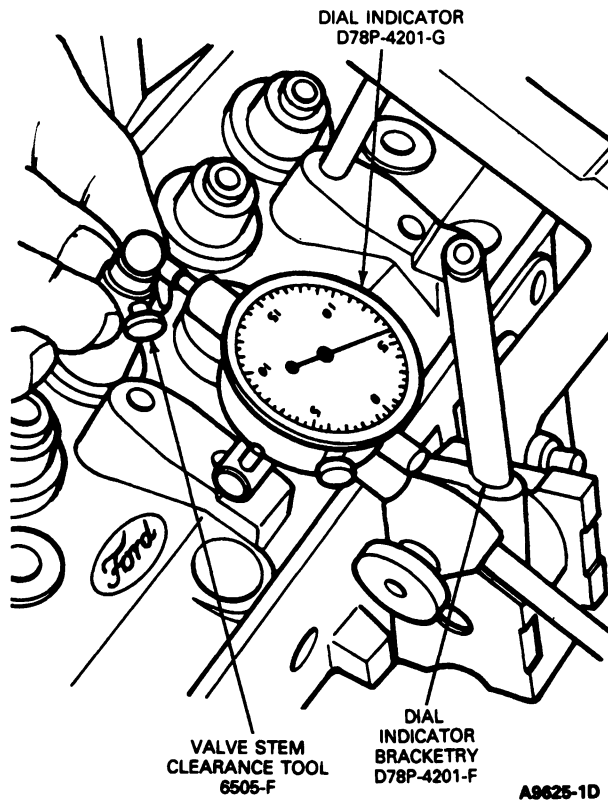
Valve Stem Clearance

Check valve stem to valve guide clearance of each valve in its respective valve guide with Valve Stem Clearance TOOL-6505-F (3/8 valves); Dial Indicator D78P-4201-G, and Dial Indicator Bracket D78P-4201-F or equivalents. Use a flat end indicator point.

Install tool onto valve stem until fully seated, and tighten knurled set screw firmly. Permit valve to drop away from its seat until tool contacts upper surface of valve guide.

CLEANING AND INSPECTION (Continued)

Position dial indicator with its flat tip against center portion of tool's spherical section at approximately 90 degrees to valve stem axis. Move tool back and forth in line with indicator stem. Take a reading on dial indicator without removing tool from valve guide upper surface. Divide reading by two, the division factor for tool. If valve stem to valve guide clearance exceeds specifications listed at the end of this section, install new valve guide as outlined in this section.



Valve Spring Pressure

Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

Valve Spring Squareness

Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

Intake Manifold

Cleaning

Remove all gasket material from machined surfaces of manifold. Clean manifold in a suitable solvent and dry with compressed air.

Inspection

Inspect manifold for cracks, nicked gasket surfaces, or other damage that would make it unfit for further service. Place cylinder head mounting faces of manifold on a smooth, clean surface and check for warpage. Replace manifold if warped or cracked.

Exhaust Manifolds

Cleaning

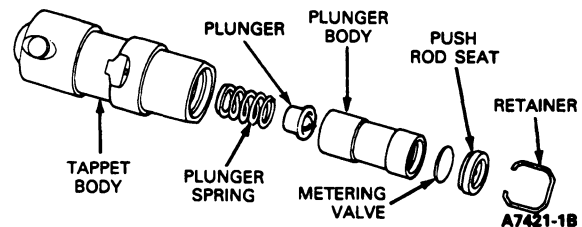
Remove all gasket material from manifold(s).

Inspection

Inspect manifold(s) for cracks, damaged gasket surfaces, or other wear or damage that would make them unfit for further service. Inspect cylinder head joining flanges of exhaust manifold(s) for evidence or warpage by placing on a flat surface. Minor warpage can be corrected by surface grinding. If warpage is extreme, replace manifold.

Hydraulic Valve Tappets

Valve tappet assemblies should be kept in proper sequence to permit installation into original position. Inspect and test each tappet separately to prevent intermixture of internal parts. **If any part of tappet assembly needs replacing, replace the entire assembly.**



Disassembly

1. Remove plunger retainer with small screwdriver.
2. Remove push rod seat and metering valve.
3. Remove plunger and plunger spring.

Cleaning

Thoroughly clean all parts in clean solvent and wipe with a clean, lint-free cloth.

Inspection

Inspect parts and discard the entire tappet assembly if any part shows pitting, scoring, galling or evidence of non-rotation. Replace entire assembly if the plunger is not free in body. Plunger should drop to bottom of body by its own weight when assembled dry.

Roller should rotate freely, without excessive play. Check for missing or broken needle bearings. Roller should be free of pits or roughness. If present, inspect camshaft lobes for similar condition. If pits or roughness are evident, replace cam follower and camshaft.

Assembly

1. Coat all parts with specified engine oil.
2. Install plunger spring and plunger into tappet body.

CLEANING AND INSPECTION (Continued)

3. Install metering valve and push rod seat into tappet body and install retaining ring.

Check for free operation by pressing down on the push rod cup. Tappets can also be checked with a hydraulic tester to test leak-down rate. Follow instructions provided with test unit.

Camshaft

Clean camshaft in solvent and wipe dry. Inspect camshaft lobes for scoring and signs of abnormal wear. Lobe wear characteristics may result in pitting in general area of lobe toe. This pitting is not harmful to the operation of camshaft; therefore, camshaft should not be replaced unless camshaft lobe lift loss has exceeded specifications.

Check camshaft lobe lift with camshaft installed in engine or on centers. Refer to Static (Engine Off) Valve Train Analysis under Diagnosis and Testing.

Check fuel pump eccentric for excessive wear.

Drive Gears**Cleaning**

Clean gears in solvent and dry with compressed air.

Inspection

Inspect gear teeth for scores, nicks, etc. Note condition of tooth contact pattern. If teeth are scored, replace gears.

It is not necessary to replace gears in sets. Replace damaged gears and check backlash, runout, etc., as described in this section, to determine if any other gear should be replaced.

Crankshaft Vibration Damper**Cleaning**

Clean oil seal contact surface on crankshaft damper sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits not readily removable with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, burrs or other imperfections which might damage oil seal during installation or cause premature seal wear.

Do not use crocus cloth to the extent that seal surface becomes polished. A finely polished surface may produce poor sealing or cause premature seal wear.

Inspection

Inspect crankshaft vibration damper sleeve oil seal surface for nicks, sharp edges or burrs that might damage oil seal during installation.

Crankshaft**Cleaning**

Handle crankshaft with care to avoid possible fractures or damage to finish surfaces. Clean crankshaft with solvent, and blow out all oil passages with compressed air.

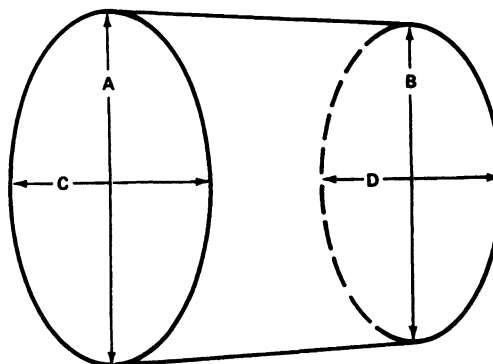
Clean oil seal contact surface at rear of crankshaft with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits not readily removable with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, burrs or other imperfections which might damage oil seal during installation or cause premature seal wear. **Do not use crocus cloth to the extent that seal surfaces become polished. A finely polished surface may produce poor sealing or cause premature seal wear.**

Inspection

Inspect main and connecting rod journals for cracks, scratches, grooves or scores.

Measure diameter of each journal in at least four places to determine out-of-round, taper or undersize condition.

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

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Bearing failures can cause overheating of crankshaft journals and a reduction of hardness. When this occurs, the crankshaft strength may be unacceptably reduced. Whenever bluing is found on the journal or fillet area, the crankshaft must be replaced.

Crankshafts must not be straightened. Even slight straightening with complete absence of cracks will endanger the high strength built into the shaft.

CLEANING AND INSPECTION (Continued)**Flywheel****Automatic Transmission****Inspection**

Inspect flywheel for cracks or other damage that would make it unfit for further service. Inspect starter ring gear for worn, chipped or cracked teeth. If teeth are damaged, replace ring gear.

With flywheel installed on crankshaft, check gear face runout of flywheel (refer to Diagnosis and Testing in this section).

Manual Transmission**Inspection**

Inspect flywheel for cracks, heat checks, or other damage that would make it unfit for further service. Machine friction surface of flywheel if it is scored or worn. If it is necessary to remove more than 1.016mm (0.040 inch) of stock from original thickness, or if flywheel thickness is less than 14mm (0.55 inch) after refacing, replace secondary flywheel. If necessary, refer to Secondary Flywheel Removal and Installation.

CAUTION: Installation of a flywheel less than 14mm (0.55 inch) thick can cause primary flywheel damage.

Inspect ring gear for worn, chipped, or cracked teeth. If teeth are damaged, replace ring gear.

With flywheel installed on crankshaft, check flywheel face runout, following procedure described under Diagnosis and Testing.

Main and Connecting Rod Bearings

Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

CAUTION: In the event of bearing failure, the oil cooler must be disassembled and the tube bundle must be replaced.

Connecting Rods

Refer to Section 03-00. These procedures are the same for diesel and gasoline engines.

Pistons, Pins and Rings**Cleaning**

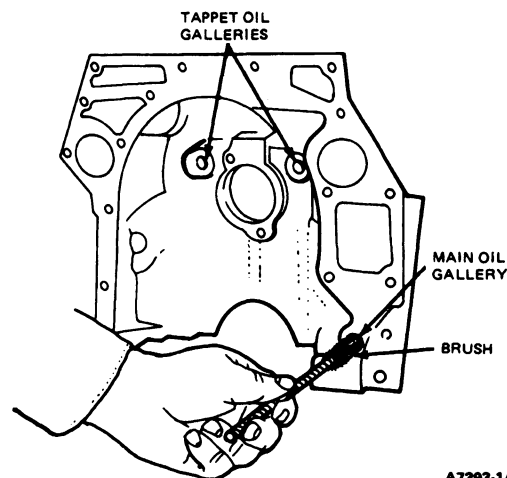
Refer to Section 03-00. This procedure is the same for diesel and gasoline engines.

CAUTION: Extreme care must be used when cleaning grooves on aluminum pistons.

Cylinder Block**Cleaning and Inspection**

These procedures are the same for diesel and gasoline engines except for the additional following steps for diesel engines.

Remove main oil gallery plug and use a 9.5mm (3/8-inch) diameter brush to clean main oil gallery. Replace oil plug after coating with Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A) or equivalent non-hardening sealing compound.



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Remove tappet oil gallery plugs by drilling small hole in plug and prying with a screwdriver or suitable tool. Clean tappet oil galleries with a 8mm (5/16-inch) brush. Replace tappet gallery plugs flush to 1.52mm (.060-inch) below crankcase surface as outlined.

Make sure threads in cylinder head bolt holes are clean. Dirt in threads may cause binding and result in false torque readings. Use tap to true-up threads and to remove any deposits.

Oil Pan**Cleaning**

Scrape any dirt or metal particles from inside of pan. Scrape or wire brush all old gasket material from gasket surface. Wash pan in a degreasing solvent and dry it thoroughly. Make sure all foreign particles are removed from below baffle plate.

Inspection

Check pan for cracks, holes and damaged drain plug threads. Check gasket surface for damage caused by over-tightened bolts. Straighten surface as required to restore original flatness.

Replace pan if repairs cannot be made.

CLEANING AND INSPECTION (Continued)**Oil Pump**

Check oil pump drive gear backlash as outlined in this section. If backlash is out of specification, replace pump. Oil pump is serviced as a complete assembly only.

Fuel Supply Pump

Inspect fuel supply pump for cracks or damage. Inspect mounting flange for distortion. Inspect rocker arm spring, pin and rocker arm for wear, cracks or damage. **If any fuel supply pump components are damaged, replace fuel supply pump.**

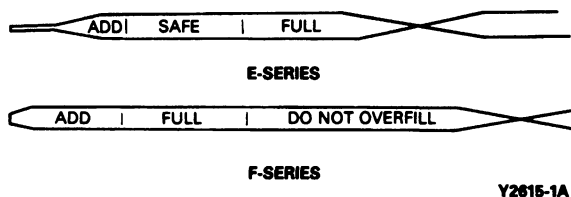
Thermostat

To check operation, place thermostat in a pan of water, heat water, and, using an accurate thermometer, observe water temperature when thermostat starts to open. Thermostat should start to open at approximately 100-107°C (180-192°F) and be fully open at approximately 111-118°C (200-212°F). The thermostat is not adjustable. If it does not operate within above limits, replace it.

If problem being investigated is insufficient heat, thermostat should be checked for leakage. This may be done by holding thermostat up to a lighted background. Light leakage around thermostat valve (thermostat at room temperature) is unacceptable, and thermostat should be replaced.

Engine Oil Level

Check crankcase oil level each time you stop for fuel. Keep the oil level between the FULL and ADD marks on the dipstick. The distance between the ADD and FULL marks on the diesel engine represents two quarts. **DO NOT OVERFILL.**

**Engine Fuel Filter**

Refer to Owner Guide or Section 00-03.

Accelerator Linkage

Check accelerator linkage for sticking or binding. Make sure that throttle lever returns to the idle stop on the injection pump. Service as necessary. Lubricate friction points as specified in Section 00-03.

SPECIFICATIONS

Refer to the following charts for specifications.

SPECIFICATIONS (Continued)

GENERAL SPECIFICATIONS

Engine	Bore and Stroke	Firing Order	Oil Pressure Hot @ 3300 RPM kPa (PSI)	Engine Type and Number of Cylinders	Compression Ratio
7.3L Diesel (444 CID)	4.1095 in. x 4.1120 in.	1-2-7-3-4-5-6-8	276-482 kPa (40-70)	O.H.V. V-8	21.5 to 1

Belt Size	Newly Installed ①		Used Over 10 Min.	
	Kg	(lbs)	Kg	(lbs)
All	55-72	120-160	34-54	75-120②

① Tension measured immediately after belt is installed and before it is stretched or seats in pulley grooves (all belts).

② If less than 34 Kg (75 lbs), readjust to 41-54 Kg (90-120 lbs).

CYLINDER HEAD

Engine	Pre-Chamber Insert Protrusion	Valve Guide Bore Diameter		Valve Seat Width ①		Valve Seat Runout TIR Maximum	Valve Arrangement Front to Rear	Gasket Surface Flatness ②
		Intake	Exhaust	Intake	Exhaust			
7.3L Diesel V-8	-0.0025 in. + 0.0025 in. (-0.064mm/ +0.064mm)	0.3736 in.	0.3736 in.	0.065"- 0.095" (1.651- 2.413mm)	0.065"- 0.095" (1.651- 2.413mm)	0.002 in. (0.05mm)	LT I-E-I-E-I-E-I-E RT E-I-E-I-E-I-E-I	0.003" (0.0762mm) in any 6 in. 0.006" (0.1524mm) overall
		0.3746 in.	0.3746 in.					

① Valve seat angle — intake 30° and Exhaust 37.5°.

② Gasket surface finish — RMS 60-150.

VALVE ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

Engine	Type	Push Rod Runout TIR Maximum	Valve Tappet or Lifter			Collapsed Tappet Gap (Clearance)③
			Standard Diameter	Clearance to Bore①	Hydraulic Lifter Leakdown Rate②	
7.3L Diesel V-8	Hydraulic Roller Follower	0.015 in.	0.9209 in.- 0.9217 in. (23.391- 23.411mm)	0.0011 in.- 0.0034 in. (0.027- 0.086mm)	20-110 Sec. For 0.125" Travel	0.185 Max.

① Service Limit — .005.

② Time required for plunger to leakdown .125 in. under load of 50 lbs. using leakdown fluid in tappet.

③ Measured at valve tip to rocker arm.

VALVE SPRINGS

Engine	Valve Spring Compression Pressure Lbs. @ Specified Height		Valve Spring Free Length (Approximate)		Valve Spring Assembled Height		Valve Spring Out of Square Maximum
	Intake①	Exhaust	Intake	Exhaust	Intake	Exhaust	
7.3L Diesel V-8	80 @ 1.83	80 @ 1.833	2.075 in. ± 0.150 in. (52.705mm ± 3.8mm)	2.075 in. ± 0.150 in. (52.705mm ± 3.8mm)	1.767	1.833	5/64 (0.078)

① Service Limit — 10% loss of pressure.

VALVES

Engine	Valve Stem to Guide Clearance①		Valve Face Angle		Valve Face Runout TIR Maximum
	Intake	Exhaust	Intake	Exhaust	
7.3L Diesel V-8	0.0055 in. (0.140mm)	0.0055 in. (0.140mm)	30°	37.5°	0.0015 in. (0.0381mm)

① Service clearance — .0055.

VALVES (Continued)

Engine	Minimum Valve Face Margin-Intake Valves	Minimum Valve Face Margin — Exhaust Valves
7.3L Diesel V-8	0.112 inch (2.84mm)	0.053 inch (1.35mm)

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SPECIFICATIONS (Continued)

VALVES (Continued)

Engine	Valve Stem Diameter		Valve Head Recession Relative To Deck Surface	
	Intake	Exhaust	Intake	Exhaust
7.3L Diesel	.37165-.37235	.37165-.37235	.042-.054 in. (1.06-1.37mm)	.051-.063 in. (1.29-1.60mm)

CAMSHAFT

Engine	Camshaft End Play		Camshaft Journal to Bearing Clearance
	End Play	Service Limit	
7.3L Diesel	.002-.009 inch (.025-.228mm)	—	0.0381-0.0889mm (0.0015-0.0035 in.)

CAMSHAFT DRIVE

Engine	Camshaft Bearing Inside Diameter②					Camshaft Front Bearing Location①	Gear Backlash
	No. 1	No. 2	No. 3	No. 4	No. 5		
7.3L Diesel V-8	2.1015- 2.1025 inch (53.37- 53.40mm)	2.1015- 2.1025 inch (53.37- 53.40mm)	2.1015- 2.1025 inch (53.37- 53.40mm)	2.1015- 2.1025 inch (53.37- 53.40mm)	2.1015- 2.1025 inch (53.37- 53.40mm)	0.020-0.050 inch)	0.0015-0.013 inch)

① Distance in inches that front edge of the bearing is installed below the front face of the cylinder block.

② All camshaft journals are 2.0990-2.1000.

INJECTION PUMP DRIVE GEAR BACKLASH — 0.0055-0.0010

CYLINDER BLOCK

Engine	Cylinder Bore Diameter①③	Main Bearing Inside Diameter②	Head Gasket Surface Flatness	Head Gasket Surface Finish	Oversize	
7.3L Diesel	4.1095-4.1115 inch (104.38-104.43mm)	3.3152-3.3162 in. (84.21-84.23mm)	0.003 inch in any 6 in. 0.006 inch overall	RMS 63-125	0.010	4.11425 inch (104.502mm)
					0.020	4.12425 inch (104.756mm)
					0.030	4.13425 inch (105.010mm)

① Maximum out-of-round — .002; Maximum taper — 0.002 inch; Cylinder bore surface finish RMS 15-30.

② With bearing caps tightened in place.

③ Note: Bore diameter of cylinders 1-6 — 4.1095 in. to 4.1115 in. Bore diameter of cylinders 7 and 8 only — 4.1100-4.1120 in.

CRANKSHAFT AND FLYWHEEL

Engine	Main Bearing Journal Diameter①	Main Bearing Journal Runout TIR Maximum②	Main Bearing Thrust Face Runout TIR Maximum	Main Bearing Journal Taper Maximum Per Inch	Thrust Bearing Journal Length	Main and Rod Bearing Journal Finish RMS Maximum	Main Bearing Thrust Face Finish RMS Maximum
7.3L Diesel	3.1228-3.1236	0.002 inch	0.001 inch	0.0005 inch	1.1325-1.1355 inch	5-20	5-20
Undersize	0.010	3.1128-3.1136 in.					
	0.020	3.1028-3.1036 in.					
	0.030	3.0928-3.0936 in.					

① Maximum out-of-round — 0.0002.

② Service limit — 0.005.

CRANKSHAFT FLYWHEEL (Continued)

Engine	Connecting Rod Journal Diameter①	Connecting Rod Journal Taper Per Inch Maximum	Crankshaft End Play ②	Flywheel and Ring Gear Runout
7.3L Diesel	2.4980-2.4990 in.	0.0005 in.	0.0025-0.0085 in.	0.030 in.
Undersize	0.010	2.488-2.489 in.		Flywheel and Ring Gear Concentricity 0.020 in.
	0.020	2.478-2.479 in.		
	0.030	2.468-2.469 in.		

① Maximum out-of-round — .0003.

② Service limit — .012.

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SPECIFICATIONS (Continued)

CRANKSHAFT BEARINGS

Engine	Connecting Rod Bearing to Crankshaft Clearance Selective Fit			Main Bearing to Crankshaft Clearance Selective Fit		
	Desired	Allowable	Bearing Wall Thickness Std.	Desired	Allowable	Bearing Wall Thickness Std.
7.3L Diesel	0.0011-0.0036 in.	0.0011-0.0036 in.	—	0.0018-0.0036 in.	0.0018-0.0046 in.	—

CONNECTING ROD

Engine	Piston Pin Bushing I.D.	Rod Bearing I.D. ① ③	Rod Length Center to Center	Connecting Rod Alignment Maximum Total Difference		Rod to Crankshaft Assembled Side Clearance
				Twist ②	Bend ②	
7.3L Diesel	1.1105-1.1108 in.	2.5001-2.5016 in.	7.128-7.132 in.	0.002 in.	0.002 in.	0.012-0.024 in.

① Connecting rod bearing bore maximum out-of-round — .0005 and maximum bore taper — .0005.

② Pin bushing and crankshaft bore must be parallel and in same vertical plane within specified total difference when measured at the ends of an 8-inch long bar, 4 inches on each side of rod centerline.

③ With bearing caps tightened in place.

PISTON

Engine	Skirt Diameter ① ②	Piston to Bore Clearance Selective Fit ②	Piston Pin Bore Diameter	Piston Height Above Crankcase	Oversize	
	Standard					
7.3L Diesel	4.10375 in. ± 0.00025 in.	See Note Below	1.1104-1.1106	0.010-0.031	0.010 in.	4.11425 in. ④
					0.020	4.12425 in.
					0.003	4.13425 in.

① Measured at 90 degrees to the pin, at 1.25 inch below oil ring groove.

② Service piston is 4.10375 in. ± 0.00025 in.

③ Clearance in cylinder bores 1-6 only: 0.0055-0.0085 inch.

Clearance in cylinder bores 7 and 8 only: 0.0060-0.0085 inch.

④ Oversize service piston specifications are all ± 0.0005 inch.

PISTON PIN

Engine	Length	Diameter	Ring End Clearance	To Piston Pin Bore Clearance ①	To Connecting Rod Bushing Clearance
7.3L Diesel	2.692-2.702 in.	1.1099-1.1101 in.	0.001-0.029 in.	0.0003-0.0007 in.	0.0004—0.0009 in.

① Selective fit.

PISTON RINGS

Engine	Standard Ring Diameters	Side Clearance①			Ring Gap			Oversize	
		Compression		Oil	Compression		Oil		
		Top	Bottom		Top	Second			
7.3L Diesel	4.11 in. (104.39mm)	0.002-0.004 in.	0.002-0.004 in.	0.001-0.003 in.	0.013-0.045 in.	0.060-0.085 in.		0.010 in.	4.120 in.
								0.020 in.	4.130 in.
								0.030 in.	4.140 in.

① Service limit — .002 maximum increase in clearance.

OIL PUMP, OIL COOLER AND OIL CAPACITY

Engine	Oil Pump Pressures		Engine Oil Capacity ①			Oil Pump Drive Gear Backlash
	700 RPM	3300 RPM	U.S. Qts.	Imperial Qts.	Liters	
7.3L Diesel	69 kPa (10 psi)	276-482 kPa (40-70 psi)	9	9.7	8.5	0.0056-0.010 in.

① Add 1 U.S. quart (or equivalent in Imperial quarts or liters) when replacing filter.

OIL SEALS

Crankcase Oil Seal Journal Finish	10-20 RMS
Front Oil Seal Journal Finish (On Damper)	10-20 RMS

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SPECIFICATIONS (Continued)

Torque Limits — 7.3L V-8 Diesel Engine

NOTE: Unless otherwise specified, use standard torque chart. Torque values are with threads and washer faces coated with engine oil. Torque values are listed without tolerance. Variations to torque will occur due to torque wrench calibration. Variation should be within 10% of nominal values.

STANDARD TORQUE

1/4x20 UNC	5/16-18 UNC	3/8-16 UNC	7/16-14 UNC	1/2x13 UNC
9.5 N-m (7 ft-lb)	19 N-m (14 ft-lb)	32 N-m (24 ft-lb)	51 N-m (38 ft-lb)	81 N-m (60 ft-lb)

PIPE THREADS

1/8x27	1/4x18	3/8x18	1/2x14
7-11 N-m (5-8 ft-lb)	17-24 N-m (12-18 ft-lb)	30-44 N-m (22-33 ft-lb)	34-47 N-m (25-35 ft-lb)

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
A/C Compressor Mounting Bracket to Engine	40-55	30-41
Accelerator Cable Bracket to Intake Manifold	16-23	11-17
Air Cleaner Stud Adapter	61 ^a	45
Alternator Bracket to Cylinder Block	54-75	40-55
Alternator Pivot Bolt	72-98	53-72
Alternator Support Bracket to Water Pump	54-75	40-55
Alternator Adjusting Arm to Support	54-75	40-55
Alternator Adjusting Bolt	54-75	40-55
CDR Valve	^b	
Camshaft Gear Screw	20	15
Connecting Rod Nuts	52	38
Connecting Rod Nuts — Step 2	69	51
Crankcase Front Cover	^b	
Crankshaft Pulley	^b	
Cylinder Head Bolts (New)	88	65
Cylinder Head Bolts — Step 2	122	90
Cylinder Head Bolts — Step 3	135	110
Damper to Crankshaft Bolt	122	90
Engine Front Cover Bolts	^b	
Exhaust Manifold (F-Series)	27	20
Fan Clutch to Water Pump (LH Thread)	61-163	45-120
Fan Shroud Bolts	4-8	35-71 in-lb
Flywheel to Crankshaft Flange	64	47
Front A/C Compressor Brace and A/C Mounting Bracket to Rear A/C Compressor Brace	40-55	30-41
Front A/C Compressor Brace to A/C Compressor	40-55	30-41

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Fuel Filter Adapter to Bracket	33-52	24-38
Fuel Filter Bracket to Cylinder Block	33-52	24-38
Fuel Filter to Adapter	^c	
Fuel Filter/Heater/Water Separator Assembly	33-52	24-38
Fuel Line Nuts onto Nozzle	30	22
Fuel Nozzle Line to Injection Pump	30	22
Fuel Outlet Line	20-24	15-18
Fuel Supply Pump	^b	
Glow Plug	16	12
Heater Hose Fitting to Water Pump	17-24	13-18
Injection Pump Outlet Fitting Nut	30	22
Injection Pump Gear Cover	19 ^a	14
Injection Pump Gear Mounting Bolts	34	25
Injection Pump to Adapter	35	26
Inlet Line/Return Line Nuts	20-24	15-18
Intake Manifold	33	24
Main Bearing Cap Bolts	101	75
Main Bearing Cap Bolts — Step 2	129	95
Manifold — Exhaust (with Prevailing Torque Bolt)	47 ^b	35
Manifold — Intake	33	24
Manifold — Intake — Step 2	33	24
Nozzle Assembly	47 ^d	35
Nozzle Connector Nut (Injection Pipe)	30	22
Oil Filter to Header Adapter	^e	
Oil Cooler to Cylinder Block	^b	
Oil Cooler Plug	21	15
Oil Pan Drain Plug	37	27
Oil Pan to Cylinder Block	^b	
Power Steering Pump Rear Support Cylinder Head	40-55	30-41
Power Steering Pump Mounting Bracket to Rear Support	53-72	39-53
Power Steering Pump Support to Water Pump	40-55	30-41
Power Steering Pump to Mounting Bracket	40-55	30-41
Pulley to Vibration Damper	^b	
Radiator Hose Clamps (screw type)	3-4	27-35 in-lb
Radiator Hose Clamps (double wire)	2-3	18-27 in-lb
Rear Cover	^b	
Rear A/C Compressor Brace to A/C Compressor	40-55	30-41
Rocker Arm Post Attaching Bolts	27	20

(Continued)



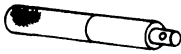


SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS (Cont'd)



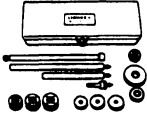
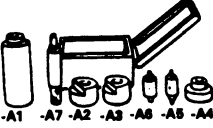




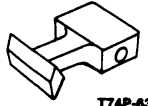
Description	N-m	Lb-Ft
Secondary Flywheel to Primary Flywheel	64	47
Vacuum Pump Mounting Plate to Cylinder Head	19-26	14-19
Vacuum Pump to Mounting Plate	19-26	14-19
Valve Cover Bolt	8	6
Valve Cover Bolt — Step 2	8	6
Valve Lever Post Bolt	27	20
Water Housing Outlet (Thermostat) to Crankcase	27	20
Water Pump to Front Cover	19 ^f	14
Water Pump Pulley	b	

- a Apply Threadlock and Sealer EOAZ-19554-AA or equivalent to all threads prior to assembly.
b See Standard Torque Chart.
c 1/2 turn after gasket contacts sealing surface.
d Tighten to 47 N-m (35 ft-lb), then tighten again to 47 N-m (35 ft-lb) in sequence. Apply anti-seize compound prior to installation.
e 1-1/4 to 2 turns after gasket contacts sealing surface — oiled gasket.
f RTV Sealer required.

SPECIAL SERVICE TOOLS / EQUIPMENT










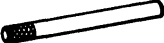
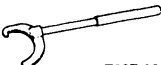
Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T59L-100-B Impact Slide Hammer	 T59L-100-B
T80T-4000-W Driver Handle	 T80T-4000-W
TOOL-4201-C Dial Indicator w/ Bracketry	 TOOL-4201-C
T77F-4220-B1 Gear Puller	 T77F-4220-B1

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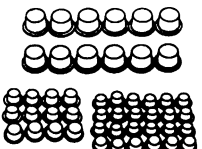
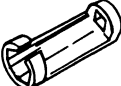
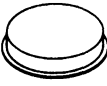


Tool Number / Description	Illustration
T83T-6000-D6.9 6.9L / 7.3L Essential Service Tool Kit	 T83T-6000-D6.9
T70P-6000 Engine Lifting Brackets	 T70P-6000
T65L-6250-A Camshaft Bearing Set	 T65L-6250-A
T68P-6135-A Piston Pin Remover / Replacer	 T68P-6135-A
T83T-6312-A Fan Clutch Pulley Holder	 T83T-6312-A
T83T-6312-B Fan Clutch Nut Wrench	 T83T-6312-B
T83T-6316-A Crank / Cam Gear and Damper Remover	 T83T-6316-A
T83T-6316-B Crank / Cam Gear and Damper Replacer	 T83T-6316-B
T74P-6375-A Flywheel Holding Tool	 T74P-6375-A

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

Tool Number/ Description	Illustration
T83T-6500-A Tappet Bleed-Down Wrench	 T83T-6500-A
TOOL-6500-E Hydraulic Tappet Leakdown Tester	 TOOL-6500-E
TOOL-6505-F Valve Stem Clearance Tool	 TOOL-6505-E
T83T-6513-A Valve Spring Compressor	 T83T-6513-A
TOOL-6513-DD Valve/Clutch Spring Tester	 TOOL-6513-DD
T83T-6571-A Valve Stem Seal Replacer	 T83T-6571-A
T83T-6700-A Front Crank Seal Replacer	 T83T-6700-A
T83T-6701-A Rear Crankshaft Seal Replacer	 T83T-6701-A
T83T-6701-B Rear Crankshaft Seal Pilot	 T83T-6701-B
T86T-9000-B Injection Pump Mounting Wrench	 T86T-9000-B
T83T-9000-C Injection Pump Rotating Tool	 T83T-9000-C

(Continued)

Tool Number/ Description	Illustration
T83T-9395-A Fuel System Protection Cap Set	 T83T-9395-A
T83T-9396-A Fuel Line Nut Wrench	 T83T-9396-A
T83T-9424-A Intake Manifold Cover	 T83T-9424-A
T83T-9527-A Nozzle Seat Cleaner	 T83T-9527-A
T71P-19703-C O-Ring Tool	 T71P-19703-C

Tool Number	Description
D82L-800-B	Hammer
D78P-4201-F	Dial Indicator Bracketry
D78P-4201-G	Dial Indicator — 1-Inch Travel
D81L-4201-A	Feeler Gauge
D81L-6002-B	Plastigage
D81L-6002-C	Piston Ring Compressor
D81L-6002-D	Piston Ring Groove Cleaner
D83T-6002-A	Glow Plug Socket
D83L-4201-A	Straight Edge
D83T-9000-E	Throttle Control
D83T-6015-B	Expansion Plug Replacer
D83T-6134-A	Piston Cooling Tube Installer
D83T-6084-A	Exhaust Valve Seat Remover/Replacer
D83T-6134-B	Cooling Jet Tube Target
D83T-6136-A	Connecting Rod Installation Guides

ROTUNDA EQUIPMENT

Tool Number	Description
014-00036	Universal Load Positioning Sling
014-00300	Injection Nozzle Tester
014-00301	Injection Nozzle Cleaning Kit
014-00306	Engine Stand Mounting Adapter
014-00312	Engine Lifting Bracket

(Continued)

**SPECIAL SERVICE TOOLS/EQUIPMENT
(Continued)****ROTUNDA EQUIPMENT (Cont'd)**

Tool Number	Description
014-00701	Compression Tester

(Continued)

ROTUNDA EQUIPMENT (Cont'd)

Tool Number	Description
014-00702	Pressure Test Kit
014-00726	Oil Cooler Internal Leakage Tester
112-00001	Oil Leak Detector

SECTION 03-03 Engine Cooling

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		DIAGNOSIS AND TESTING (Cont'd.)	
Cleaning Cooling System	03-03-24	Thermostat Test	03-03-6
Heater Core Back-Flushing	03-03-24	Visual Inspection	03-03-4
Radiator Coolant Level Check	03-03-24	REMOVAL AND INSTALLATION	
Radiator Pressure Cap	03-03-27	Coolant Recovery Bottle	03-03-10
DESCRIPTION AND OPERATION		Radiator and Fan Shroud	03-03-11
Coolant Recovery System	03-03-1	Thermostat	03-03-9
Draining, Filling and Bleeding the Cooling System	03-03-4	SERVICE PROCEDURES	
Radiator	03-03-2	Aluminum Crossflow Radiators	03-03-29
DIAGNOSIS AND TESTING		Copper/Brass Radiators	03-03-27
Cooling System Pressure Test	03-03-5	Radiator Core Service	03-03-34
Diagnosis Guides	03-03-7	Threaded Radiator Draincock	03-03-29
Leak Test	03-03-6	SPECIAL SERVICE TOOLS/EQUIPMENT	03-03-40
Radiator Cap Pressure Test	03-03-6	SPECIFICATIONS	03-03-39
		VEHICLE APPLICATION	03-03-1

VEHICLE APPLICATION

E-150-250-350, F-150-250-350, F-Super Duty and Bronco Vehicles

DESCRIPTION AND OPERATION

Coolant Recovery System

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

NOTE: Walter C. Avrea, the owner of patents 3,601,181 and RE27,965, has granted Ford Motor Company rights with respect to cooling systems covered by these patents.

The correct coolant level is essential for maximum circulation and adequate cooling. In addition, for the cooling system to perform its function, it must receive proper care. This includes keeping the radiator fins clean and periodically inspecting the cooling system for leakage.

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN YOU ARE SURE ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

In production, E-150-250-350, Bronco, F-150-250-350 and F-Super Duty series vehicle cooling systems are filled with a 50/50 solution of Ford Cooling System Fluid and water which prevents corrosion, keeps the cooling system clean, provides antifreeze protection to -28.8 to -37.2°C (-20 to -35°F) in winter and provides for higher summer operation temperatures.

NOTE: A coolant mixture of 50 percent coolant concentrate and 50 percent water is recommended to maintain best overall performance. To avoid damaging the radiator, the coolant concentrate should not exceed 60 percent.

For the most effective cooling system operation, a 50/50 mixture strength should be maintained all year round and in all climates. Refer to Draining, Filling and Bleeding the Cooling System in this section.

Coolant should be the specified mixture of Ford Premium Cooling System Fluid E2FZ-19549-AA (ESE-M97B44-A or ESE-M97B43-A) or equivalent and water. If Ford Cooling System Fluid is not available, another reputable permanent antifreeze meeting Ford specification ESE-M97B44-A must be used and diluted with an equal quantity of tap water.

Ordinary tap water may be used in an emergency except in areas where the water is known to be exceptionally hard or to have a high alkali content. The cooling system should be drained and flushed and the proper mixture of antifreeze added as soon as possible.

DESCRIPTION AND OPERATION (Continued)

To avoid possible overheating in very hot weather, do not use mixtures with more than 50 percent antifreeze except in areas where antifreeze protection below -37°C (-35°F) is required. In this case, refer to the coolant mixture chart on the Ford Premium Cooling System Fluid container.

A standard ethylene glycol hydrometer or Rotunda Anti-Freeze Tester 021-00046 or equivalent can be used to check the protection level of the long-life coolant.

When water or antifreeze must be added to the cooling system during periods of below-freezing ambient temperature, always either drive or operate the engine at fast idle for 30 minutes before letting the vehicle stand with the engine off for prolonged periods. This will create a uniform mixture throughout the cooling system and prevent damage by freezing, when sufficient antifreeze is used.

If the fan drive belt(s) is noisy, check the tension of the belt(s) to make certain it is within specifications. Also, check for misaligned pulleys. If the drive belt(s) is worn or frayed, replace it. Refer to Section 03-05.

Coolant recovery systems are standard on all vehicles. Maintain the coolant level in the radiator flush with the cap seal in the filler neck to 38mm (1.5 inches) below the cap seal.

WARNING: DO NOT REMOVE THE RADIATOR CAP WHEN THE COOLING SYSTEM IS HOT.

Coolant Recycling

Ford Motor Company does **not** authorize the use of recycled coolant for use in vehicles. Equipment that recycles engine coolant does not return coolant with the same cooling and corrosion protection properties.

Recycled coolant is **not** equivalent to Ford specifications for Ford Premium Cooling System Fluid (E2FZ-19549-AA) or Ford Heavy Duty Low Silicate Cooling Fluid (E6HZ-19549-A).

Coolant Disposal

When disposing of used coolant, always do so in accordance with all applicable federal, state and local laws and regulations.

Thermostat

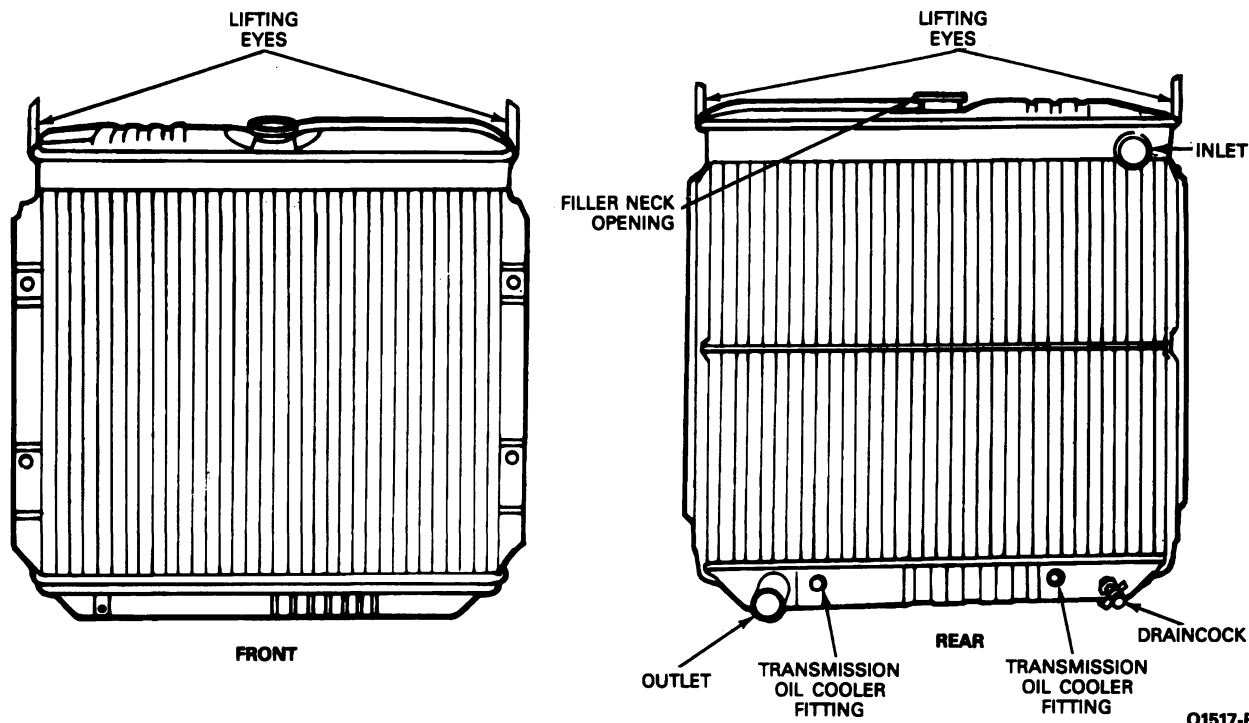
A poppet-type thermostat is used with all engines.

When the thermostat is closed, coolant flows to the water pump through a bypass passage at the front of the engine. When the thermostat is open, coolant flows through the coolant outlet elbow (thermostat housing) to the radiator.

The thermostat used in production is a high temperature thermostat for use with a mixture of water and permanent-type antifreeze. A low temperature thermostat should be installed if a non-permanent type antifreeze and water coolant solution is used.

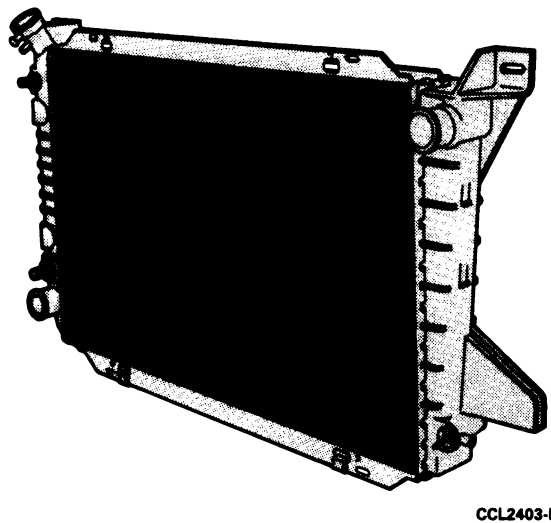
Radiator**E-150-250-350 Gasoline Engines**

All radiators are of the tube and fin type with the tubes arranged for vertical flow of the coolant. Two header tanks, one on the top and one on the bottom of the radiator provide uniform distribution of the coolant to the tubes. The radiator outlet port (lower tank) is connected to the water pump inlet port. The radiator inlet port (upper tank) is connected to the coolant outlet elbow of the engine, thereby permitting coolant circulation through the radiator when the thermostat is open. The 7.5L radiator uses turbulator type tubes and cannot be rodded out.

DESCRIPTION AND OPERATION (Continued)**Typical Down Flow Radiator****F-150-250-350, F-Super Duty Chassis Cab, Motorhome Chassis and Bronco Gasoline Engines**

All radiators are the tube and fin type with the tubes arranged for horizontal flow of the coolant. Two header tanks, one on each end of the radiator, allow uniform distribution of engine coolant to the radiator tubes. The radiator outlet port (lower hose connection) is connected by a hose to the water pump inlet port. The radiator inlet port (upper hose connection) is connected by the hose to the coolant outlet elbow of the engine, allowing coolant circulation through the radiator when the engine thermostat is open.

The crossflow radiator used with gasoline engines is constructed with a vacuum brazed aluminum core and nylon end tanks. The nylon end tanks are attached to the aluminum core by bending tabs on the core header over the edge of the nylon tank. An O-ring gasket is placed between the nylon tank and the radiator core header to achieve a seal between the tank and the radiator core header. The nylon tanks are a molded one-piece design with the mounting brackets part of each tank.

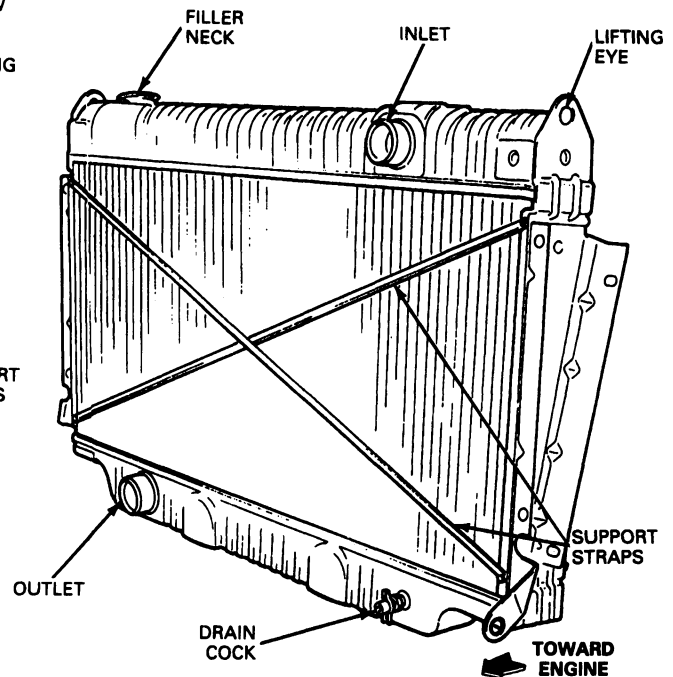
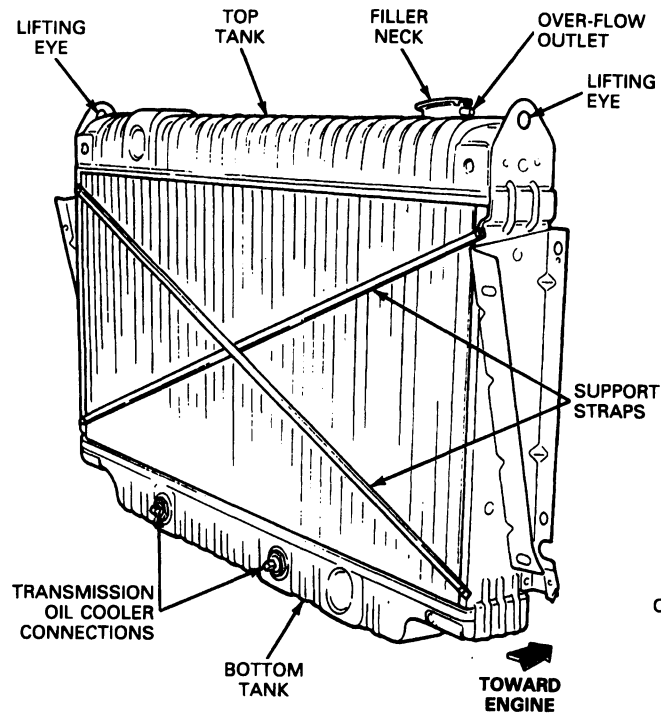
Typical Crossflow (Horizontal) Flow Radiator**F-250-350, F-Super Duty Chassis Cab, Commercial Chassis and E-350 7.3L Diesel Engine**

The vertical flow radiator used with the 7.3L diesel engine is the conventional copper / brass design similar to the E-Series gasoline engine radiators.

However, the diesel radiator uses turbulator type tubes and cannot be rodded out.

DESCRIPTION AND OPERATION (Continued)

7.3L Diesel Radiator, Typical



Q1714-D

Draining, Filling and Bleeding the Cooling System

To prevent loss of coolant when draining the radiator, attach a hose on the radiator draincock and drain the coolant from the radiator into a clean container.

To drain the radiator, open the draincock located at the bottom of the radiator and remove the radiator cap or supply tank cap. The cylinder block of the V-8 engine is drained by removing the drain plugs located on both sides of the block. The 6-cylinder engines have one drain plug located at the left rear of the cylinder block.

If replacing coolant, dispose of old coolant in accordance with applicable federal, state, and local laws and regulations. Promptly clean up any spilled coolant.

To fill the cooling system, install the cylinder block drain plug(s) and close the radiator draincock. Disconnect the heater outlet hose at the water pump to bleed or release trapped air in the system. When the coolant begins to escape, connect the heater outlet hose.

Fill the radiator until the coolant is between the cap seal in the filler neck to 38mm (1-1/2 inches) below the cap seal. Install cap.

WARNING: DO NOT STAND IN LINE WITH OR NEAR ENGINE COOLING FAN WHEN ENGINE IS RUNNING.

Start engine, warm up, shut off engine. Allow engine to cool, remove cap and check coolant level. Fill as required.

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN YOU ARE SURE ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

DIAGNOSIS AND TESTING

Visual Inspection

1. Check for leaks at:
 - a. All hoses and hose connections.
 - b. Radiator seams, radiator core, and radiator drain petcock.
 - c. All block core plugs and drain plugs.

DIAGNOSIS AND TESTING (Continued)

- d. Edges of all other cooling system gaskets.
 - e. Transmission oil cooler.
 - f. Vehicle heating system components.
 - g. Water pump.
 - h. Radiator and coolant recovery bottle caps.
 - i. Coolant recovery bottle.
2. Examine oil dipstick for evidence of engine oil contaminated with coolant — a brownish-milky appearance.
 3. Check radiator for evidence of oil in coolant (leakage at transmission oil cooler) — a deep red or brown oily film on top.
 4. Install the analyzer from Rotunda Cooling System Pressurization Kit 021-00012 or equivalent to assist in testing the cooling system. Follow the manufacturer's recommended connections and testing procedures.

Cooling System Pressure Test

1. Shut the engine off.

WARNING: NEVER REMOVE THE RADIATOR CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN YOU ARE SURE ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

2. Adjust the radiator coolant level (fill or drain) to 25mm (one inch) below the filler neck opening before testing. Wipe clean, and then wet the rubber sealing surfaces in the cap and filler neck before installing the cap tightly on the radiator.
3. Disconnect the electrical connector from the coolant temperature sending unit and remove the temperature sending unit from the engine.

With the radiator cap installed and the cooling system pressure relieved, only a small amount of coolant will be lost when the sending unit is removed.

4. Install the adapter fitting from Rotunda Cooling System Pressurization Kit 021-00012 or equivalent (male thread on one end, and a hose connector on the other end to accommodate the tester hose) tightly into the intake manifold or cylinder head in place of the sending unit.
5. On E-150-250-350, Bronco, F-150-250-350 and F-Super Duty series vehicles, remove the radiator overflow hose from the overflow nipple. Install a separate hose firmly on the overflow nipple. Insert the free end of separate hose into container of water.
6. Attach the pressure pump and gauge to the adapter-fitting and pressurize the cooling system to 69 kPa (10 psi).

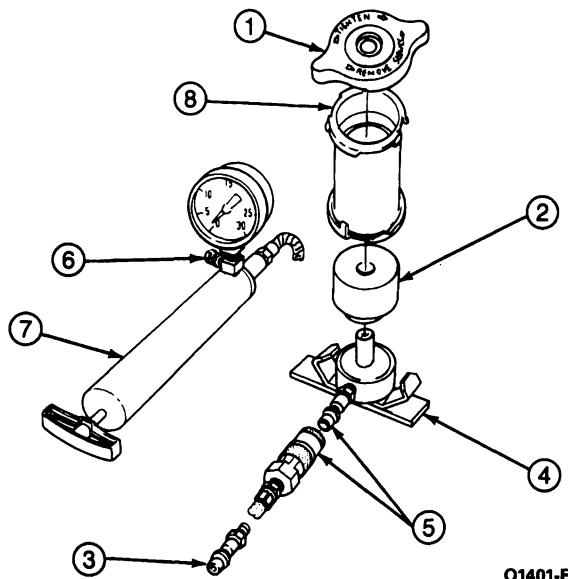
No bubbles should appear in the water container when the system is pressurized to the LOWER LIMIT (69 kPa [10 psi]). If the system is satisfactory at the lower limit, gradually increase the system pressure until a slight stream of bubbles appears in the water container. This is the release pressure of the pressure cap.

Replace any radiator cap which has a release pressure that is greater than the specified UPPER LIMIT pressure (90 kPa [13 psi]) without discharging bubbles.

7. If the radiator cap does not hold pressure, remove and wash the cap in clean water to dislodge all foreign particles from the gaskets. Check the sealing surface in the radiator filler neck.
- Inspect the cam lock flanges on both sides of the filler neck for maximum cap engagement.
8. Pressurize the cooling system as outlined in Step 6 (using a radiator cap that operates within the specified upper and lower pressure limits) and observe the gauge reading for approximately two minutes. Pressure should be held between 69 and 90 kPa (10 and 13 psi) and should not drop during this time.
9. If the pressure drops, check for leaks at the engine-to-heater core hoses, engine-to-radiator hoses, bypass hose, water valve hose (if applicable), thermostat housing gasket, radiator and heater core, etc. Also refer to engine system checks if a leak cannot be located in the cooling system. Any leaks which are found must be corrected and the system checked again.

If the system holds pressure proceed to Step 10.

DIAGNOSIS AND TESTING (Continued)



Item	Description
1	Radiator Cap
2	Filler Neck Seal
3	Temperature Sender Pressure Hose Adapter
4	Filler Neck Adapter
5	Quick Disconnect Fittings
6	Pressure Relief Screw
7	Pressure Test Pump 021-00012 or Equivalent
8	Radiator Cap Pressure Test Adapter

TQ1401A

- Release the system pressure by loosening the radiator cap and removing the adapter. Install the temperature sending unit, check coolant level and replenish, if necessary, with the correct coolant solution.

Radiator Cap Pressure Test

- Remove the radiator cap from the radiator filler neck.
- Use water to clean the cap in the area of the rubber seal and the vacuum relief valve as outlined. Immerse the radiator cap in water to wet the seals and install on the shallow filler neck of Rotunda Radiator Cap Pressure Test Adapter 021-00012 or equivalent adapter.

NOTE: The adapter is designed to accept both deep and shallow neck radiator caps.

- Before installing the radiator cap on the adapter, immerse the filler neck seal in water and install it in the filler neck adapter. If the adapter is made of plastic, check its sealing surfaces to be certain that they are free of rough spots and contain no parting lines or core marks.

NOTE: The filler neck seal is reversible so that it may be used on either a deep or shallow radiator filler neck. It will also fit either end of the radiator cap pressure test adapter.

- Install the filler neck adapter with filler neck seal on the deep filler neck end to the radiator cap pressure test adapter.
- Connect the female quick disconnect fitting of the pressure test pump to the male quick disconnect fitting of the filler neck adapter.
- SLOWLY depress the plunger of the pressure test pump until the pressure gauge reading stops increasing and note the highest pressure reading obtained.

NOTE: If the plunger of the pump is depressed too fast, an erroneous pressure reading will result.

- Release the pressure by depressing the pressure relief valve stem. Then, tighten the pressure relief screw and repeat Step 6 (at least twice) to make sure the pressure test reading is repeatable within the acceptable gauge reading limits of the radiator cap and is not erratic. Refer to Specifications at end of this section.
- If the pressure test gauge readings are not within the acceptable gauge reading limits, replace the radiator cap, and perform a Cooling System Pressure Test. If the pressure test gauge readings are within the acceptable gauge reading limits, perform the Cooling System Pressure Test.

Thermostat Test

If the problem being investigated is insufficient heat, inspect the thermostat for leakage. Hold the thermostat up to a lighted background. Light leakage around the thermostat valve (thermostat at room temperature) is unacceptable and the thermostat should be replaced. It is possible, on some thermostats, that a slight leakage of light at one or two locations on the perimeter of the valve may be detected. This is considered normal.

Leak Test

Clean the radiator before leak testing to prevent contaminating the test tank. Leak test the radiator in clean water at 145 kPa (21 psi) air pressure.

CAUTION: Do not leak test an aluminum radiator in the same water that is used to leak test copper/brass radiators. Flux and caustic cleaners may be present in the tank and they will attack aluminum.

DIAGNOSIS AND TESTING (Continued)

A separate, clean test tank is recommended for aluminum radiators. If a separate tank is not available for aluminum radiator testing, thoroughly clean the test tank each time before testing an aluminum radiator.

NOTE: When a plastic tank is removed to service a tube-to-header leak, the core can be tested by clamping the tank to the core.

Diagnosis Guides

Refer to the following Diagnosis Guides for cooling system complaints, their possible cause and recommended resolution. Refer to the pertinent section for testing and service.

Use a cooling system analyzer or equivalent to assist in diagnosing the cooling system. Follow the manufacturer's instructions for connections at testing.

The most frequent cooling system complaints concern leakage and overheating. Either of these problems will soon render the vehicle inoperable.

Most vehicles use an ethylene glycol base antifreeze solution to which the manufacturers have added a dye color. The dye color makes the antifreeze solution an excellent leak detector. If this type of solution is not being used in the cooling system, a vegetable dye may be added to aid in locating external leakage.

LOSS OF COOLANT DIAGNOSIS GUIDE — TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	VISUAL CHECK		
	<ul style="list-style-type: none"> Make visual check for leaking hoses, and connections to radiator, heater core and engine. Is everything operating properly? 	Yes No	GO to A2 . Make necessary repairs. GO to A2 .
A2	PRESSURE TEST		
	<ul style="list-style-type: none"> Pressure test cooling system to check for dirty or damaged radiator cap, external leakage and/or internal leakage. 	Cooling system Checks OK Dirty or damaged radiator cap External leak Internal leak	RETURN vehicle to customer. CLEAN or REPLACE cap. REPEAT A2 . REPAIR or REPLACE as necessary. REPEAT A2 . DISASSEMBLE engine as necessary to determine cause of leakage. CHECK for: cracked intake manifold, blown head gasket, warped block or head gasket surfaces, cracked cylinder head(s), cracked cylinder block. REPAIR or REPLACE as necessary. REPEAT A2 .

TCQ1701E

DIAGNOSIS AND TESTING (Continued)

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE — TEST B

TEST STEP		RESULT	ACTION TO TAKE
B1	TEMPERATURE CHECK		
	<ul style="list-style-type: none"> Operate engine at high rpm or under load for 20 minutes. Check coolant temperature with thermometer. <p>WARNING: USE CARE WHEN REMOVING RADIATOR CAP TO AVOID INJURY FROM ESCAPING STEAM OR HOT WATER.</p> <p>NOTE: Remove radiator cap before running this test. Then use a known quality thermometer for checking coolant temperature.</p> <ul style="list-style-type: none"> Measure the temperature at top of radiator. Specifications are as follows: Gasoline engines — 91-121°C (195-250°F) Diesel Engines — 91-114°C (195-237°F) Is coolant temperature within specifications? 	Yes No	GO to B2 . GO to B3 .
B2	GAUGES / LIGHTS		
	<ul style="list-style-type: none"> Check operation of temperature gauge (Refer to Section 13-05, Gauges, Engine Operation.) Is gauge operating properly? 	Yes No	ADVISE customer of normal operation. REPAIR or REPLACE components as necessary.
B3	THERMOSTAT		
	<ul style="list-style-type: none"> Remove and test thermostat. (Refer to Thermostat Testing in this section.) Is thermostat operating properly? 	Yes No	ADVISE customers of normal operation. REPLACE the thermostat. GO to B1 .

ENGINE OVERHEATS — TEST C

TEST STEP		RESULT	ACTION TO TAKE
C1	COOLANT		
	<ul style="list-style-type: none"> Check coolant level. Is coolant level within specifications? 	Yes No	GO to C2 . REFER to Coolant Loss Diagnosis Guide in this section. GO to C2 .
C2	TEMPERATURE CHECK — (DOWN FLOW RADIATOR ONLY)		
	<ul style="list-style-type: none"> Operate engine at high rpm or under load for 20 minutes. Check temperature with a thermometer. <p>CAUTION: Use care when removing radiator cap to avoid injury from escaping steam or hot water. If engine overheats, shut down immediately and GO to C4.</p> <p>NOTE: Remove radiator cap before running this test.</p>	Temperature is within specifications Temperature too low Temperature too high	GO to C3 . GO to Engine Fails to Reach Normal Operating Temperature Diagnosis Guide in this section. GO to C4 .
C3	TEMPERATURE GAUGE		
	<ul style="list-style-type: none"> Check operation of temperature gauge. (Refer to Section 13-05, Gauges, Engine Operation.) Is temperature gauge operating properly? 	Yes No	ADVISE customer of normal operation. REPAIR or REPLACE components as necessary.

DIAGNOSIS AND TESTING (Continued)

ENGINE OVERHEATS — TEST C (Continued)

TEST STEP		RESULT	ACTION TO TAKE
C4	FAN BELT		
	<ul style="list-style-type: none"> Check fan belt tension. (Refer to Section 03-05, Accessory Drive.) Is fan belt tension within specifications? 	Yes No	GO to C5 . REPLACE fan belt and/or ADJUST belt tension. GO to C2 . Check automatic belt tensioner for proper operation.
C5	RADIATOR		
	<ul style="list-style-type: none"> Check radiator and air conditioning condenser fins for obstructions. 	No obstructions Obstructions present	GO to C6 . CLEAR radiator fins. GO to C2 .
C6	SYSTEM CIRCULATION		
	<ul style="list-style-type: none"> Remove radiator cap. Operate engine at high rpm. Coolant should not overflow radiator filler neck. Does coolant overflow filler neck? 	Yes No	GO to C7 . GO to C9 .
C7	DISTRIBUTOR BASICS		
	<ul style="list-style-type: none"> Check ignition initial timing and distributor advance. (Refer to the Technical Bulletin Special Specifications Issue for distributors.) Are ignition initial timing and distributor advance correct? 	Yes No	GO to C8 . MAKE adjustments, repairs, and/or parts replacements as necessary. GO to C2 .
C8	WATER PUMP		
	<ul style="list-style-type: none"> Remove water pump and check for binding or sheared impeller shaft. 	No binding or shearing Binding or shearing present	REINSTALL water pump and ADVISE customer of normal operation. REPLACE water pump. GO to C2 .
C9	THERMOSTAT		
	<ul style="list-style-type: none"> Check thermostat operation. (Refer to Thermostat Test in this section.) Is thermostat operating properly? 	Yes No	GO to C10 . REPLACE thermostat. GO to C2 .
C10	COOLING SYSTEM		
	<ul style="list-style-type: none"> Flush, clean and refill cooling system. (Refer to Cleaning and Inspection in this section.) Repeat test Step C2. Is temperature within specifications? 	Yes No	ADVISE customer of normal operation. GO to C11 .
C11	FAN CLUTCH		
	<ul style="list-style-type: none"> Check automatic fan drive system operation. (Refer to Section 03-05, Accessory Drive.) Is fan drive system operating properly? 	Yes No	ADVISE customer of normal operation. REPLACE fan clutch and GO to C2 .

TCQ1704A

REMOVAL AND INSTALLATION

Thermostat

Do not attempt to service the thermostat. It should be replaced if it is not operating properly.

Check the thermostat before installing it, following the Thermostat Test procedures.

4.9L (300 CID) I-6**Removal**

1. Drain the radiator so that the coolant level is below the thermostat.

2. Remove the coolant outlet elbow attaching bolts.
3. Pull the elbow away from the cylinder head sufficiently to provide access to the thermostat.
4. Remove the thermostat and gasket.

Installation

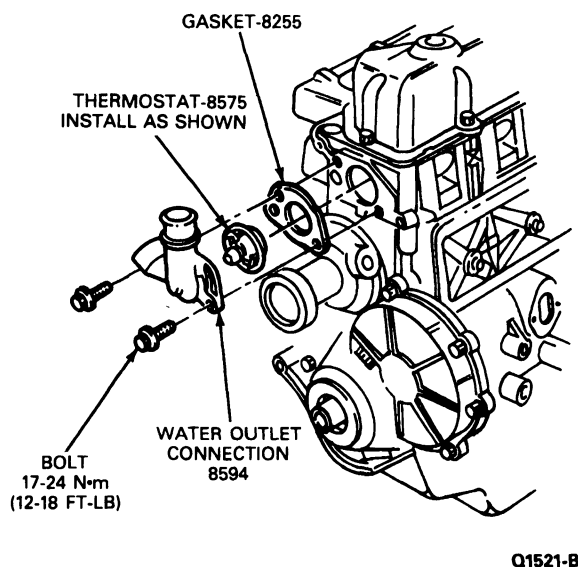
1. Clean the coolant outlet elbow and cylinder head gasket surfaces.

REMOVAL AND INSTALLATION (Continued)

- Coat a new gasket with Perfect Seal Sealing Compound B5A-19554-A or D7AZ-19554-BA (ESR-M18P2-A and ESE-M4G115-A) or equivalent.
- Position the gasket on the cylinder head opening. The gasket must be positioned on the cylinder head **before** the thermostat is installed.
- The coolant outlet elbow contains a locking recess into which the thermostat is turned and locked. Install the thermostat with pellet side out.
- Turn the thermostat clockwise to lock it in position on the flats cast into the outlet elbow.
- Position the coolant outlet elbow against the cylinder head. Install and tighten the attaching bolts to 16-24 N·m (12-18 ft-lb).

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

- Fill and bleed the cooling system as outlined.
- Check for leaks and proper coolant level after the engine has reached normal operating temperatures.



V-8

Removal

- Drain the radiator so that the coolant level is below the thermostat.
- Disconnect the bypass hoses at the water pump and intake manifold.
- Remove the bypass tube.
- Remove the water outlet housing attaching bolts.
- Bend the radiator upper hose upward and remove the thermostat and gasket.

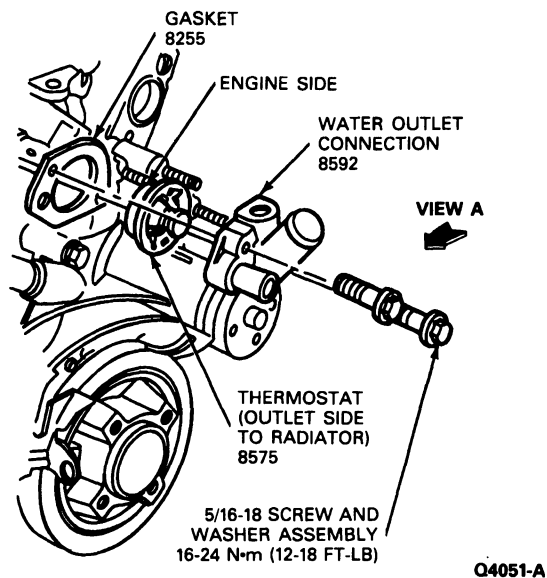
Installation

- Clean the water outlet housing gasket surfaces. Coat a new water outlet housing gasket with Perfect Seal Sealing Compound B5A-19554-A or D7AZ-19554-BA (ESR-M18P2-A or ESE-M4G115-A) or equivalent.
- Position the water outlet housing gasket on the intake manifold opening.
- Install the thermostat in the intake manifold opening with the copper pellet or element toward the engine and the thermostat flange positioned in the recess. If the thermostat is improperly installed, it will cause a retarded flow of coolant.
- Position the water outlet housing against the intake manifold.
- Install and tighten the attaching bolts. Refer to Specifications.
- Install the water bypass line and tighten hose connections.

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

- Fill and bleed the cooling system as outlined.
- Operate the engine until normal operating temperature is reached; then check the coolant level and check for leaks.

Thermostat Installation, 5.0L / 5.8L Shown



Coolant Recovery Bottle

Removal

- Pinch the overflow hose until it is closed. Remove the overflow hose from the radiator filler neck nipple. Drain the coolant from the coolant recovery bottle.

REMOVAL AND INSTALLATION (Continued)

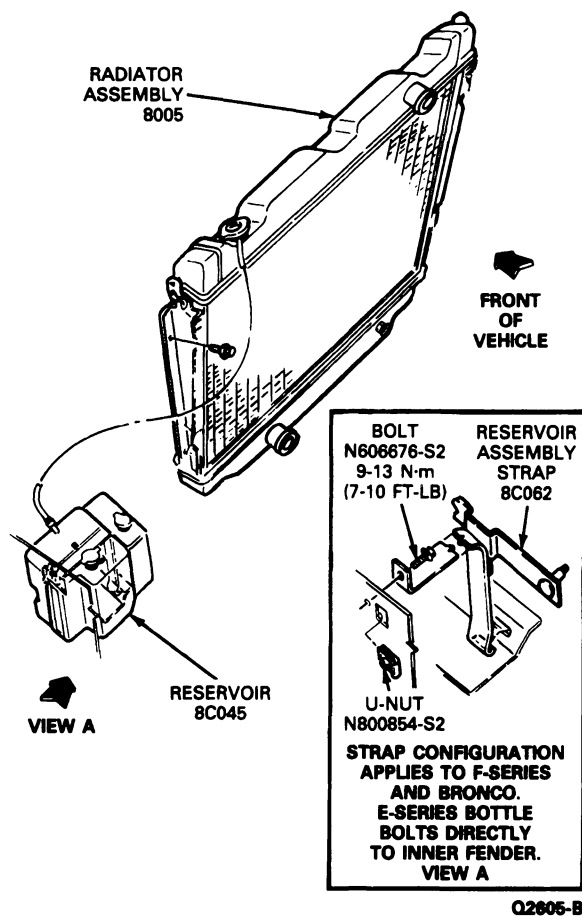
2. Remove the recovery bottle strap or bracket attaching bolt(s) and remove the recovery bottle.
3. Disconnect the radiator overflow line at the recovery bottle.
4. Remove the overflow tube from the recovery bottle.

Installation

1. Position the recovery bottle in the chassis and install the strap or bracket attaching bolt(s).
2. Connect the overflow tube to the recovery bottle.
3. Connect the overflow hose to the radiator filler neck nipple.

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

4. Fill and bleed the cooling system as described in this section. Check for coolant leaks and proper coolant level after the engine reaches normal operating temperatures.

**Radiator and Fan Shroud****E-150-250-350, All Engines****F-250-350, F-Super Duty Chassis Cab and Commercial Chassis with 7.3L Diesel Engine****Removal**

1. Drain the cooling system by removing the radiator cap and opening the draincock located at the lower rear corner of the radiator tank. To prevent coolant loss when draining radiator, slip a hose on the draincock and drain coolant into a clean container.
2. Remove the rubber overflow tube from the coolant recovery bottle and detach it from the shroud (where appropriate).
3. Remove the shroud's two or four attaching bolts; lift the shroud back and drape it on the fan.
4. Loosen the upper and lower hose clamps at the radiator and remove the hoses from the radiator connectors.
5. Disconnect the two automatic transmission (if so equipped) oil cooling lines from radiator fittings.
6. Disconnect the heated water bypass hose attached to the lower tank (E-Series) or to the radiator filler neck (F-Series, Bronco) on E4OD equipped vehicles only.
7. Remove the four radiator attaching bolts.
8. Tilt the radiator back approximately 25mm (one inch) and lift directly upward, clear of the radiator support.
9. If either hose is to be replaced, loosen clamp at the engine end and slip the hose off the connection with a twisting motion.
10. Lift the shroud off the fan and remove from the vehicle.

Installation

1. Position shroud on fan until radiator is installed.
2. If either hose has been replaced, install on engine with index arrow in line with mark on fitting. Install double wire clamps and tighten clamps to 3-4 N·m (27-35 in-lb).
3. Position radiator into engine compartment to radiator support, being careful to clear fan.
4. Install the radiator with four bolts and tighten to specifications.
5. Connect the two automatic transmission (if so equipped) oil cooling lines to radiator connectors and tighten tube nuts to 16-24 N·m (12-18 ft-lb), or clamps to 4-5 N·m (35-44 in-lb).
6. Attach upper and lower radiator hoses. Install double wire clamps and tighten to 3-4 N·m (27-35 in-lb).
7. Attach the heated water bypass hose (E4OD equipped vehicles only).
8. Position shroud to radiator and attach with four bolts. Tighten bolts to specifications.

REMOVAL AND INSTALLATION (Continued)

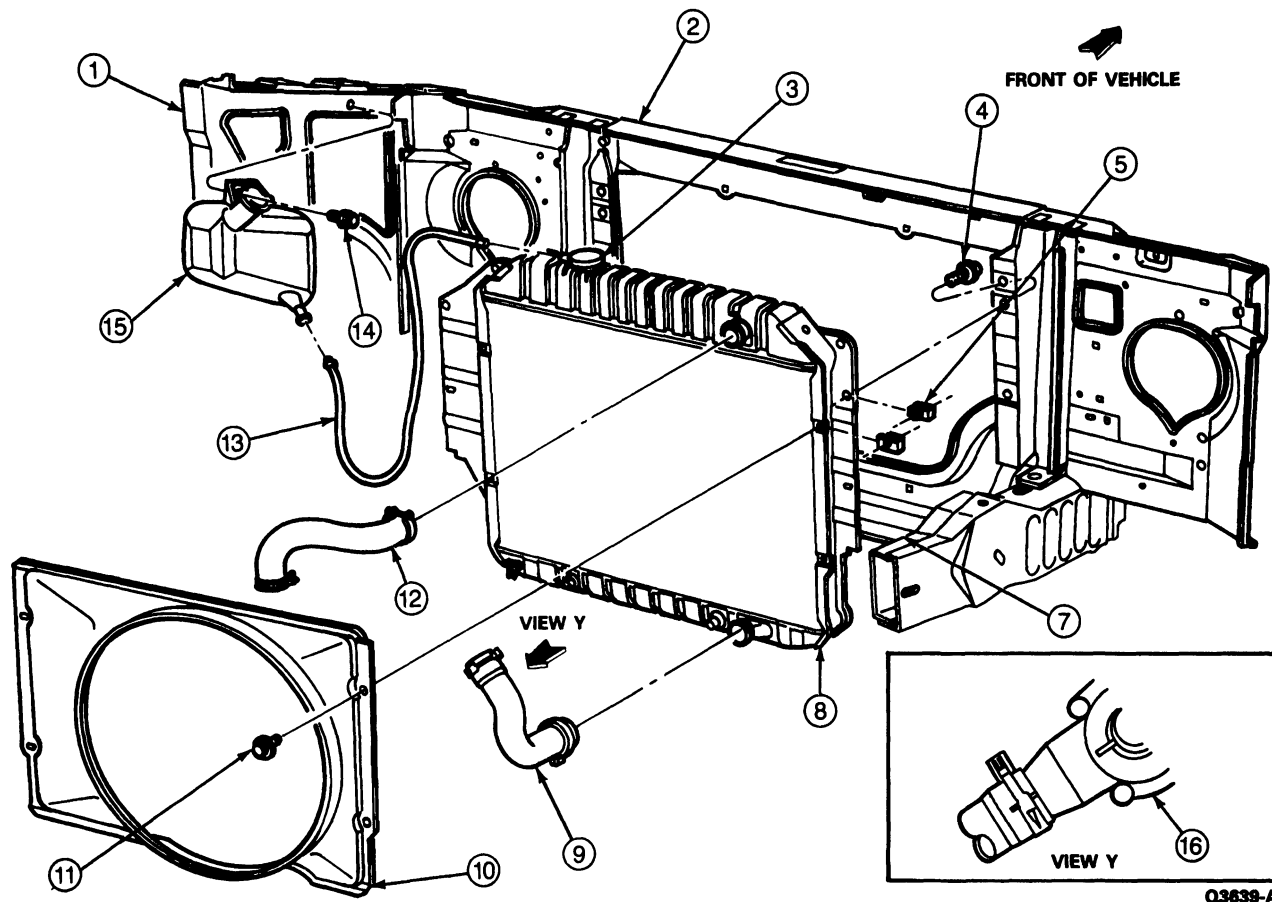
9. Attach rubber overflow tube from coolant recovery bottle to radiator (where applicable).

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

NOTE: A 50/50 mixture of coolant concentrate water is recommended to maintain best overall performance. To avoid damaging the radiator or engine, the coolant concentrate should not exceed 60 percent.

10. Install new 50/50 mixture of water and Premium Cooling System Fluid E2FZ-19549-AA or equivalent and operate the engine for 15 minutes. Check the coolant level and bring it up to within 38mm (1-1/2 inches) of the radiator filler neck.

Radiator Installation, E-150-250-350 4.9L (Typical for 5.0L, 5.8L and 7.5L)



Q3639-A

Item	Part Number	Description
1	16154	Radiator Support
2	8A297	Upper Radiator Support
3	8100	Cap Assembly — Radiator
4	N605905-S2	Bolt M8 15-20 N-m (10-15 Ft-Lb)
5	N623333-S2	U-Nut M8
6	N623332-S2	U-Nut M6
7	19E667	Air Deflector
8	8005	Radiator
9	8B273	Hose and Clamp Assembly — Lower

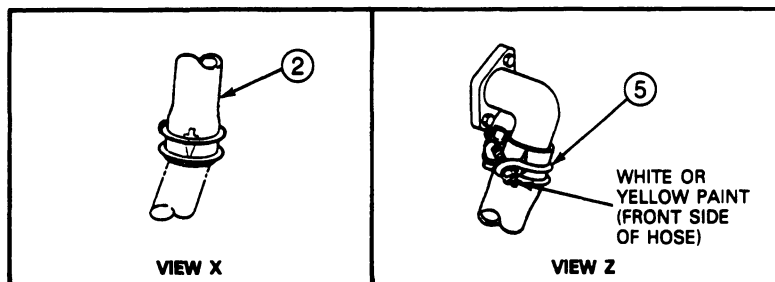
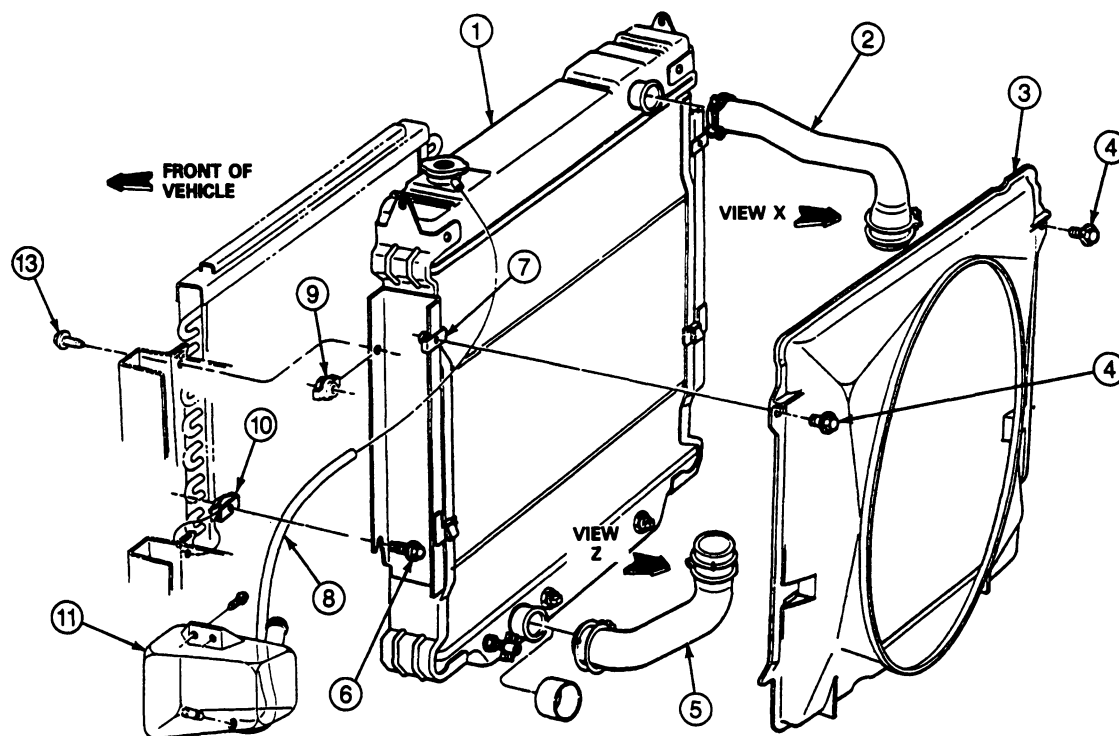
Item	Part Number	Description
10	8146	Shroud Assembly — Fan
11	N606677-S2	Bolt M6 6-8 N-m (53-71 In-Lb)
12	8B274	Hose and Clamp Assembly — Upper
13	381440-S480A	Hose
14	W611102-S2	Screw & Washer M6 Tap 6-8 N-m (53-71 In-Lb)
15	8C045	Reservoir Assembly
16	8507	Water Pump

TQ3639A

(Continued)

REMOVAL AND INSTALLATION (Continued)

Radiator Installation, E-250-350 7.3L Diesel



Q3641-A

Item	Part Number	Description
1	8005	Radiator Assembly
2	8B274	Hose and Clamp Assembly (Upper)
3	8146	Shroud — Fan
4	57131-S2	Screw and Washer Assembly 1/4-20 5-8 N·m (44-71 In·Lb)
5	8B273	Hose and Clamp Assembly (Lower) 3-4 N·m (27-35 In·Lb)

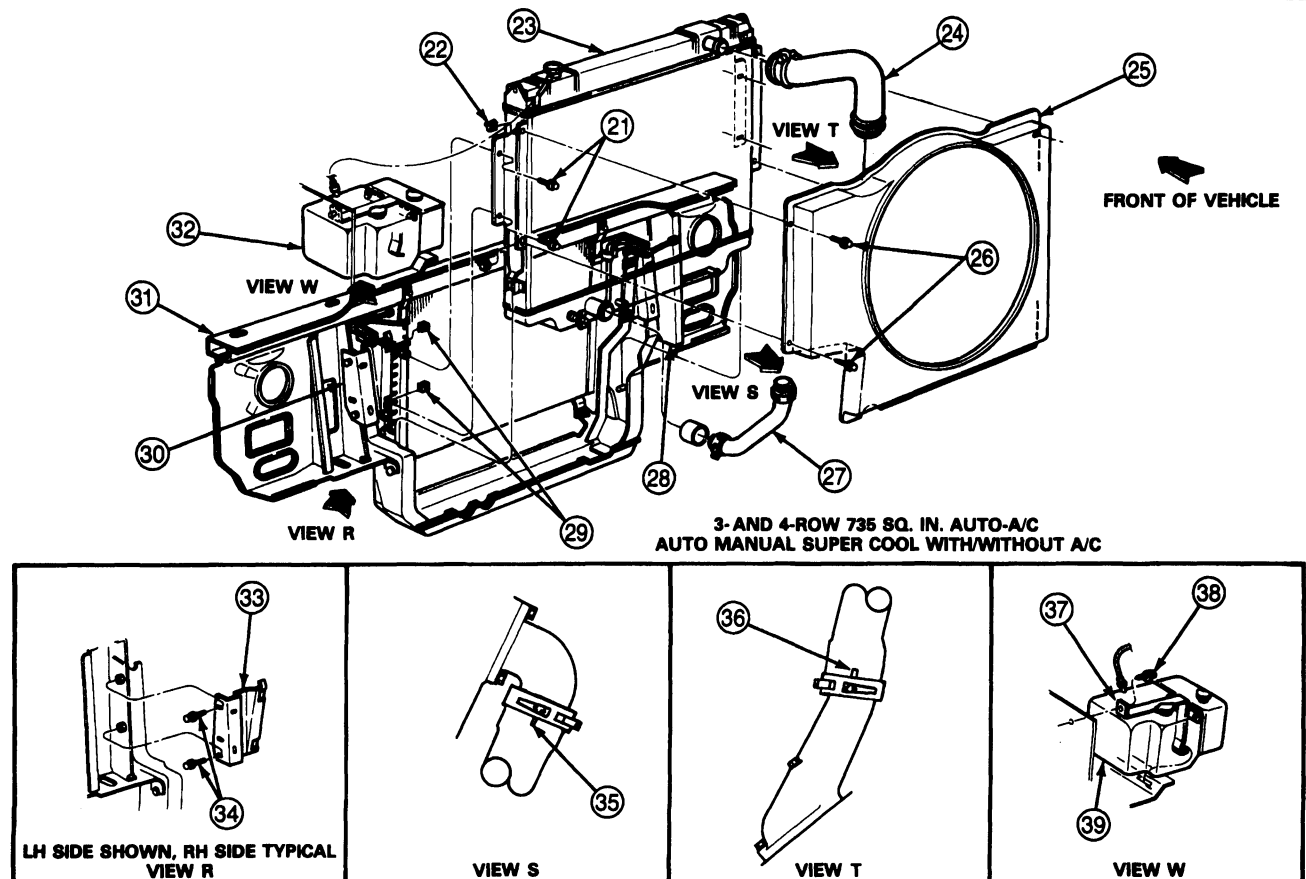
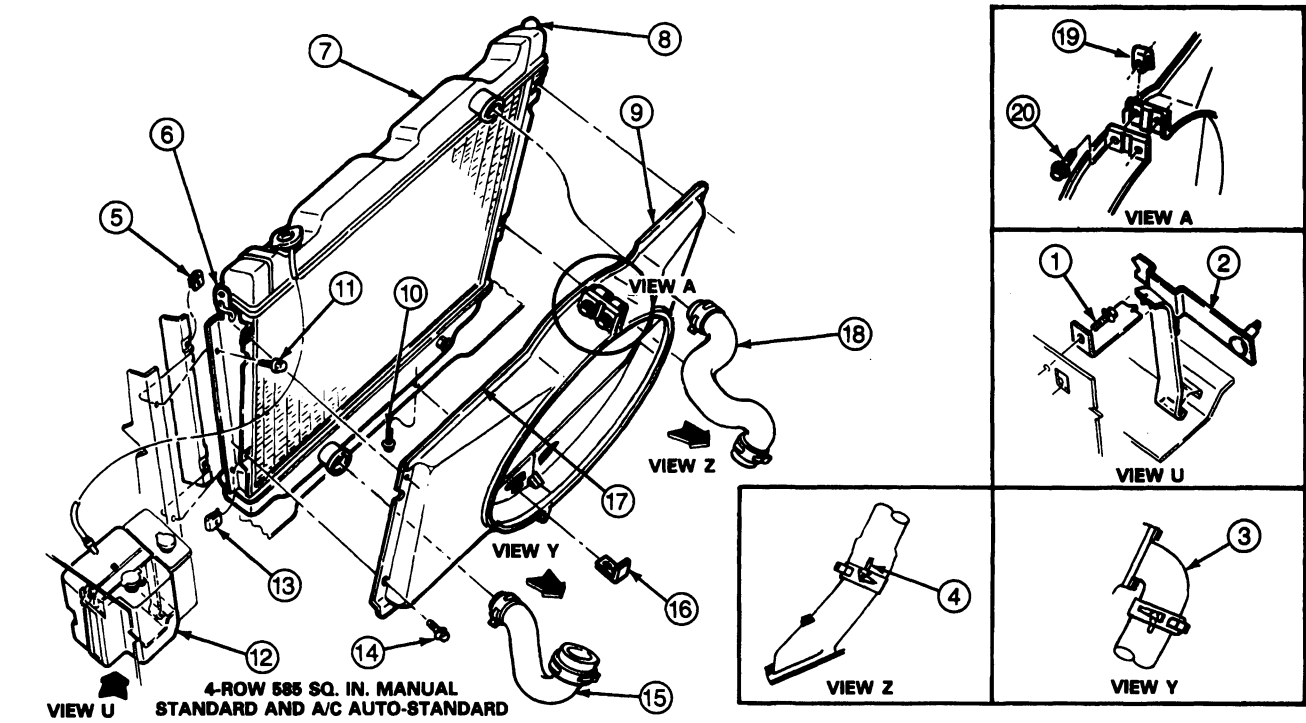
(Continued)

Item	Part Number	Description
6	390049-S2	Bolt 3/8-16 x 1.40 14-20 N·m (10-15 Ft·Lb)
7	385843-S2	U-Nut 1/4-20
8	381440-S480A	Hose
9	45268-S101	U-Nut 5/16-18
10	45265-S2	U-Nut 3/8-16
11	8C045	Reservoir Assembly
12	W611102-S2	Screw & Washer M6 Tap 6-8 N·m (53-71 In·Lb)
13	56720-S2	Bolt 5/16-18 x .88 14-20 N·m (10-15 Ft·Lb)

TQ3641A

REMOVAL AND INSTALLATION (Continued)

Radiator Installation, F-250-350, F-Super Duty 7.3L Diesel Engine



Q2128-G

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W611105-S2	Screw 9-13 N-m (7-10 Ft-Lb)
2	8K088	Reservoir Assembly Strap
3	—	Paint White or Yellow Front Side of Hose
4	—	Paint White or Yellow Front Side of Hose
5	N623333	U-Nut
6	—	Lifting Eye
7	8005	Radiator Assembly
8	—	Lifting Eye
9	8142AA	RH Shroud
10	55981-S2	Screw
11	606689	Screw and Washer 24-33 N-m (18-25 Ft-Lb)
12	8C045	Reservoir
13	N800854-S2	U-Nut
14	N606677-S2	Bolt and Washer
15	8B273	Lower Hose and Clamp Assembly
16	8C278	Bracket
17	8147-BA	LH Shroud
18	8B274	Upper Hose and Clamp Assembly
19	N800854-S2	U-Nut
20	N606677-S2	Screw
21	N623333-S2	Screw and Washer Assembly 24-33 N-m (18-25 Ft-Lb)

(Continued)

Item	Part Number	Description
22	N800854-S2	Nut
23	8005	Radiator
24	8B274	Upper Hose and Clamp Assembly
25	—	Fan Shroud
26	N606677-S2	Screw and Washer Assembly 7-9 N-m (62-80 In-Lb)
27	8B273	Lower Hose and Clamp Assembly
28	8A348	Bracket
29	N602734-S2	Nut
30	8A347	Bracket
31	8A297	Radiator Support
32	8C045	Reservoir
33	8A347	Bracket
34	N606682-S2	Bolt
35	—	Line up Paint Stripe Front Side of Hose
36	—	Line up Paint Stripe Front Side of Hose
37	8K088	Strap
38	W611105	Screw and Washer Assembly 7-11 N-m (62-97 In-Lb)
39	8C045	Reservoir

TQ2128A

F-150-250-350, F-Super Duty Chassis Cab and Motorhome Chassis with Gasoline Engine**Removal**

1. Drain the cooling system by removing the radiator cap and opening the draincock located at the lower rear corner of the radiator tank. To prevent coolant loss when draining radiator, slip a hose on the draincock and drain coolant into a clean container.
2. Remove the rubber overflow tube from the coolant recovery bottle and detach it from the radiator.
3. Remove the shroud's two upper attaching screws, lift the shroud out of the lower retainer clips and drape it on the fan. On F-Super Duty Motorhome Chassis vehicles remove the two screws at the bottom of the shroud.
4. Loosen the upper and lower hose clamps at the radiator and remove the hoses from the radiator connectors.
5. Remove the heated water bypass hose (E4OD equipped vehicles only) located directly below the overflow nipple on the radiator outlet tank.
6. Disconnect the two automatic transmission (if so equipped) oil cooling lines from radiator fittings.

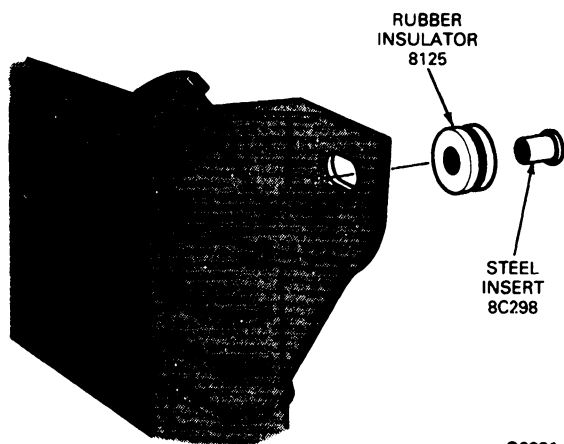
7. Remove the two radiator upper attaching screws or bolts.
8. Tilt the radiator back approximately 25mm (one inch) and lift directly upward, clear of the radiator support and cooling fan.
9. If either hose is to be replaced, loosen clamp at the engine end and slip the hose off the connection with a twisting motion.
10. Lift the shroud off the fan and remove from the vehicle.
11. Remove the radiator lower support rubber pads (insulators).

Installation

1. Position the radiator lower support rubber pads to the lower frame.
2. Position shroud on fan until radiator is installed.
3. If either hose has been replaced, install on engine with index arrow in line with mark on fitting on engine. Install double wire clamps and tighten to 3-4N-m (27-35 in-lb).
4. Install the heated water bypass hose (E4OD equipped vehicles only) to the nipple located below the overflow tank.

REMOVAL AND INSTALLATION (Continued)

5. Position radiator into engine compartment to radiator support, being careful to clear fan.
6. Inspect the radiator upper rubber insulators. Replace if necessary.



Q2281-1B

7. Install two upper attaching bolts or screws. Tighten to specifications.
8. Connect the two automatic transmission (if so equipped) oil cooling lines to radiator connectors and tighten tube nuts to 16-24 N·m (12-18 ft-lb) or clamps to 4-5 N·m (35-44 in-lb).
9. Attach radiator upper and lower hoses to radiator. Position hose on radiator connection so that index arrow on hose is in line with mark on connection. Install double wire clamps and tighten to 3-4 N·m (27-35 in-lb).
10. Position shroud on the lower retainer clips and attach the top of the shroud to radiator with two screw and washer assemblies. On F-Super Duty Motorhome Chassis vehicles install the two lower screws. Tighten screws to 6-8 N·m (53-71 in-lb).
11. Attach rubber overflow tube from coolant recovery bottle to radiator.

WARNING: DO NOT STAND IN LINE WITH OR NEAR RADIATOR FAN WHEN ENGINE IS RUNNING.

NOTE: A 50 / 50 mixture of coolant concentrate and water is recommended to maintain best overall performance. To avoid damaging the radiator, the coolant concentrate should not exceed 60 percent.

12. Install new 50 / 50 mixture of water and Premium Cooling System Fluid E2FZ-19549-AA or equivalent and operate the engine for 15 minutes. Check the coolant level and bring it up to within 38mm (1-1 / 2 inches) of the radiator filler neck.

REMOVAL AND INSTALLATION (Continued)

F-150-250-350 and Bronco 4.9L (300 CID) Engine

4.9 LITER ENGINE
MAIN VIEW

VIEW Y

VIEW Z

VIEW X

FRONT OF VEHICLE

VIEW Y

FRONT OF VEHICLE

VIEW X

VIEW Z

Q2144-E

Item	Part Number	Description
1	8005	Radiator Assembly
2	N804639-S2	Nut
3	17B613	Reservoir Assembly
4	8083	Bracket

(Continued)

Item	Part Number	Description
5	—	Clamp
6	8B274	Upper Hose
7	N606677-S2	Screw 5-8 N-m (44-71 In-Lb)
8	8B273	Lower Hose

(Continued)

REMOVAL AND INSTALLATION (Continued)

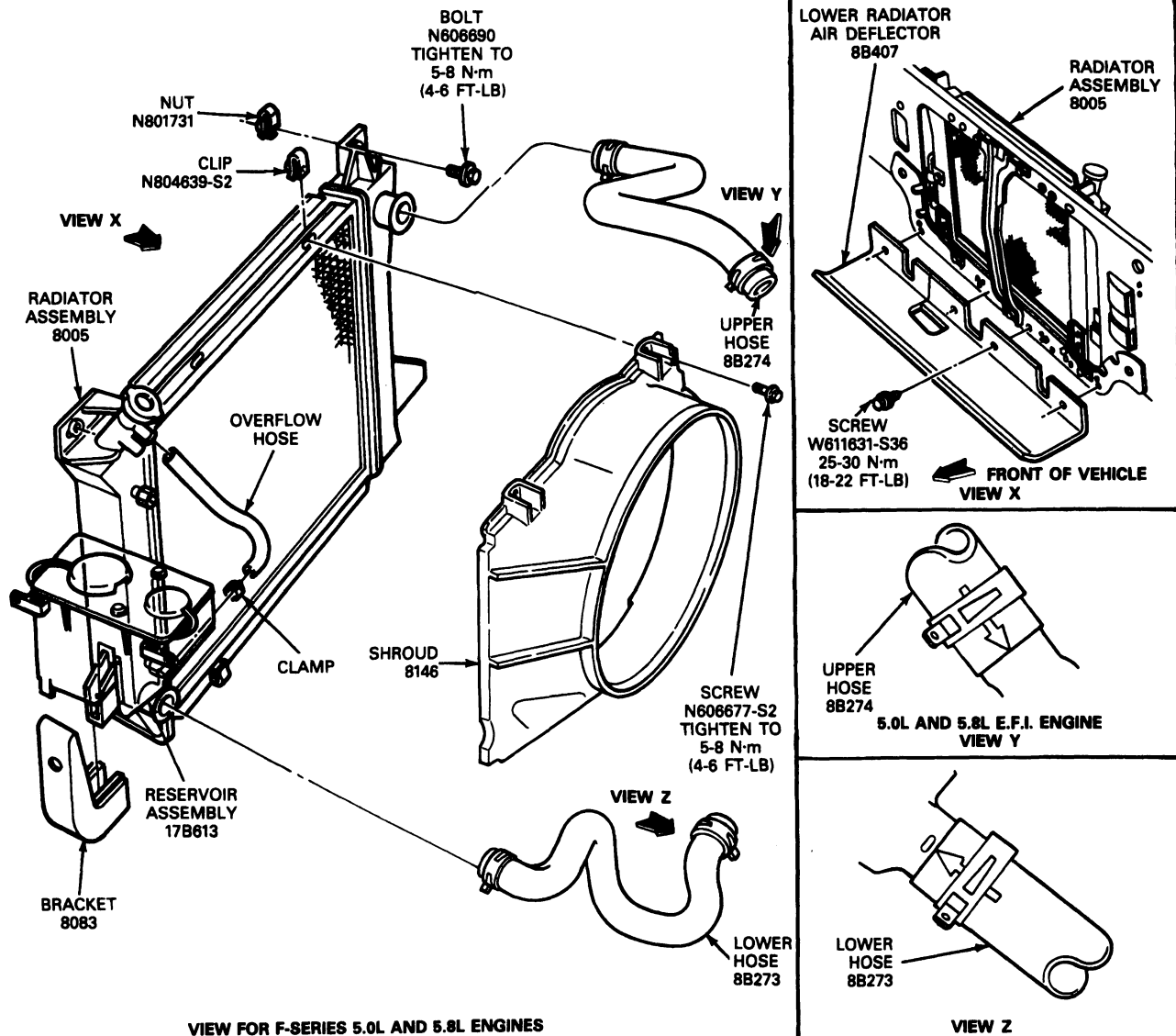
Item	Part Number	Description
9	8147	Upper Fan Shroud
10	8075	Overflow Hose
11	19E525	Upper Radiator Air Deflector
12	W611631-S36	Screw 25-30 N-m (18-22 Ft-Lb)

Item	Part Number	Description
13	8B407	Lower Radiator Air Deflector
14	N606691	Screw 11-14 N-m (8-11 Ft-Lb)
15	8146	Shroud

TQ2144A

(Continued)

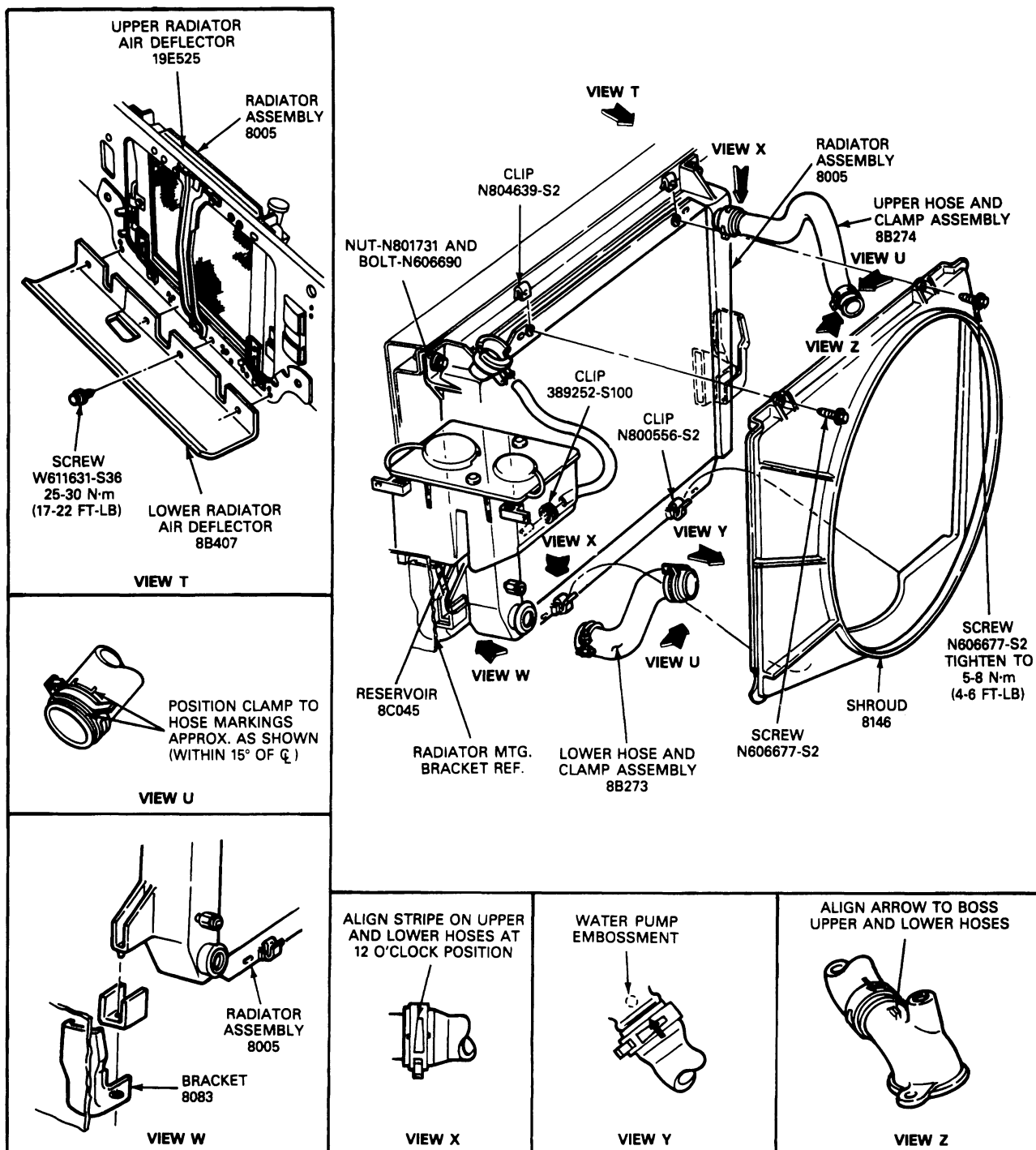
F-150-250-350 and Bronco 5.0L (302 CID) and 5.8L (351 CID) Engines



Q2145-D

REMOVAL AND INSTALLATION (Continued)

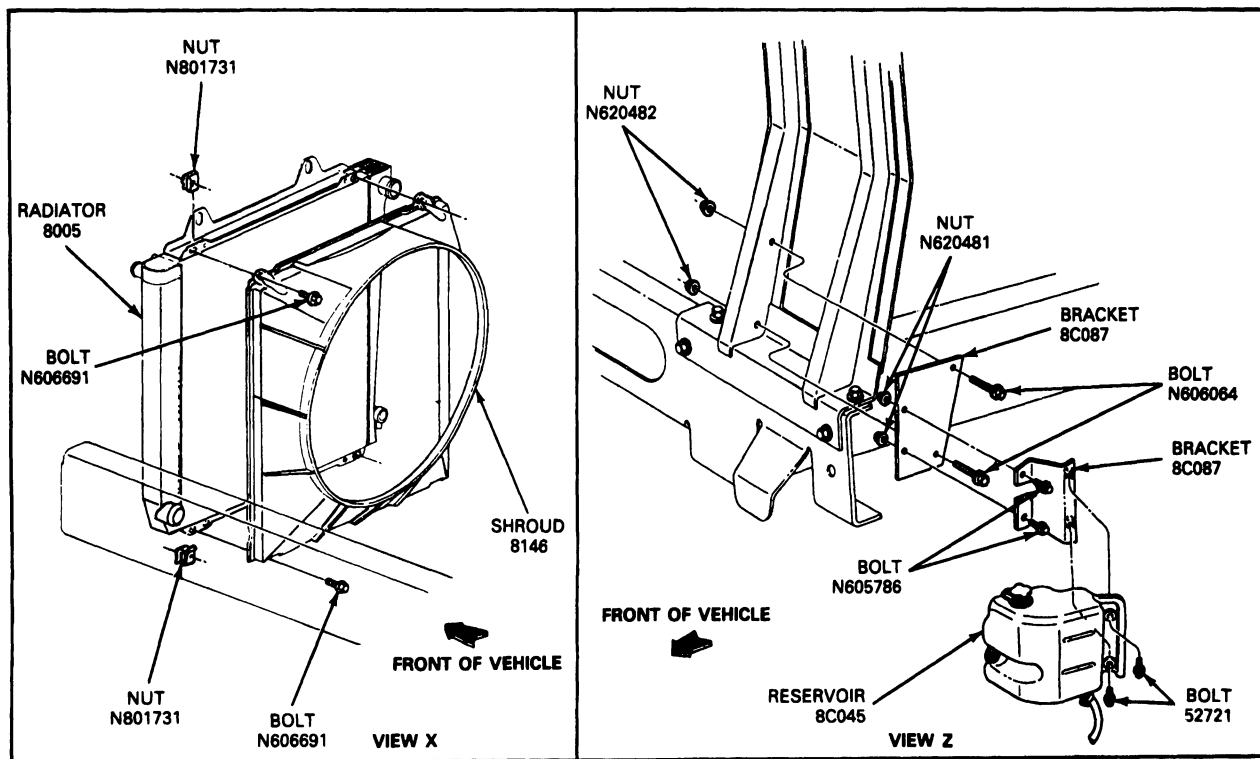
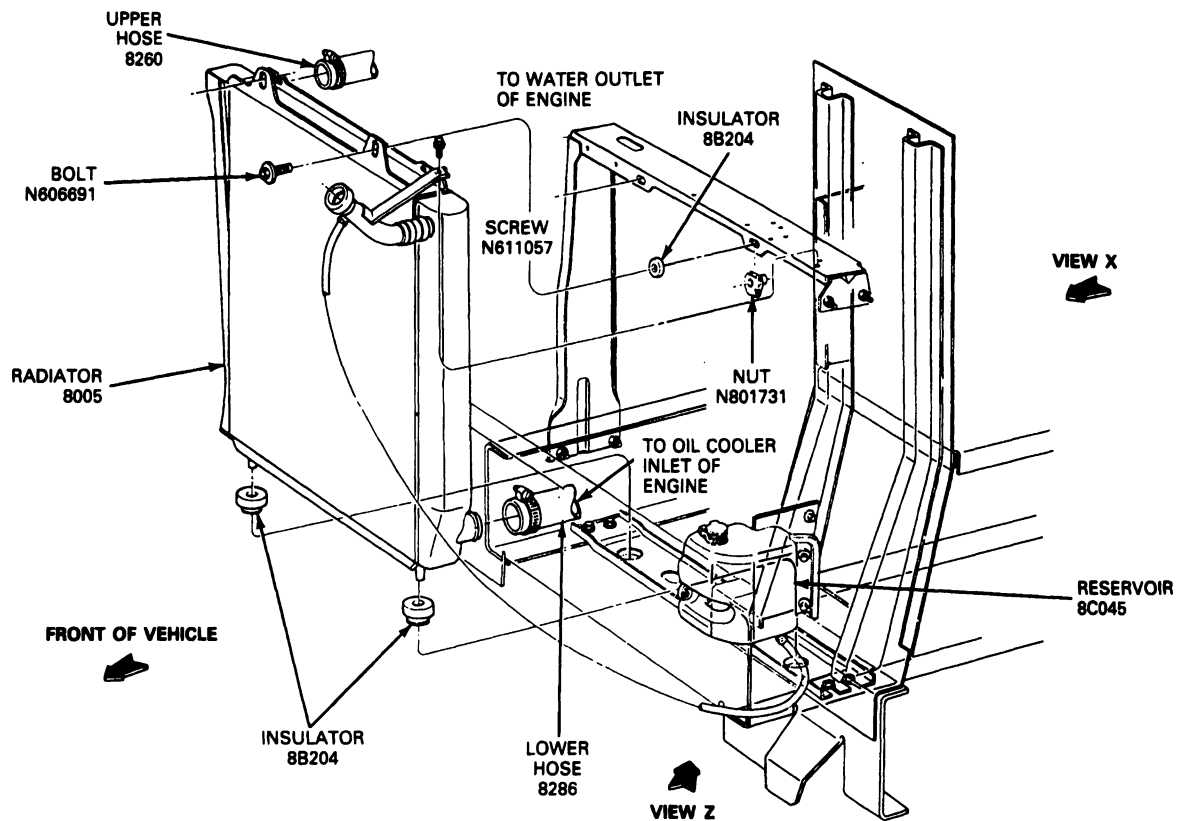
F-250 HD, F-350 and F-Super Duty Chassis Cab with 7.5L (460 CID) Engine



Q2143-E

REMOVAL AND INSTALLATION (Continued)

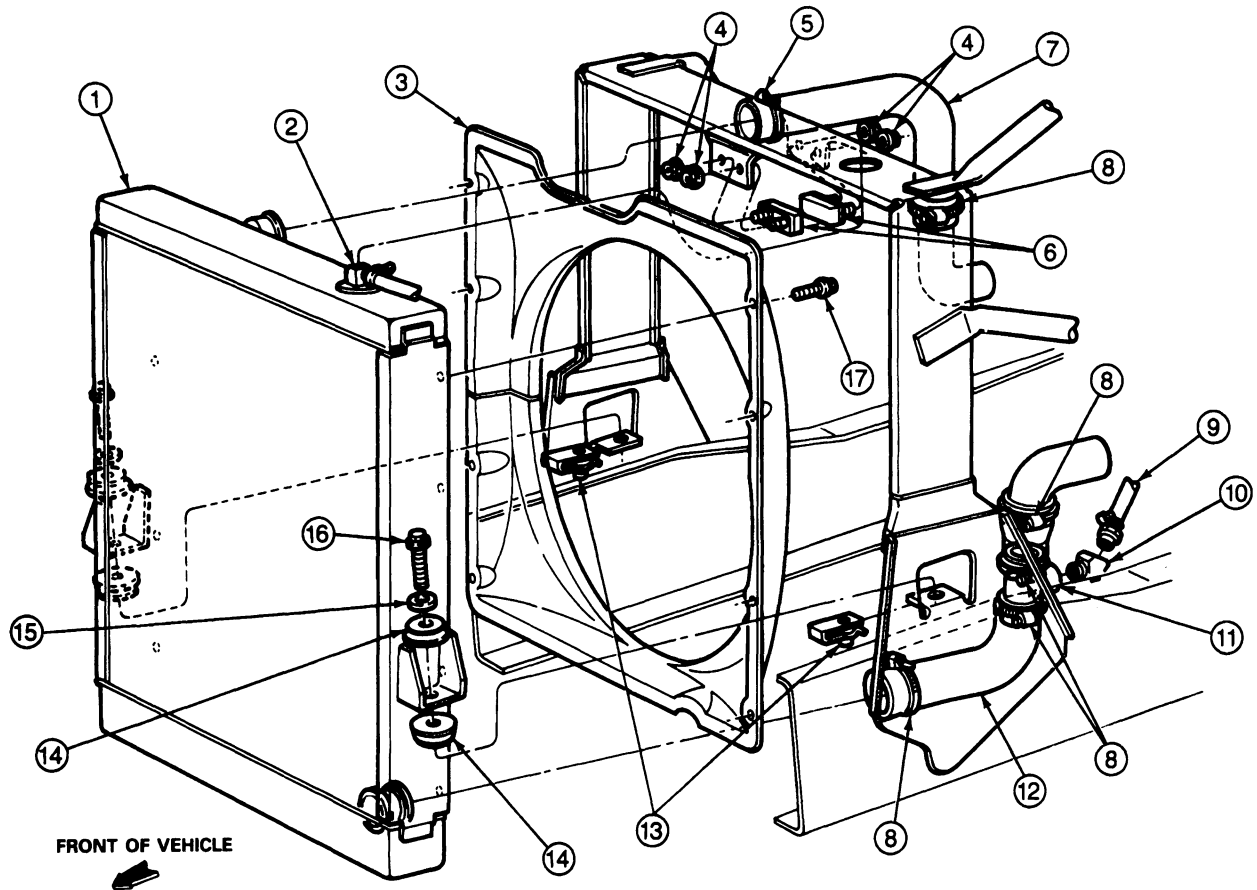
Radiator Installation, F-Super Duty Motorhome Chassis



Q1781-D

REMOVAL AND INSTALLATION (Continued)**F-Super Duty Commercial Chassis****Removal**

1. Drain the radiator by removing the radiator cap and disconnecting the lower radiator hose. To prevent coolant loss when draining the radiator, drain the radiator into a clean container.
2. Remove the rubber overflow tube from the coolant recovery reservoir.
3. Remove the fan shroud's eight attaching bolts, lift the shroud back and drape it over the fan.
4. Loosen the upper radiator hose clamp, and remove the hose from the radiator.
5. Remove the two radiator attaching bolts from the side mounts, and remove the rubber insulators from the mounting pads.
6. Remove the upper radiator support by removing four attaching bolts, and remove the radiator by lifting up and out.
7. Lift the fan shroud off the fan and remove from the vehicle.

Radiator Installation, F-Super Duty Commercial Chassis

Q1773-C

Item	Part Number	Description
1	8005	Radiator Assembly
2	390235	90° Elbow
3	8146	Shroud
4	—	Nut 21-32 N·m (15-24 Ft·Lb)
5	8A354	Clamp
6	8B463	Insulator Assembly
7	8260	Hose
8	388656	Clamp

(Continued)

Item	Part Number	Description
9	—	Hose To Surge Tank
10	—	45° Elbow
11	8B448	Pipe
12	8286	Hose
13	390882	Nut
14	8A421	Insulator
15	44879	Washer
16	—	Bolt 102-142 N·m (75-105 Ft·Lb)

TQ1773A

REMOVAL AND INSTALLATION (Continued)**Installation**

1. Position the fan shroud on the fan.
2. Install the radiator from the bottom into the upper radiator insulators, then install the rubber insulators and the mounting bolts. Tighten the bolts to 102-142 N·m (75-105 ft·lb).
3. Install the upper and lower hoses and tighten the hose clamps.
4. Install the fan shroud and tighten the eight shroud bolts.
5. Install the overflow hose to the coolant recovery bottle.

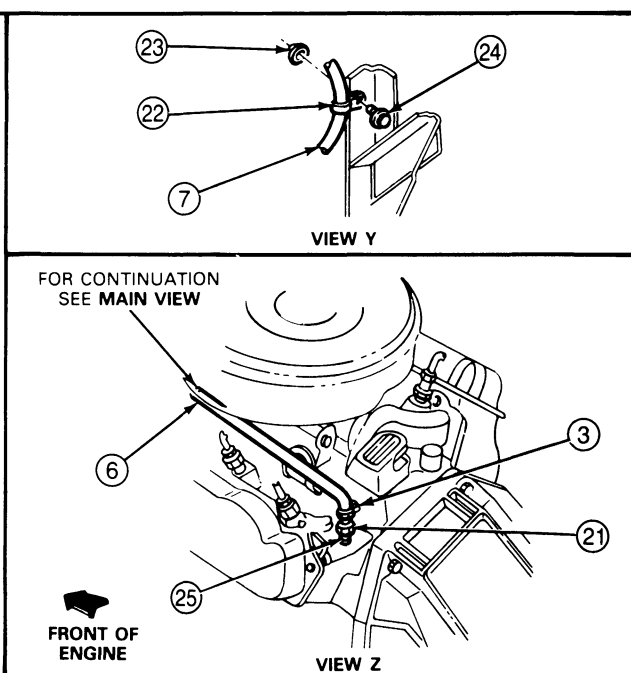
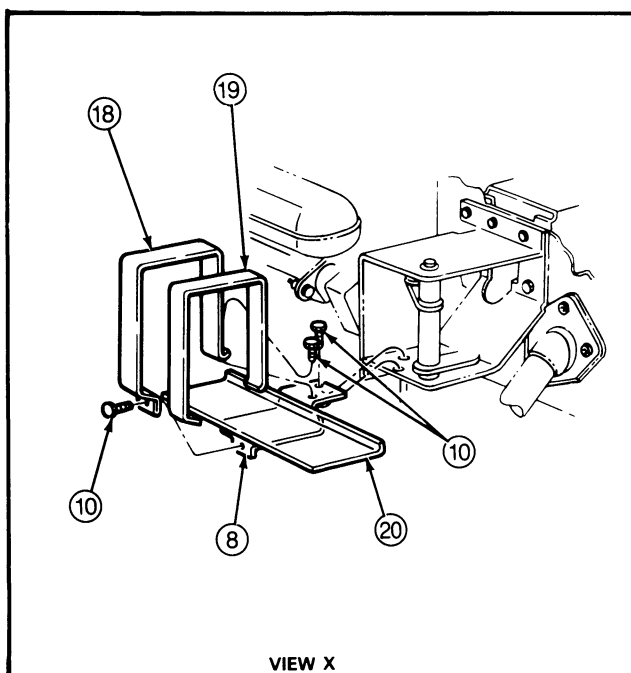
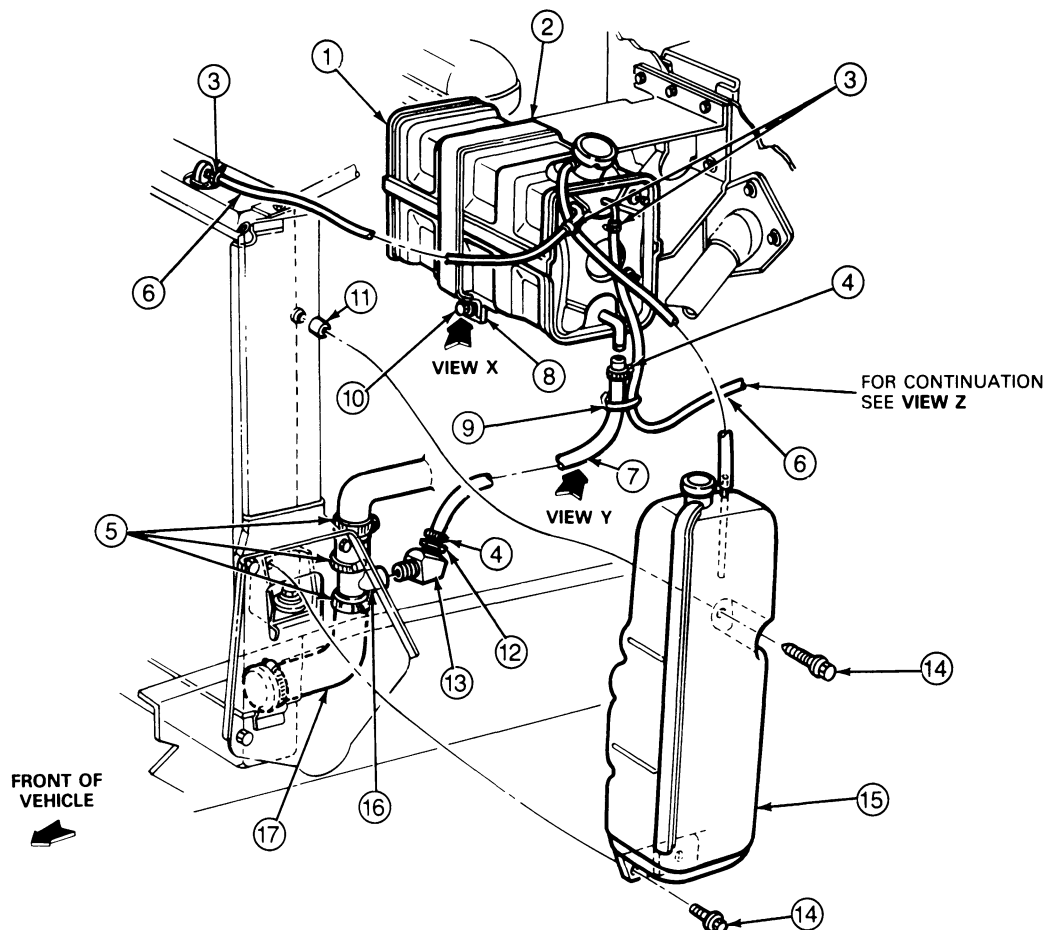
WARNING: DO NOT STAND IN LINE WITH OR NEAR THE RADIATOR FAN WHEN THE ENGINE IS RUNNING.

NOTE: A 50 / 50 mixture of coolant concentrate and water is recommended to maintain best overall performance. To avoid damaging the radiator, the coolant concentrate should not exceed 60 percent.

6. Install new 50 / 50 mixture of water and Premium Cooling System Fluid E2FZ-19549-AA or equivalent and operate the engine for 15 minutes. Check the coolant level and bring it up to within 38mm (1-1 / 2 inches) of the radiator filler neck. Add two Cooling System Stop Leak Pellets D9AZ-19558-A (ESE-M99B37-B) or equivalent.

REMOVAL AND INSTALLATION (Continued)

Reservoir And Surge Tank, F-Super Duty Commercial Chassis



Q1174-D

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	8A080	Surge Tank Assembly
2	88290	Strap
3	388650	Clamp
4	388652	Clamp
5	388656	Clamp
6	8C063	Hose
7	381201	Hose
8	8A081	Bracket
9	9B873	Strap
10	58635	Bolt
11	N800878	Spacer
12	380940	Connector
13	—	45° Elbow

(Continued)

Item	Part Number	Description
14	—	Bolt 40-64 N-m (30-47 Ft-Lb)
15	8C045	Coolant Recovery Reservoir
16	8B448	Pipe
17	8286	Hose
18	8K196	Strap
19	8B420	Anti-Squeak Strap
20	8A354	Anti-Squeak Pad
21	382323	Connector
22	372751	Clip
23	—	Nut 11-17 N-m (8-13 Ft-Lb)
24	605773	Bolt
25	357518	Bushing

TQ1774A

CLEANING AND INSPECTION

Radiator Coolant Level Check

Engine should be at normal operating temperature.

In addition to maintaining the correct coolant level, the radiator fins must be cleaned and the cooling system inspected periodically for leaks in order to be sure the system operates at maximum efficiency.

Check the cooling system for dirty or rusty appearance. Dirty or rusty coolant requires replacement to protect the cooling system from corrosion damage.

Cleaning Cooling System

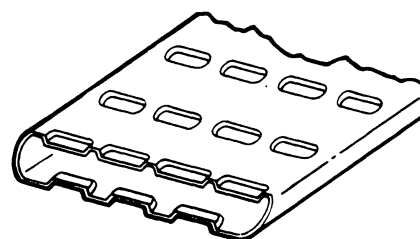
To remove rust, sludge and other foreign material from the cooling system, use Ford Premium Cooling System Flush D6AZ-19A503-AA (ESR-M14P7-A) or equivalent. Flush system using Rotunda Cooling System Flusher 106-00010 or equivalent. Removal of such material restores cooling efficiency and avoids overheating.

Always remove the thermostat prior to pressure flushing. A pulsating or reversed direction of flushing water flow will loosen sediment more quickly than a steady flow in the normal direction of coolant flow. In severe cases where cleaning solvents will not properly clean the cooling system for efficient operation, use the pressure flushing method. Various types of flushing equipment are available.

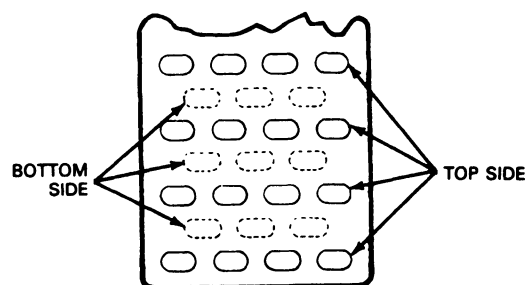
Do not back-flush cooling systems that have a water shutoff valve in the heater system, or damage to the valve can result.

CAUTION: Do not rod out the copper / brass 7.5L gas radiator or diesel radiator. The tubes have integral turbulators embossed into them and damage to the tubes will result.

Dispose of old coolant and flushing chemicals in accordance with local, state, and federal laws.



SECTIONAL VIEW



VIEW SHOWING POSITIONS OF TURBULATORS ON BOTH SIDES OF TUBE

Q2168-1A

Heater Core Back-Flushing

All engine cooling system flushing and back-flushing procedures must include a separate back-flushing of the heater or air conditioning / heater system heater core, after the flushing or back-flushing of the engine cooling system. This will prevent engine cooling system particles from clogging the heater core tubes and reducing (or eliminating) coolant flow through the heater core.

CLEANING AND INSPECTION (Continued)

The heater core must be back-flushed separately from the engine cooling system for proper back-flush water flow direction through the heater core.

The correct heater core back-flushing procedure is as follows:

1. On F-Series and Bronco vehicles, disconnect the heater core outlet heater hose from the water pump fitting and install a female garden hose-end fitting adapter in the end of the outlet heater hose. Secure with a hose clamp.

On Econoline vehicles, disconnect the heater core outlet hose from the heater core. Then, fabricate a jumper hose with a Quick Connect Coupling Assembly (Part No. 18D435) on one end and a female garden hose fitting on the other end. Attach the jumper hose to the heater core outlet tube.
2. Connect the female garden hose-end of the outlet heater hose to the male end of a water supply garden hose.
3. Disconnect the heater core inlet heater hose from the engine block fitting and allow to drain onto the ground or into a floor drain.

4. If a water valve is installed in the heater core inlet heater hose, check to be certain the water valve is open (no vacuum).
5. Turn the water supply valve on and off several times so that the surge action will help to dislodge larger stubborn particles from the heater core tubes. Allow full water pressure to flow for approximately five minutes.
6. If a water valve is installed in the heater core inlet heater hose, apply vacuum to the water valve vacuum motor to make sure water valve operates and closes properly to prevent water leakage. Replace the water valve if required.
7. Remove the hose clamp and female garden hose-end adapter from the end of the outlet heater hose and connect the outlet heater hose onto the water pump fitting.
8. Connect the inlet heater hose onto the engine block fitting.
9. Fill the cooling system, as outlined.

CLEANING AND INSPECTION (Continued)

10. Test the system for proper heater performance with the specified engine cooling system conditions.

	O-RINGS	SPACER	COMPLETE ASSEMBLY
1/4 IN TO 1/2 IN QUICK CONNECT	390422-S	390420-S	- 18D535 -
1/2 IN TO 3/4 IN QUICK CONNECT	390423-S	390421-S	- 18D535 -

COMPLETE QUICK CONNECT ASSEMBLY CONTAINS THE FOLLOWING:
 2 - O-RINGS (SILICONE FLUID)
 1 - SPACER
 1 - COUPLING RETAINER
 1 - HOUSING

SILICONE FLUID
 ESF-M99B112-A

HEATER CORE TUBE

QUICK CONNECT COUPLING - DISCONNECTED

TO CONNECT COUPLING

ALWAYS USE NEW O-RINGS WHEN RE-CONNECTING TO HEATER CORE TUBES

NOTE: LUBRICATE O-RINGS WITH ESF-M99B112-A SILICONE FLUID

INSPECT SPACER FOR CRACKS OR DAMAGE — REPLACE IF NECESSARY

INSPECT COUPLING RETAINER FOR CRACKS OR DAMAGE — REPLACE IF NECESSARY

CLEAN HEATER CORE TUBE AND LUBRICATE WITH SILICONE

ASSEMBLE FITTINGS TOGETHER BY PUSHING TOGETHER — LISTEN FOR COUPLING RETAINER TO SNAP IN PLACE.

HEATER HOSE ASSEMBLY

TO HEATER CORE

TO ENSURE QUICK CONNECT ENGAGEMENT, LIGHTLY PULL ON THE HEATER HOSE ASSEMBLY

TO DISCONNECT COUPLING

CAUTION — ENGINE SHOULD BE OFF BEFORE DISCONNECTING COUPLING

HEATER HOSE DISCONNECT TOOL
 1/4 INCH T85T-18539-AH1
 3/4 INCH T85T-18539-AH2

EXTENSION HANDLE
 T85T-18539-AH3

1

COUPLING RETAINER

HEATER HOSE DISCONNECT TOOL

HEATER CORE TUBE

HEATER HOSE ASSEMBLY

PUSH HEATER HOSE ASSEMBLY TOWARDS HEATER CORE TUBE TO ENSURE LOCKING TABS ARE FULLY EXPOSED, THEN PUSH TOOL OVER COUPLING RETAINER WINDOWS TO COMPRESS RETAINER LOCKING TABS — THEN PULL HOSE ASSEMBLY AWAY FROM HEATER CORE TUBE. REMOVE TOOL THEN CONTINUE PULLING HOSE ASSEMBLY AWAY FROM HEATER CORE TUBE.

2

NOTE: WHEN COMpressing WHITE COUPLING RETAINER, THE TOOL MUST BE PERPENDICULAR AND ON THE HIGHEST POINT OF THE COUPLING RETAINER AS SHOWN ABOVE.

SPREAD RETAINER APART TO REMOVE FROM HEATER CORE TUBE, AND REPLACE WITH NEW RETAINER

3

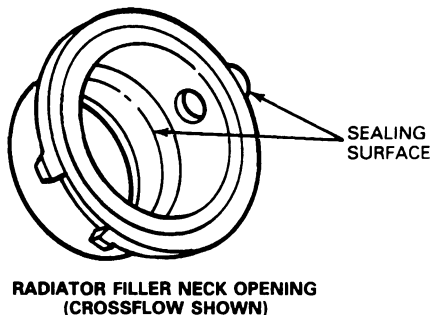
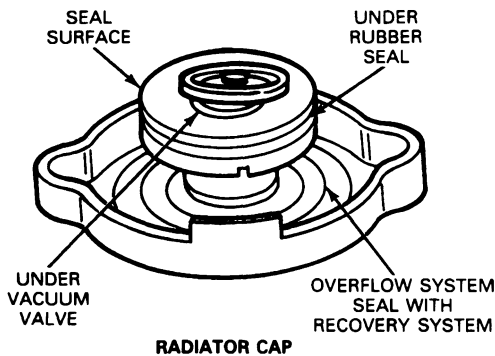
WHEN THE QUICK CONNECT COUPLING IS DISCONNECTED — THE WHITE COUPLING RETAINER WILL REMAIN ON THE HEATER CORE TUBE. INSTALL NEW COUPLING RETAINER, SPACER & NEW LUBRICATED O-RINGS INTO QUICK CONNECT ASSEMBLY HOUSING BEFORE RE-INSTALLING HEATER HOSE ASSEMBLY TO HEATER CORE TUBES.

CCL 2443-A

CLEANING AND INSPECTION (Continued)**Radiator Pressure Cap**

1. Inspect the areas under the vacuum valve and rubber seal for rust or dirt particles.
2. Using warm tap water, raise and clean the vacuum valve and rubber seals. Thoroughly flush away loose rust or dirt particles trapped under the vacuum valve and rubber seal and on the surfaces of the seals.
3. Inspect and remove any imbedded rust or dirt particles on the sealing surfaces of the rubber seal.
4. Inspect the radiator filler neck opening for rust or dirt particles on the sealing surface at the bottom of the filler neck opening. Use a clean cloth and wipe the sealing surface to remove any rust or dirt particles.

NOTE: If paint is observed on the filler neck sealing surface, remove it using paint thinner.



Q1413-G

SERVICE PROCEDURES**Copper / Brass Radiators****E-150-250-350, All Engines****F-250-350 7.3L Diesel Engine****Radiator Core and Tank Service**

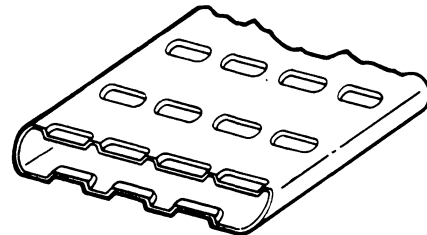
Conventional soft solder service methods should be used when repairing the copper / brass core.

CAUTION: Only manufactured or natural gas torches should be used to perform radiator repairs. Do not use acetylene. No attempt should be made to repair a fractured radiator tank. It must be replaced. Tank repairs usually result in repeated failures due to flexing of the tank caused by pressure increase and decrease.

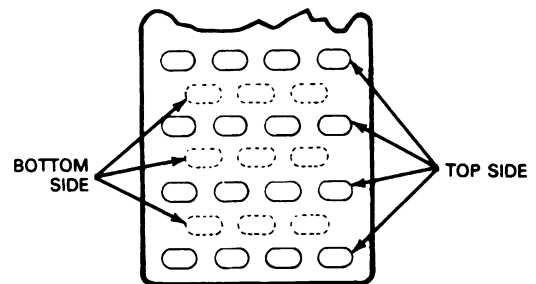
Cleaning and Inspection

Refer to Cleaning and Inspection in this section for procedures.

CAUTION: Do not rod out the copper / brass 7.5L radiator or diesel radiator. The tubes have integral turbulators embossed into them and damage to the tubes will result.



SECTIONAL VIEW



VIEW SHOWING POSITIONS OF TURBULATORS ON BOTH SIDES OF TUBE

Q2168-1A

Oil Cooler and Soldered Radiator Draincock

Replacement of the automatic transmission oil cooler or radiator draincock in the radiator lower tank is usually performed by radiator specialty shops. However, the operation can be performed, providing proper equipment is available.

The draincock is soldered directly to the radiator lower tank.

Only manufactured or natural gas torches should be used to perform radiator repairs. Do not use acetylene.

SERVICE PROCEDURES (Continued)

No attempt should be made to repair a fractured radiator tank. Should a fractured tank be encountered, it must be replaced. Tank repairs usually result in repeat failures, due to the flexing of the tank caused by pressure increase and decrease.

Removal

1. Drain the cooling system. To prevent coolant loss when draining radiator, slip a hose on the draincock and drain coolant into a clean container.
2. Remove the radiator from the vehicle as outlined.
3. Thoroughly clean the radiator assembly internally and externally by submerging in a tank filled with a caustic solution. Then, using clean water, flush until the caustic solution is removed from all internal and external surfaces.

CAUTION: Care should be exercised during the disassembly and assembly solder operation of radiator components. Avoid excess heat concentration which could result in burning through the radiator sheet metal or loosening an adjoining soldered area.

4. Remove the radiator tank containing the damaged or leaking oil cooler. (Tank removal is not necessary for repair of draincock).
5. Melt the puddled solder from the oil cooler inlet and outlet fittings, or draincock. Remove the retaining rings from the oil cooler fittings.
6. Remove the oil cooler or draincock.
7. Clean the soldered surface areas and inspect and tin as necessary to ensure proper solder bonding.

Installation

1. **Draincock:** Position the replacement draincock or draincock boss in the tank opening and solder using the procedures for oil cooler.

NOTE: If one-piece draincock is not available, a threaded boss (8120) and draincock (8115) must be used. Solder the boss into the tank following the procedure for one-piece draincocks, then wrap the draincock threads with sealer tape and install the draincock in the boss. Tighten the draincock to 16-20 N·m (12-15 ft·lb).

Oil Cooler: Install the replacement oil cooler assembly into the tank openings and secure cooler with new retaining rings. For bead design, push ring past fitting bead. Retaining ring tangs should point away from tank.

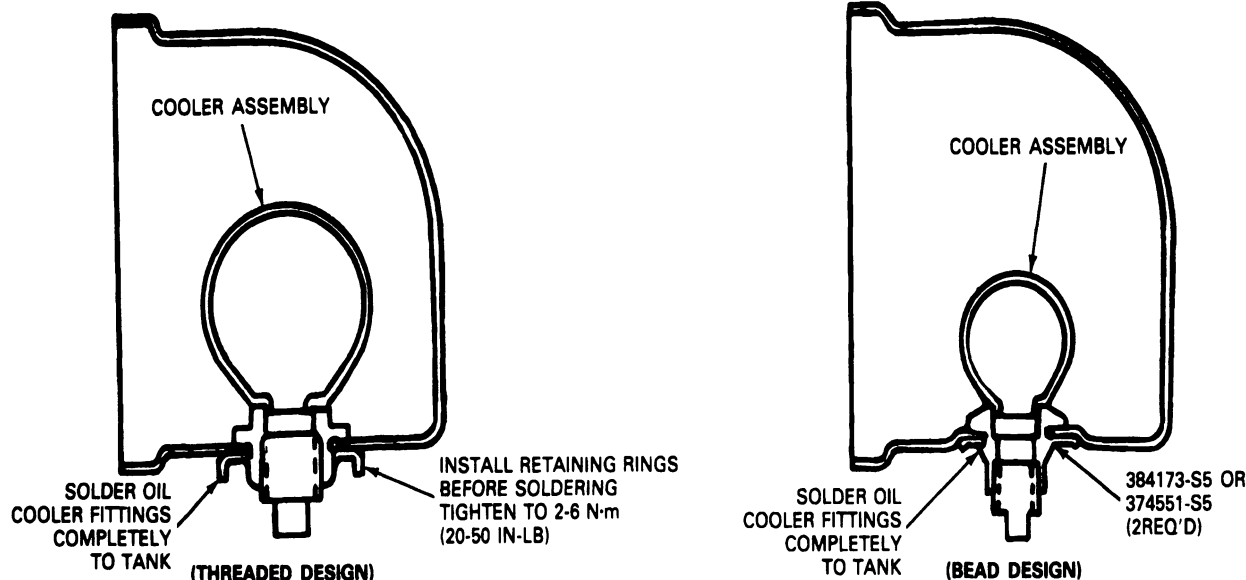
2. Puddle-solder the oil cooler fitting completely to the tank.
3. Seat the tank assembly in the header well and solder securely, completely filling the well. Use 40-60 solder with zinc chloride 30 (BAUME), 5-B NALCO or equivalent flux.
4. Flush off all excess acid, internally and externally.
5. Pressure test the radiator assembly to 132-137 kPa (19-20 psi) for leaks.
6. Paint as required.
7. Install the radiator and fan shroud in the vehicle as described in this section.

NOTE: A 50 / 50 mixture of coolant concentrate and water is recommended to maintain best overall performance. To avoid damaging the radiator, the coolant concentrate should not exceed 60 percent.

8. Flush the cooling system and refill and bleed with the recommended mixture of all-season coolant. Refer to Cleaning and Inspection in this section for procedure.

SERVICE PROCEDURES (Continued)

Typical Crossflow and Downflow Radiator Oil Coolers



Q1524-D

Threaded Radiator Draincock

Repair or Replace

1. Drain the cooling system and remove the threaded draincock assembly from the radiator.
2. Inspect the pipe threads on the draincock assembly and the threaded draincock boss in the radiator tank.
3. If the boss threads are damaged, repair them with a 1/4-inch pipe tap. If the threads are damaged beyond repair, install a new draincock boss in the radiator tank.
4. Apply a small amount of D8AZ-19554-A (ESG-M4G194-A) Pipe Sealant with TEFLON® or equivalent to threads and install the draincock. Tighten the draincock to 16-20 N·m (12-15 ft·lb).
5. Fill and bleed the cooling system and check for leaks. Refer to Cleaning and Inspection in this section for procedure.

Aluminum Crossflow Radiators

F-150, F-Super Duty and Bronco Gasoline Engines

External Cleaning

The aluminum core can be cleaned externally with a soft bristle brush, warm water and a mild household liquid detergent. Then, rinse with clear water.

If the radiator is equipped with an oil cooler, install steel or brass plugs in the oil cooler fittings before cleaning and keep them installed during the entire service operation.

Internal Cleaning

NOTE: Do not use caustic cleaning solutions or copper / brass radiator cleaning agents on aluminum radiators. Internal cleaning of the aluminum tubes can be accomplished with sonic cleaning equipment or by removing one end tank to gain access to tubes. Then, clean the tubes with a mild household liquid detergent. Rinse the core with clean water when completed. Do not use a metal brush to clean an aluminum core. Use only horsehair, bristle or nylon brushes.

Radiator Tank

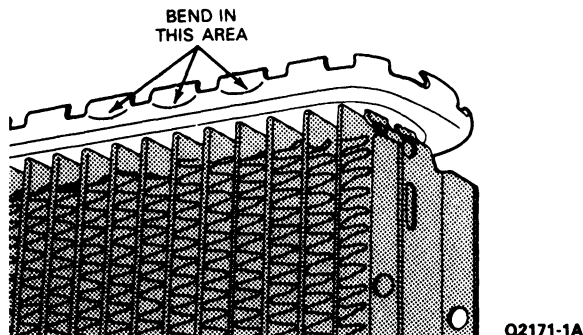
Removal

The radiator tanks are molded, glass-filled nylon and are attached to the core header by bending the header tabs over the edge of the tank.

When removing a nylon tank, a screwdriver or one of the various special tools available can be used to open the header tabs. Some of these tools, including a screwdriver, may cause a small section of the header side to bend with the tabs as they are opened. This slight deformation is permissible, provided the tabs are opened only enough for tank removal. The header sides will usually return to the normal position when the tabs are crimped during tank installation.

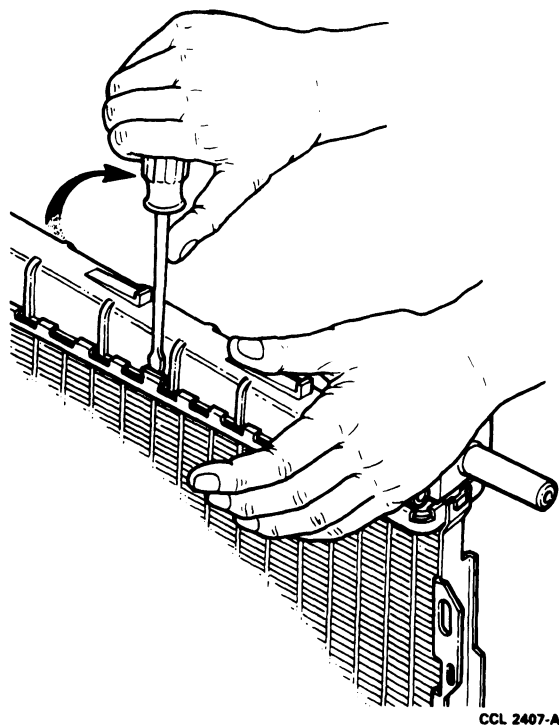
SERVICE PROCEDURES (Continued)

Procedures are given for tank removal using a screwdriver, a Borroughs Tool BT-8260 or equivalent. Follow the manufacturer's instructions for other radiator tab opening and closing tools.



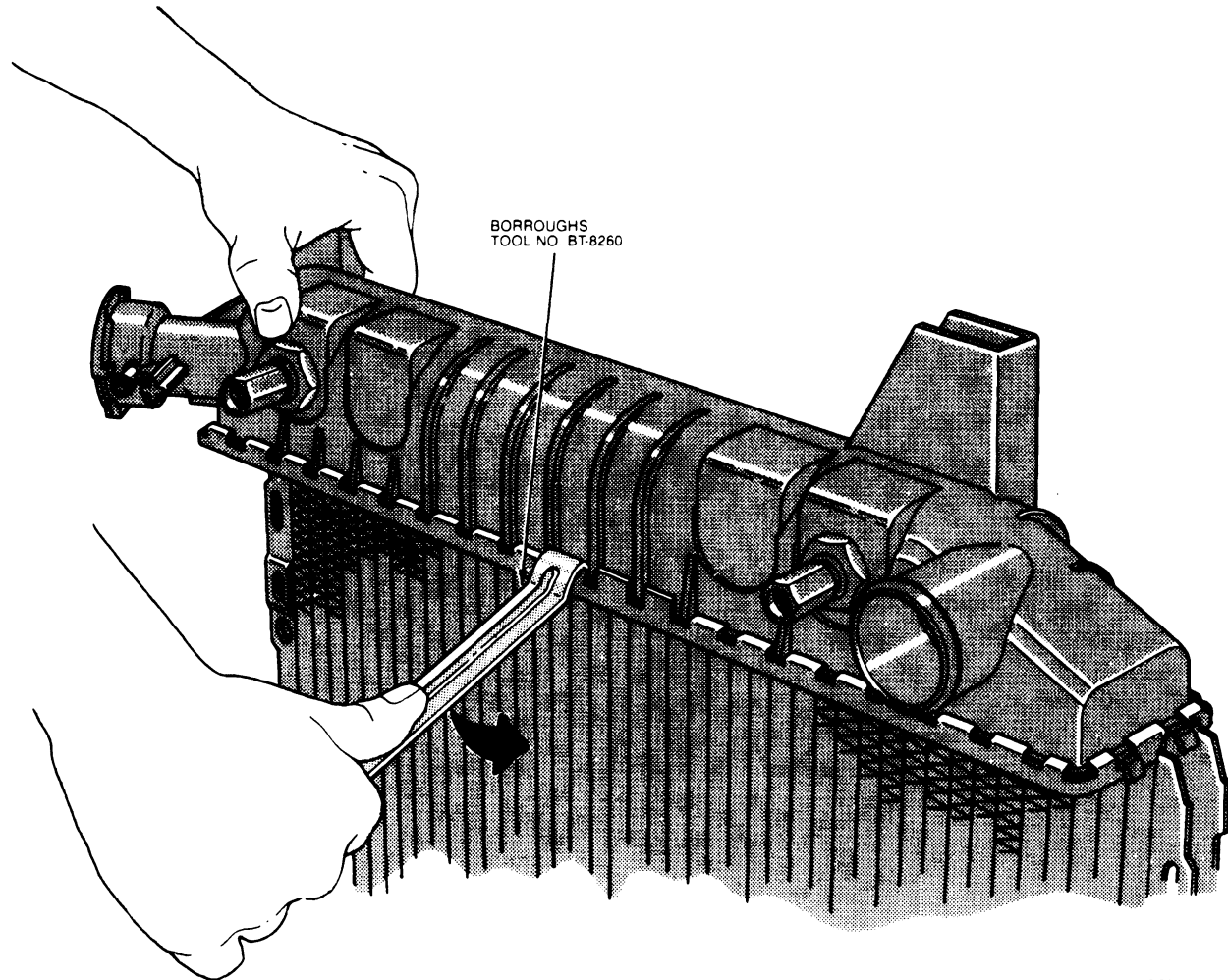
With Screwdriver

1. Insert the end of a medium tip screwdriver between the end of the header tab and the tank. Then, press the screwdriver blade against the tank to bend (pry) the tab away from the tank edge. Repeat this procedure for each tab.
NOTE: Bend (open) the tabs only enough for tank removal.
2. Lift the tank from the core header when all of the header tabs are bent away from the tank edge.
3. Remove the O-ring gasket from the header.



With Borroughs Tool BT-8260

1. Insert the end of Borroughs Tool BT-8260 between the end of the header tab and the tank. Then, push the tool handle down toward the core to bend the tab away from the radiator tank. **Do not open the tabs more than is necessary for tank removal.**
2. Repeat Step 1 for each header tab. Then, lift the tank from the header.
3. Remove the O-ring gasket from the header.

SERVICE PROCEDURES (Continued)**Radiator Tank Removal with Borroughs Tool BT-8260**

CCL 2478-A

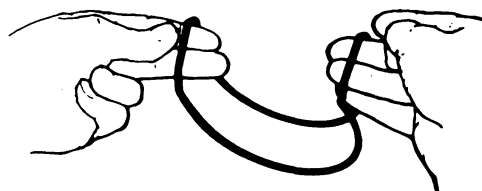
Installation

NOTE: If any header tabs are missing from an aluminum core, the core should be replaced.

1. Inspect the seal surface of the radiator core header to make sure it is clean and free of foreign material or damage.
2. Check the new O-ring to make sure it is not twisted.



TWISTED O-RING GASKET



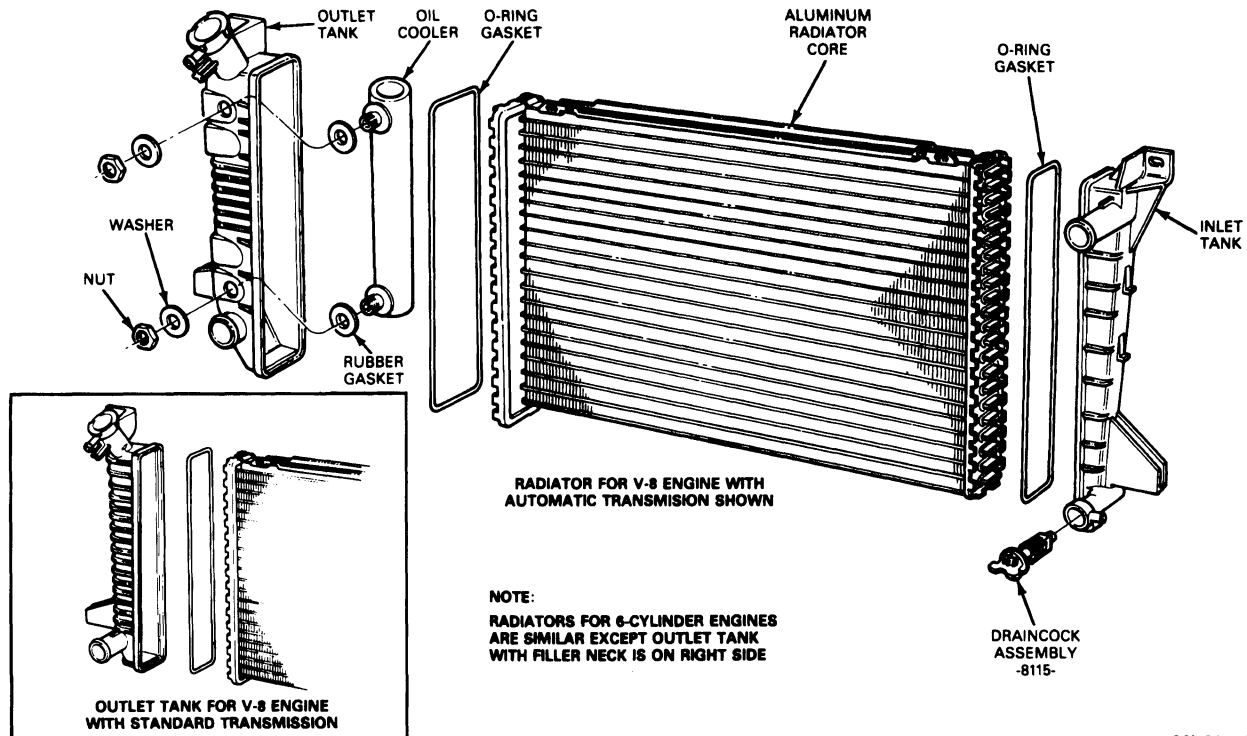
O-RING GASKET NOT TWISTED

Q2170-1A

SERVICE PROCEDURES (Continued)

3. Dip the new O-ring gasket in glycol, silicone or equivalent lubricant, and place the gasket in the header groove.

4. If the outlet tank is being replaced and is equipped with an oil cooler, transfer the oil cooler from the replaced tank to the new tank as outlined.

Radiator for V-8 Engine with Automatic Transmission

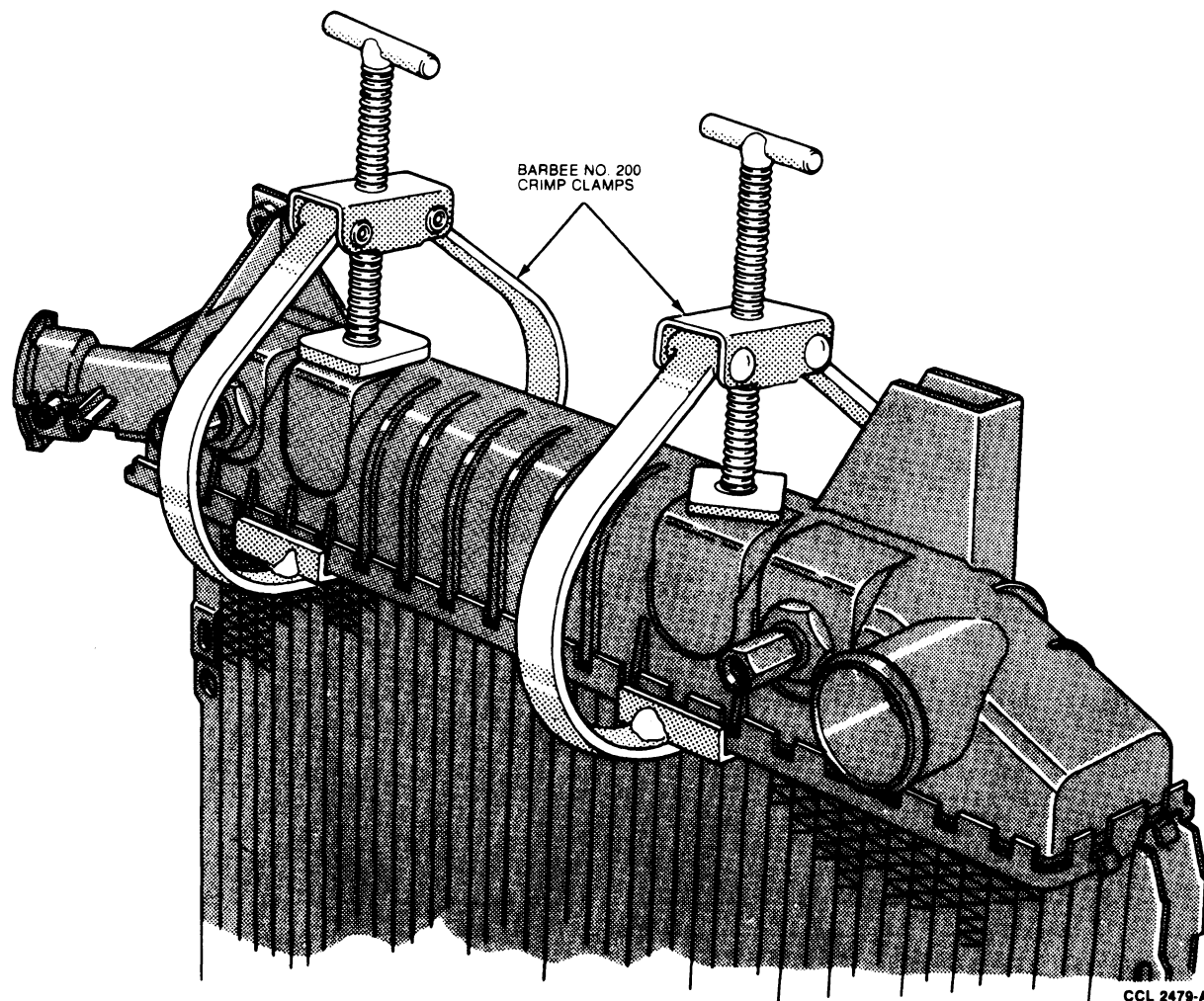
CCL 2408-A

5. Position the tank to the header using care not to scratch the tank sealing surfaces with the header tabs. Make sure the top and bottom of the tank is positioned properly with the other tank.

6. Clamp the tank in position on the header with two header clamps as shown. Tighten the header clamps to compress the O-ring gasket.

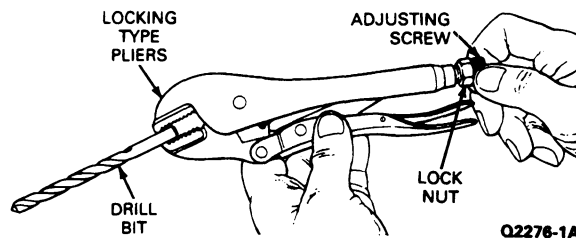
SERVICE PROCEDURES (Continued)

Radiator Tank Removal



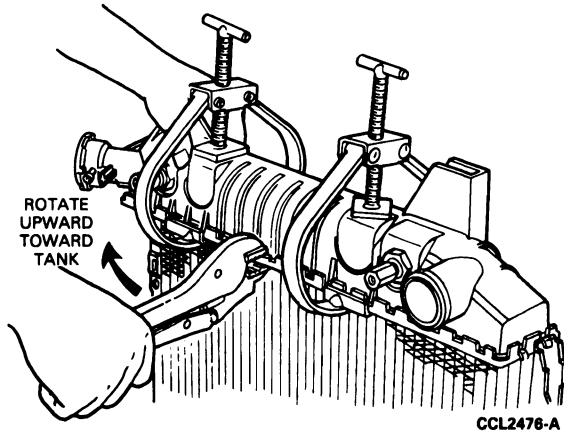
7. If locking-type pliers are used to squeeze the header tabs against the tank, install a hex nut on the pliers adjusting screw.

8. With the jaws of the locking-type pliers closed and locked, turn the adjusting screw to position the jaws against the shank of a 13/32-inch drill bit. Then, tighten the hex nut on the adjusting screw against the handle to lock the adjustment in place.

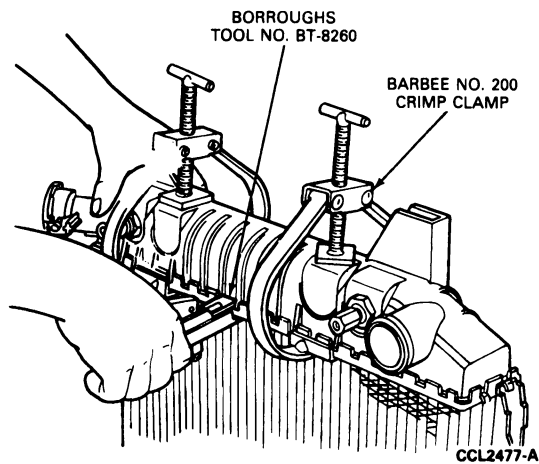


SERVICE PROCEDURES (Continued)

9. Squeeze the header tabs down against the lip of the tank base with the locking-type pliers while rotating the pliers toward the tank.



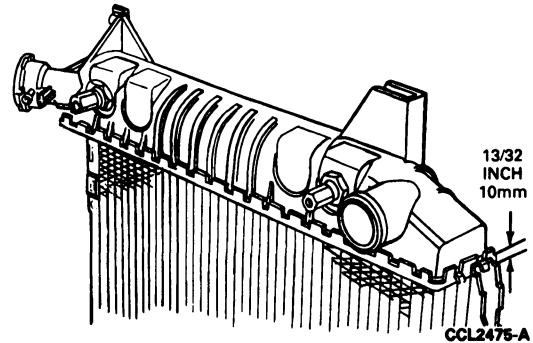
10. If a special crimping tool is used follow the manufacturer's instructions.



CAUTION: It is, however, important that the assembled height of the crimp be 10.3mm (13/32 inch) when measured from the bottom of the header to the top of the tab.

11. Remove the header clamps and squeeze the header tabs down that were behind the clamps.

12. Leak test the radiator at 145 kPa (21 psi). Most minor leaks at the header-to-tank seal can be corrected by again squeezing the header tabs down against the tank lip in the area of the indicated leak.



Radiator Core Service

The only approved service method for the aluminum radiator core is using a two-part epoxy material. The materials and supplies necessary to service the aluminum core radiator are:

- EPOXI-PATCH KIT No. 6C Aluminum, Hysol Division of the Dexter Corporation, Olean, New York 14760.
- Sandpaper and / or emery paper, 80 or 100 grit.
- Stainless steel wire brush No. 23151 or equivalent, Milwaukee Brush Manufacturing Co., Menomonee Falls, Wisconsin 53051.
- 375-watt heating lamp.
- Mixing card and spatulas.

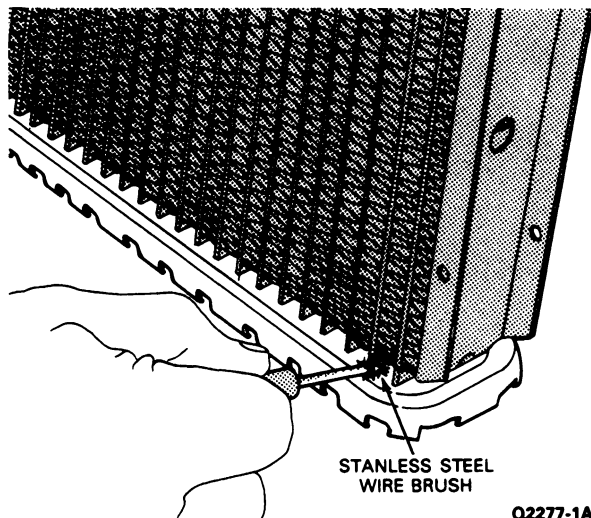
Service Procedure

1. Clean and leak test core as described in this section.
2. Mark leak(s) and dry core with compressed air in area of leak(s).
3. If leak is in fin area of core, spread fins away from leak before cleaning area.

SERVICE PROCEDURES (Continued)

4. Thoroughly clean the area around the leak with a stainless steel wire brush and, if necessary, emery paper to get to hard to reach areas. Use the brush on the epoxy as well as on the aluminum.

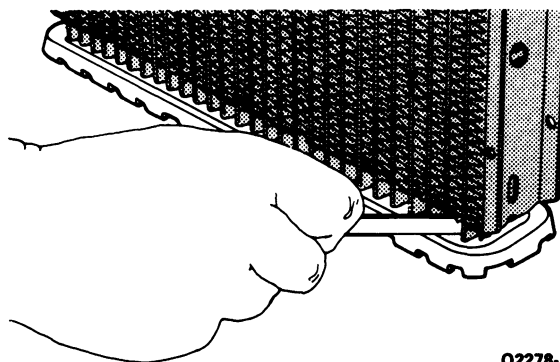
CAUTION: Do not use wire brushes that are not stainless steel.



5. Squeeze a bead (length) of Epoxi-Patch service material resin (Part A) on a clean, dry disposable flat mixing surface. Use uniform pressure to obtain an even bead.

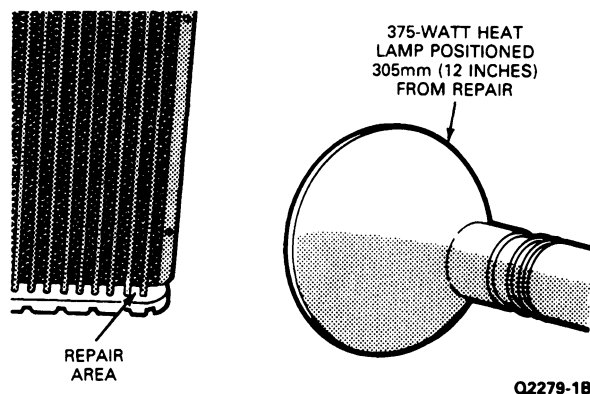
WARNING: OBSERVE ALL CAUTIONS AND WARNINGS PRINTED ON THE SERVICE MATERIAL CONTAINERS.

6. Squeeze an equal bead (length) of Epoxi-Patch hardener (Part B) parallel to the Part A bead. Mix Parts A and B together.
7. If it is necessary to have the epoxy flow to obtain a satisfactory repair, warm the core around the leak with a 375-watt heat lamp. Then, apply the Epoxi-Patch material to the leak.



8. Position the 375 watt heat lamp 305mm (12 inches) from the service area and allow the epoxy to cure for two hours.

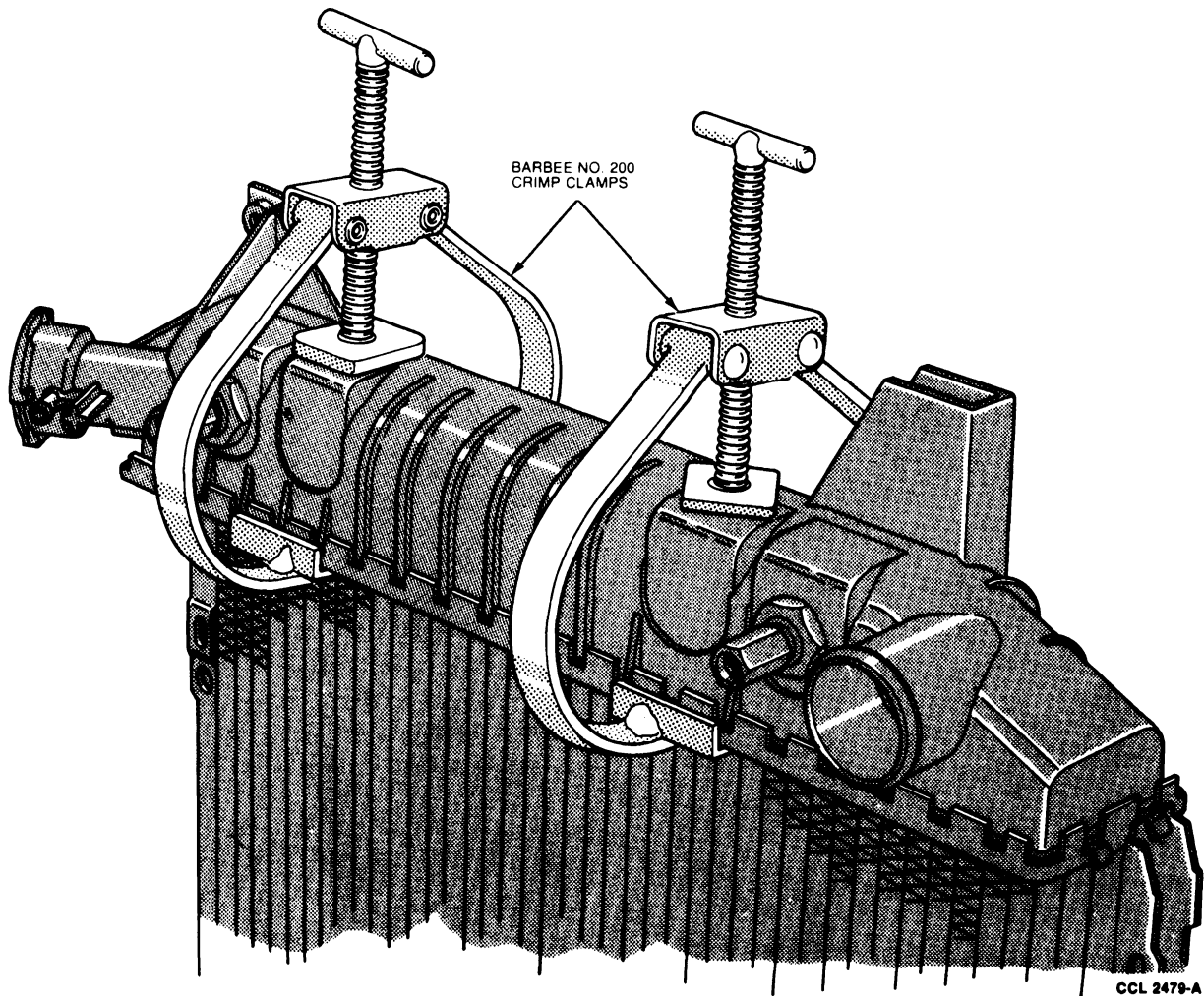
CAUTION: Do not position the heat lamp closer to the epoxy area than 305mm (12 inches). Do not use a heat gun or overheat the epoxy material.



9. When the epoxy is cured, test the service area. If tank has been removed, clamp it to the header with No. 200 crimp clamps or equivalent to leak test.

SERVICE PROCEDURES (Continued)

10. After a successful leak test, paint if required. Install the radiator tank as described in this section.

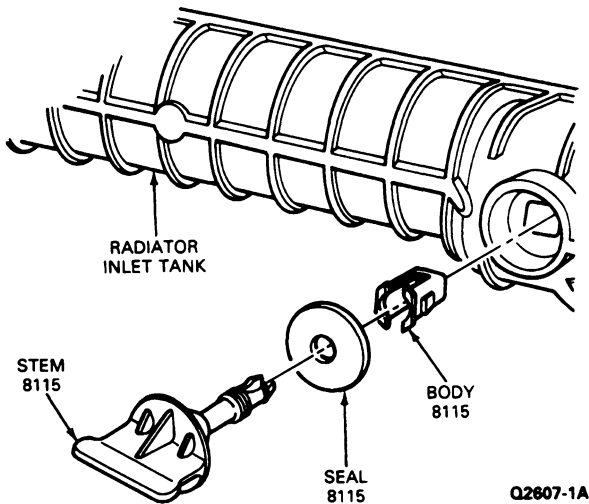
**Draincock Replacement**

The draincock is located near the bottom of the inlet tank and can be replaced without removing the tank from the radiator. However, the radiator must be drained and should be removed from the vehicle for access to the draincock.

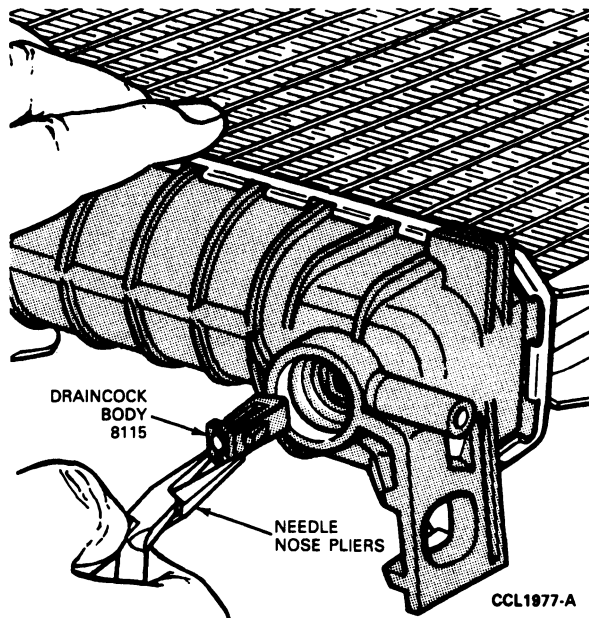
SERVICE PROCEDURES (Continued)

Removal

1. Turn the draincock stem counterclockwise to unscrew the stem and drain the radiator. After the radiator is drained, and when the stem is unscrewed to the end of the threads, pull the stem from the radiator tank and draincock body.

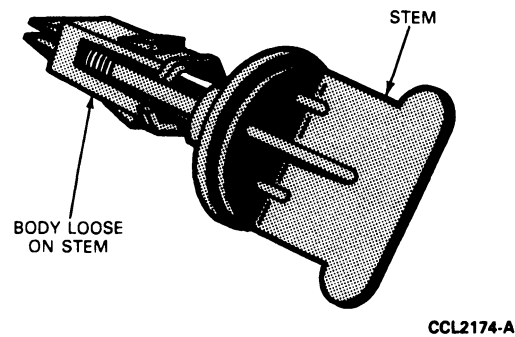


2. Remove the draincock body from the radiator tank by squeezing the sides together with a pair of needle nose pliers. Then, pull the body from the inlet tank.



Installation

1. Check the draincock to be sure the body is installed loosely on the stem. If the stem is screwed into the body, the draincock cannot be installed into the tank opening.
2. Push the loosely assembled draincock assembly body into the tank opening until it snaps into place.
3. Tighten the draincock stem by turning clockwise to 2-3 N·m (18-27 in-lb) torque.



Oil Cooler Transfer Or Replacement

Removal

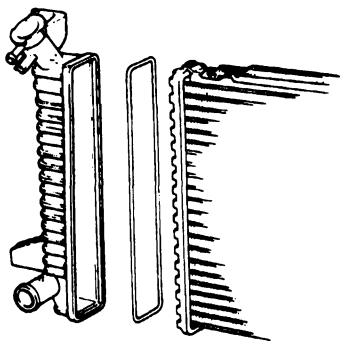
1. Remove the outlet tank from the radiator as outlined.
2. Remove the retaining nuts and washers from the oil cooler inlet and outlet connections. Then, lift the oil cooler from the radiator outlet tank.
3. Remove the rubber gaskets from the oil cooler inlet and outlet connections if the oil cooler is to be reused.

Installation

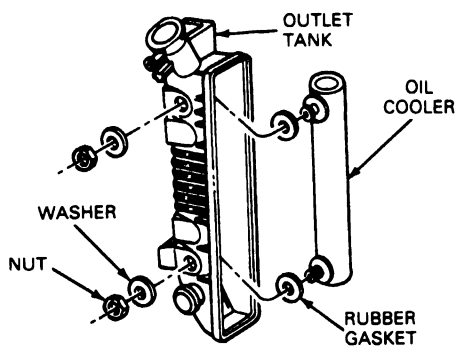
1. Install new rubber gaskets on the oil cooler inlet and outlet connections.
2. Position the oil cooler to the radiator outlet tank and insert the inlet and outlet connections through the holes in the outlet tank.
3. Install the flat washer and nut on each oil cooler connection to retain the oil cooler in the radiator outlet tank.
4. Tighten the oil cooler retaining nuts to 12-15 N·m (9-11 ft-lb).

SERVICE PROCEDURES (Continued)

5. Install the outlet tank on the radiator core header as outlined.



**OUTLET TANK FOR V-8 ENGINE
WITH STANDARD TRANSMISSION**



**NOTE: V8 RADIATOR SHOWN.
I-6 RADIATOR HAS OIL
COOLER AND FILLER
NECK IN RH TANK**

Q2608-1A

SPECIFICATIONS

Refer to the following charts for engine cooling specifications.

ENGINE COOLING SYSTEM REFILL CAPACITIES — F-150 THROUGH F-350, BRONCO, F-SUPER DUTY SERIES, AND E-150 THROUGH E-350 — DIESEL

Engine	Truck Model/Type	Equipment	Approximate Capacity		
			U.S. Quarts	Imperial Quarts	Liters
4.9L (300 CID) I-6	F-150/350, F-Super Duty & Bronco	Manual and Auto. Trans. — Standard	13	10	12
		Manual Trans. with A/C or Super Cool Auto. Trans. with Super Cool or Standard	14	11	13
		Manual Trans. with A/C and Super Cool Auto. Trans. with A/C and Super Cool or just A/C	15	12	14
5.0L (302 CID) V-8	F-150/250 Bronco	Manual Trans. — Standard	13	10	12
		Manual and Auto. Trans. with A/C Auto. Trans. — Standard	14	11	13
		Manual and Auto. Trans. with Super Cool or Super Cool and A/C	15	12	14
5.8L (351 CID) V-8	F-150/350 Bronco	Manual Trans. — Standard	15	12	14
		Auto. Trans. — Standard or A/C, Manual Trans. with A/C	16	13	15
		Manual and Auto. Trans. with Super Cool or Super Cool and A/C	17	14	16
7.5L (460 CID) V-8	F-250/350, F-Super Duty Chassis Cab and Motor Home Chassis Vehicles	All options	18	15	17
7.3L Diesel	F-250/350 and F-Super Duty Chassis Cab and Commercial Stripped Chassis	All options	29①	23①	27①
	E-250/350	All options	31①	25①	29①

① Include 5 quarts (or equivalent liters or Imperial quarts) in reservoir bottle.

CQ2806-2C

ENGINE COOLING SYSTEM REFILL CAPACITIES E-150-250-350 GASOLINE

Model	Engine	Vehicle Equipment	Approximate Capacities		
			U.S. Qts.	Imp. Qts.	Liters
All	4.9L MFI (300 CID) Six	Without Air Conditioning	15	12.5	14.2
All	4.9L MFI (300 CID) Six	With Air Conditioning or Super Cooling	18	14.5	16
E-150-250	5.0L MFI (302 CID) V-8	Standard and Air Conditioning	17.5	14.0	16.6
E150-250	5.0L MFI (302 CID) V-8	Super Cooling	18.5	15.3	17.5
E-150-250-350	5.8L (351 W CID) V-8	Standard Cooling	20	16	19
E-150-250-350	5.8L (351 W CID) V-8	Air Conditioning or Super Cooling	21	16.8	20
E-250-350	7.5L (460 CID) V-8	All Options	28	23	26

NOTE: Add 1 quart (U.S.) for heater.
Add 1.8 quarts (U.S) for auxiliary heater (Econoline models).

TQ2735A

SPECIFICATIONS (Continued)

Description	N-m	Lb-Ft
Radiator to Body Sheet Metal E-150-250-350	15-20	10-15
Radiator Hose Clamp (Double Wire Clamp)	3-4	27-35 In-Lb
Radiator Hose Clamp (Tangential Screw)	3	27 In-Lb
Thermostat Housing, All Engines Except 7.5L	16-24	12-18
Thermostat Housing, 7.5L	32-37	23-38
Radiator Top Brackets to Radiator Support, F-150-250-350, F-Super Duty and Bronco	11-14	8-11
Radiator Top Brackets to Radiator Support, F-Super Duty Stripped Chassis	3-5	27-44 In-Lb
Radiator to Frame Insulator, F-Super Duty Commercial Chassis	102-142	75-105
Radiator Support to Frame Insulator Bolts, F-150-250-350, F-Super Duty and Bronco	41-47	30-35
Radiator Support to Frame Insulator Bolts, F-Super Duty Stripped Chassis	160-217	118-160
Shroud to Radiator, E-Series	6-8	53-71 In-Lb

(Continued)




Description	N-m	Lb-Ft
Shroud to Radiator, F-150-250-350, F-Super Duty and Bronco	7-10	4-6
Shroud to Radiator, F-Super Duty Commercial	3-5	27-44 In-Lb
Shroud to Radiator, F-Super Duty Motorhome	6-8	53-71 In-Lb
Fan Clutch Assembly to Water Pump, 4.9L	41-136	30-100
Fan Clutch Assembly to Water Pump, All V-8 Engine Except 7.3L	17-24	12-18
Fan Clutch Assembly to Water Pump, 7.3L Diesel	113-153	83-113
Water Filter Hose Clip to Air Inlet Housing, 3/8-16	28-33	18-23
Water Filter Hose Clip to Engine Idle Gear Cover, 3/8-16	40-48	29-36
Transmission Oil Line Fitting to Radiator, E-Series, F-Series, F-Super Duty and Bronco	24-31	18-23
Transmission Oil Line Nut to Fitting on Radiator, E-Series, F-Series, F-Super Duty and Bronco	16-24	12-18
Oil Cooler Line Clamps	4-5	35-44 In-Lb
Draincock to Radiator	16-20	12-15
Draincock Stem to Draincock	2-3	18-27 In-Lb

COOLING SYSTEM PRESSURES (PSI)

Vehicle	Operating Pressure	Min. Test Pressure
F-150-F-350, F-Super Duty, Bronco, E-150-E350	90 kPa (13 psi)	(10 psi)


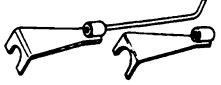
SPECIAL SERVICE TOOLS/EQUIPMENT

- No. 200 Crimp Clamp:
The Barbee Company
P.O. Box 323
Louisville, Kentucky 40201.
- No. 23151 Stainless Steel Wire Brush:
The Milwaukee Brush Manufacturing Co.
P.O. Box 830
Menomonee Falls, Wisconsin 53051.
- Heat Lamp and Socket: 375 Watt.
- Epoxi-Patch Kit No. 6C Aluminum:
Hysol Division of the Dexter Corporation
Olean, New York 14760.
- Tool BT8260 and 8260-A Radiator Core Remover
and Replacer:
Borroughs Tool and Equipment Corporation
2429 North Burdick St.
Kalamazoo, Michigan 49007.

Tool Number/ Description	Illustration
T83T-6312-A Fan Clutch Pulley Holder — 7.3L Diesel	
T83T-6312-B Fan Clutch Nut Wrench — 7.3L Diesel	
T84T-6312-C Fan Clutch Pulley Holder — 4.9L Engine	

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

Tool Number/ Description	Illustration
T84T-6312-D Fan Clutch Nut Wrench — 4.9L Engine	 T84T-6312-D
T85T-18539-AH Heater Hose Disconnect Tool	 T85T-18539-AH

ROTUNDA EQUIPMENT

Tool Number	Description
021-00012	Cooling System Pressurization Kit
021-00046	Anti-Freeze Tester
106-00010	Cooling System Flusher

SECTION 03-04A Fuel Charging and Controls, 5.0L and 5.8L

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		REMOVAL AND INSTALLATION (Cont'd.)	
Idle Air Control Valve Cleaning	03-04A-16	Fuel Injector	03-04A-15
DESCRIPTION AND OPERATION		Fuel Pressure Regulator	03-04A-14
Air Intake Manifold	03-04A-2	Fuel Supply Manifold Assembly	03-04A-12
Fuel Injectors	03-04A-2	Idle Air Control Valve Assembly (IAC)	03-04A-11
Fuel Pressure Regulator	03-04A-3	Lower Intake Manifold	03-04A-7
Fuel Supply Manifold Assembly	03-04A-4	Post-Service Procedures	03-04A-5
Throttle Body Assembly	03-04A-3	Pre-Service Procedures	03-04A-5
DIAGNOSIS AND TESTING		Throttle Position (TP) Sensor	03-04A-11
Tips to Avoid Lean Air-Fuel Conditions	03-04A-5	Upper Intake Manifold and Throttle Body	03-04A-6
REMOVAL AND INSTALLATION		SPECIAL SERVICE TOOLS / EQUIPMENT	03-04A-17
Air Intake Throttle Body	03-04A-10	SPECIFICATIONS	03-04A-17
		VEHICLE APPLICATION	03-04A-1

VEHICLE APPLICATION

Vehicles Equipped with 5.0L and 5.8L MFI V-8 Engines

DESCRIPTION AND OPERATION

The Multiport Fuel Injection system (MFI) is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered into each intake port in a sequential firing order. Injectors pulse to follow engine firing order in accordance with engine demand through injectors mounted on a tuned intake manifold.

A Powertrain Control Module (PCM)(12A650) accepts input from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio throughout the entire engine operational range. The PCM then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

The PCM also determines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude (i.e., from sea level to mountains) and will also permit push-starting the vehicle should it become necessary (manual transmission only).

The fuel delivery subsystem consists of a high-pressure in-tank mounted fuel pump and a fuel filter / reservoir delivering fuel from the fuel tank through a 20 micron fuel filter to a fuel charging manifold assembly.

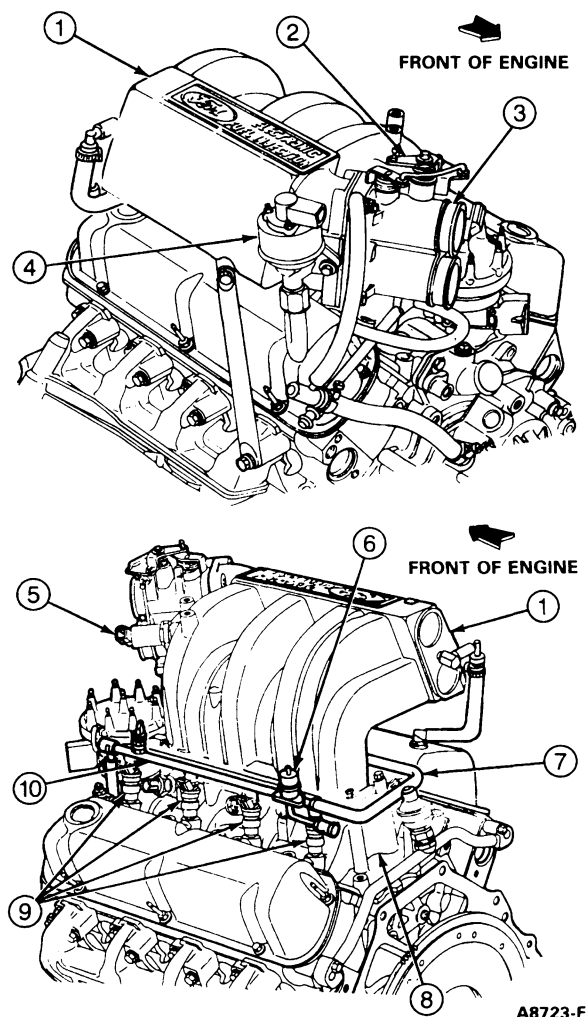
The fuel charging manifold assembly incorporates electrically actuated fuel injectors directly above each of the engine's intake ports. The injectors, when energized, spray a metered quantity of fuel into the intake air stream.

A constant fuel pressure drop is maintained across the injector nozzles by a pressure regulator. The regulator is connected in series with the fuel injectors and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator and returns to the fuel tank through a fuel return line.

One group of four injectors is energized simultaneously, once every crankshaft revolution followed by the second group of injectors in the next crankshaft revolution. The period of time that the injectors are energized (injector "on time" or pulse width) is controlled by the PCM. The PCM receives input from various engine sensors and uses this information to compute the required fuel flow rate necessary to compute the prescribed air / fuel ratio for the given engine operation. The PCM determines the needed injector pulse width and outputs a command to the injector to meter the exact quantity of fuel.

DESCRIPTION AND OPERATION (Continued)

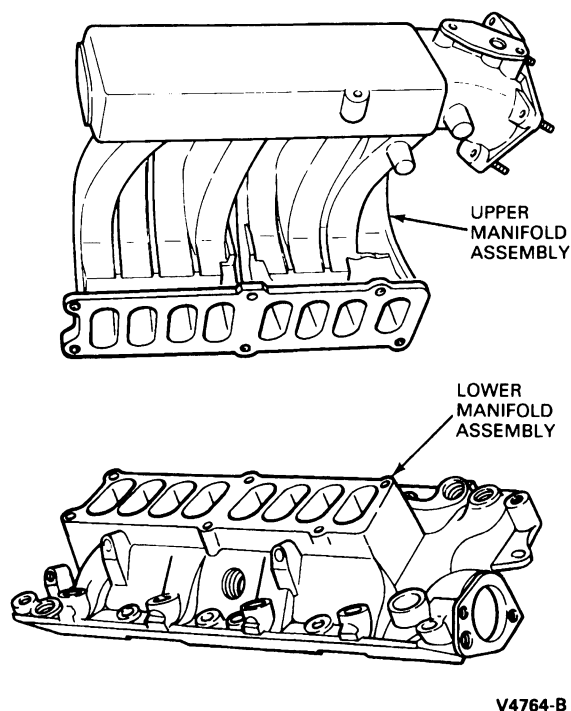
Electronic Fuel Injection, 5.0L and 5.8L MFI Engine



Item	Part Number	Description
1	9425	Upper Intake Manifold
2	Ref.	Throttle Linkage
3	9E926	Throttle Body Assembly
4	9F483	EGR Valve
5	9F715	Idle Air Control Valve
6	Ref.	Fuel Pressure Regulator Assembly
7	9C968	Crossover Tube (Part of Fuel Supply Manifold)
8	9424	Lower Intake Manifold Assembly
9	9F593	Fuel Injector Assembly
10	9F792	Fuel Supply Manifold Assembly

Air Intake Manifold

The air intake manifold is a two-piece (upper and lower intake manifold) aluminum casting. Runner lengths are tuned to optimize engine torque and power output. The manifold provides mounting flanges for the air throttle body assembly, fuel supply manifold and accelerator control bracketry and the EGR valve and supply tube. Vacuum taps are provided to support various engine accessories. Pockets for the fuel injectors are machined to prevent both air and fuel leakage. The pockets in which the injectors are mounted are placed to direct the injector fuel spray immediately in front of each engine intake valve.

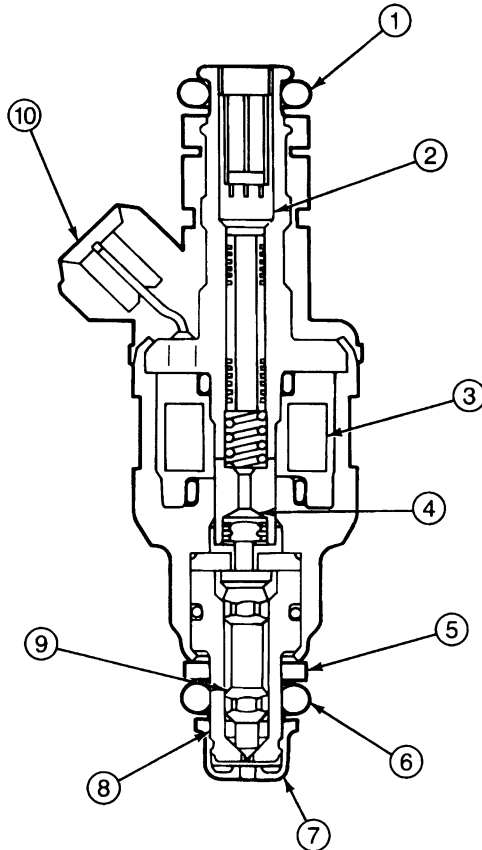


Fuel Injectors

The eight fuel injector nozzles are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The Multiport fuel injectors are mounted in the lower intake manifold and are positioned so that their tips direct fuel just ahead of the engine intake valves. The injector consists of a solenoid and valve assembly. An electrical control signal from the PCM unit activates the injector solenoid, causing the needle to move inward off the seat, allowing fuel to flow. Since the injector flow orifice is fixed and the fuel pressure drop across the injector tip is constant, fuel flow to the engine is regulated by how long the solenoid is energized. Atomization is obtained by a director metering plate at the point where the fuel separates.

DESCRIPTION AND OPERATION (Continued)

All vehicles equipped with 5.0L, 5.8L, 7.0L and 7.5L MFI engines have Deposit Resistant Injectors (DRI) installed. This injector is designed to eliminate the lean fuel delivery concerns which occur with conventional multiport fuel injectors when low grade, non-detergent fuels are used.

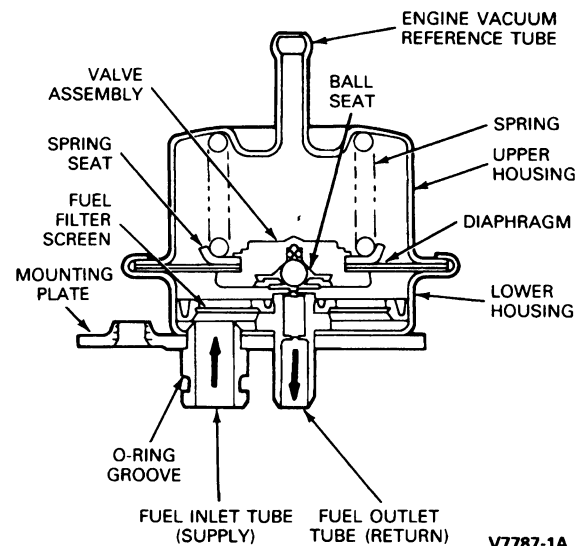


A19017-A

Item	Description
1	Supply Manifold O-Ring
2	Integral Filter
3	Coil
4	Armature
5	Washer
6	Lower Intake Manifold O-Ring
7	Pintle Protection Cap
8	Stainless Steel Valve Body
9	Stainless Steel Needle (Pintle)
10	Electrical Connector

Fuel Pressure Regulator

The fuel pressure regulator is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the injectors. The regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the injectors. Fuel in excess of that used by the engine is bypassed through the regulator and returns to the fuel tank.



V7787-1A

Throttle Body Assembly

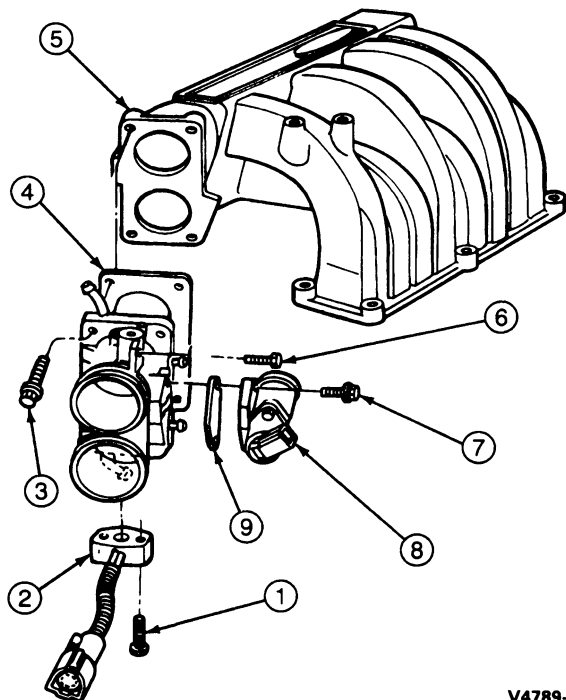
The throttle body assembly controls airflow to the engine through a double butterfly-type valve. The throttle position is controlled by a multiple-link, progressive opening, throttle linkage. The body is a single-piece die casting made of aluminum. It has a dual bore with an air bypass channel around the throttle plate. This bypass channel controls both cold and warm engine idle airflow as regulated by an idle air control valve (9F7 15) assembly mounted directly to the throttle body. The idle air control valve assembly is an electro-mechanical device, controlled by the PCM that meters the amount of air bypassed around the throttle plates in order to control engine idle speed. Engine coolant is diverted through the throttle body mounting pad to improve cold weather operation.

Other features of the air throttle body assembly include:

1. A pre-set stop to locate the WOT position.
2. A throttle body-mounted throttle position sensor.

DESCRIPTION AND OPERATION (Continued)

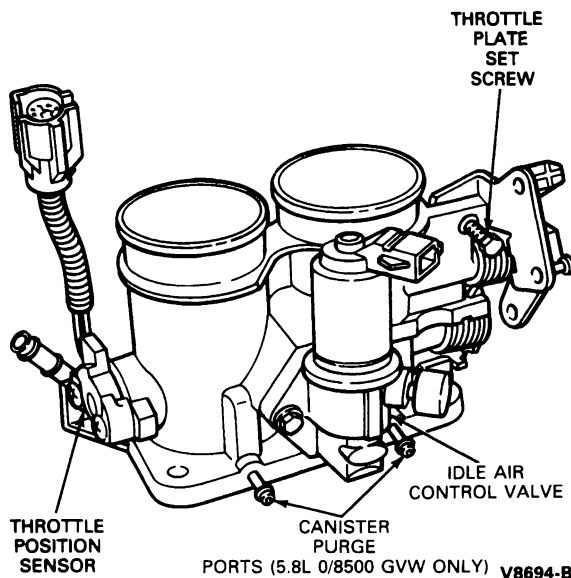
Upper Intake Manifold and Throttle Body Assemblies



V4789-H

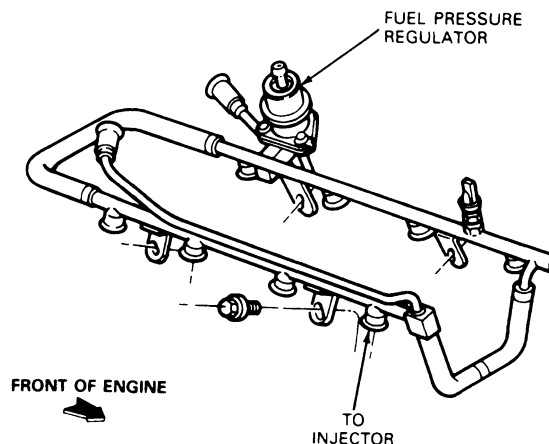
Item	Part Number	Description
1	N803469-S100	Screw and Washer Assembly, 1-2 N-m (9-18 In-Lb) (2 Req'd)
2	9B989	Throttle Position Sensor
3	56524-S8	Bolt, 5/16-18 x 1.5 16-24 N-m (12-18 Ft-Lb) (4 Req'd)
4	9E936	Throttle Body Gasket
5	9424	Upper Intake Manifold
6	391252-S2	Screw
7	N605733-S100	Bolt, M6 x 20
8	9F715	Idle Air Control Valve (IAC)
9	9F670	IAC Valve Gasket

Throttle Body, 5.8L MFI, 5.0L MFI Similar



Fuel Supply Manifold Assembly

The fuel supply manifold assembly delivers high pressure fuel from the vehicle fuel supply line to the eight fuel injectors. The assembly consists of two banks of tubular fuel rails connected by two permanent crossover connections, eight injector connectors, a mounting flange to the fuel pressure regulator and mounting attachments which locate the fuel manifold assembly and provide fuel injector retention. The fuel inlet and outlet connections have push-connect fittings. The unit is serviced as an assembly only.



V5301-1B

DIAGNOSIS AND TESTING

Tips to Avoid Lean Air-Fuel Conditions

Rough idle, hesitation, poor throttle response, induction backfire and stalls during cold start / warm-up may be caused by the poor volatility of some high octane premium grade unleaded fuels (91 octane or higher $[R+M]/2$). When compared to regular grade unleaded fuel (87 octane $[R+M]/2$), high octane premium grade unleaded fuel may cause long crank time.

Use a regular grade unleaded fuel in all vehicles, except where a premium unleaded fuel is recommended in the Owner Guide. If lean air-fuel type symptoms are experienced, determine the grade and brand of fuel used and offer the following service tips.

- Advise those using a higher octane grade fuel to switch to a regular grade unleaded fuel. For those using a regular grade fuel, advise them to try another brand.
- Do not advise using a higher octane unleaded fuel than is recommended for that specific engine. Ford engines are designed to perform best using a high quality regular grade unleaded fuel.
- Only advise using a higher octane unleaded fuel to avoid potentially damaging spark knock or ping, but do so only after mechanical repairs are ineffective.

NOTE: All unleaded gasolines used should contain detergent additives that are advertised as having "keep clean" or "clean up" performance for both intake valves and fuel injectors.

1. Open hood and install protective covers.
2. Disconnect battery ground cable and secure it out of the way. Be sure ignition is in the off position.

NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

3. Remove fuel cap and release tank pressure.
4. Release pressure from fuel system at the fuel pressure relief valve using MFI Pressure Gauge T80L-9974-B or equivalent. The fuel pressure relief valve is located on the fuel line in the upper right corner of the engine compartment. To gain access to the fuel pressure relief valve, the valve cap must first be removed.

NOTE: Not all assemblies may be serviceable while on the engine. In some cases, removal of the fuel charging assembly may ease service of the various subassemblies. To remove the entire fuel charging assembly, the following procedure should be performed.

REMOVAL AND INSTALLATION

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT, HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

Pre-Service Procedures

The fuel charging assembly consists of the air throttle body, and the upper and lower intake manifolds. Prior to service or removal of the fuel charging assembly, the following steps must be taken:

Post-Service Procedures

After the service is complete and the fuel charging assembly is installed onto engine, the following steps must be taken:

1. Install fuel cap at tank.
2. Connect battery ground cable.
3. Add engine coolant, if necessary.
4. Turn ignition switch on and off several times without starting engine to check for fuel leaks.

NOTE: Check all connections at fuel rails, push connect fittings, etc.

CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

5. Start engine and warm to operating temperature. Check for coolant leak if coolant was removed.
6. Perform EEC-IV Self Test to check systems function. Refer to Powertrain Control / Emissions Diagnosis Manual.¹

¹ Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)**Upper Intake Manifold and Throttle Body****Removal**

1. Disconnect electrical connectors at idle air control valve, throttle position sensor and EGR position sensor.
2. Disconnect throttle linkage at throttle ball. Disconnect AOD (5.0L only) or C6 (5.8L only) transmission linkage from throttle body. Remove two bolts securing throttle linkage bracket to intake. Position bracket with cables out of way.

CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the stud and pry slowly. Pulling by hand may damage the cable.

3. Disconnect upper intake manifold vacuum fitting connections by disconnecting all vacuum lines to vacuum tree, vacuum lines to EGR valve and vacuum line to fuel pressure regulator.
4. Disconnect PCV system by disconnecting hose from fitting on rear of upper manifold.
5. On Econoline models, remove the oil fill tube.
6. Remove canister purge line(s) from fitting(s) on throttle body.
7. Disconnect water heater lines from the throttle body.
8. Disconnect EGR tube from EGR valve by removing flange nut.
9. Remove bolt from upper intake support bracket to upper manifold.
10. Remove six upper intake manifold retaining bolts.
11. Remove upper intake and throttle body as an assembly from lower intake manifold.

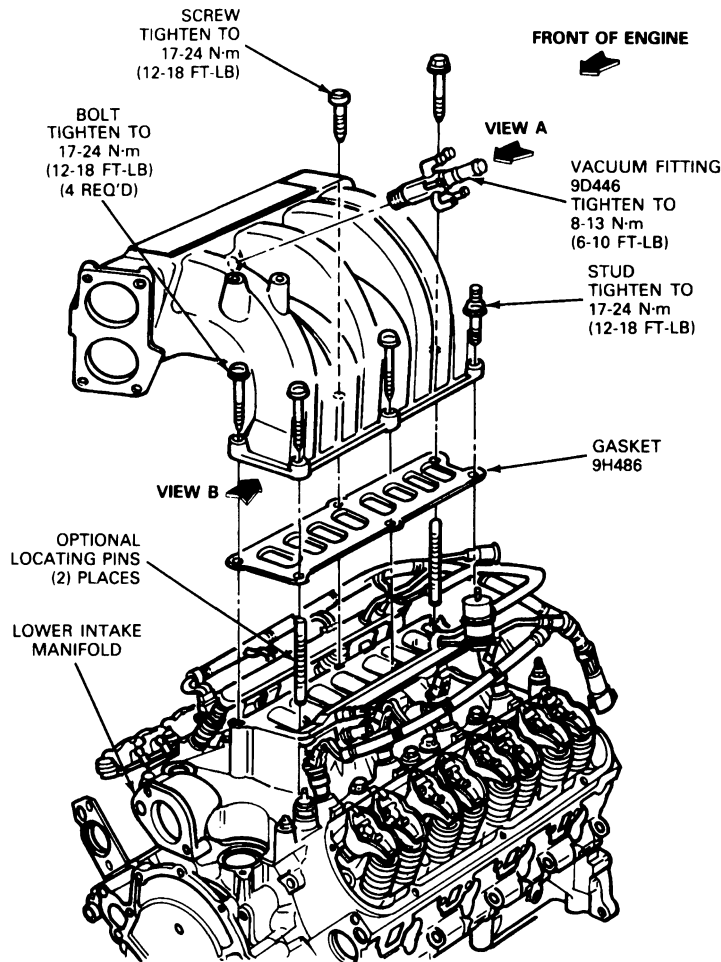
Installation

1. Clean and inspect the mounting faces of the lower and upper intake manifolds.
2. Position new gasket on lower intake mounting face. The use of alignment studs may be helpful.
3. Install upper intake manifold and throttle body assembly to lower manifold making sure gasket remains in place (if alignment studs are not used).
4. Install six upper intake manifold retaining bolts and tighten to 17-24 N·m (12-18 ft-lb).
5. Install upper intake support bracket to upper manifold attaching bolt.
6. Install EGR tube. Tighten flange nuts to 34-47 N·m (25-35 ft-lb).
7. Install canister purge lines to fittings on throttle body.
8. Connect water heater lines to the throttle body.
9. Connect PCV hose to rear of upper manifold.
10. Install oil fill tube (Econoline models).
11. Connect vacuum lines to vacuum tree, EGR valve and fuel pressure regulator.
12. Position throttle linkage bracket with cables to upper intake manifold. Install two retaining bolts and tighten to 11-13 N·m (8-10 ft-lb). Connect throttle cable and transmission cable to throttle body.
13. Connect electrical connectors at idle air control valve, TP sensor and EGR position sensor.

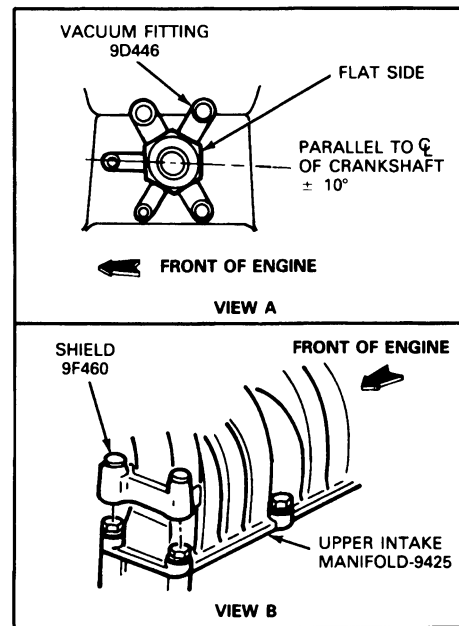
NOTE: If lower intake manifold was removed, fill and bleed cooling system as outlined. Refer to Section 03-03.

REMOVAL AND INSTALLATION (Continued)

Intake Manifold



5.8L SHOWN,
5.0L TYPICAL



V5302-E

Lower Intake Manifold

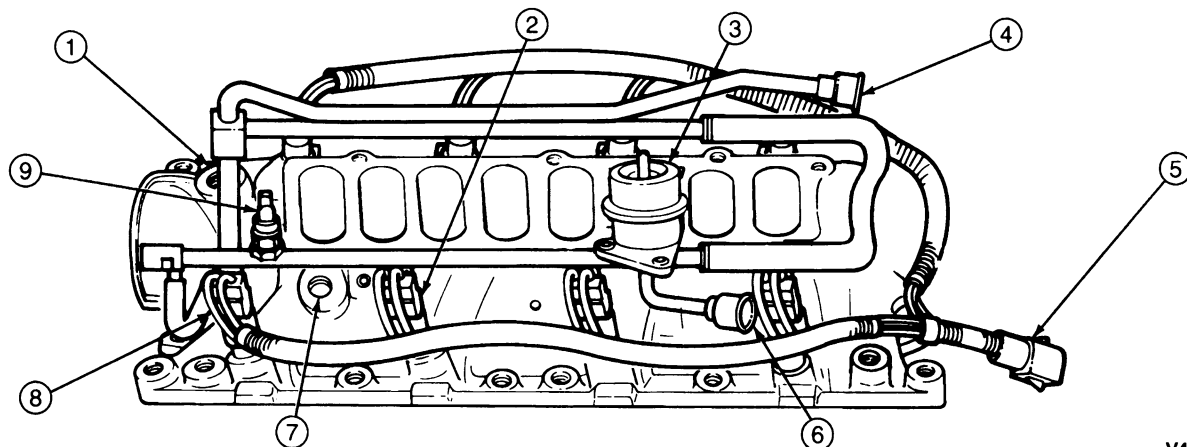
Removal

1. Remove upper intake manifold, throttle body and air cleaner assembly as outlined in this section, prior to lower intake manifold removal.
2. Drain cooling system.
3. Remove distributor assembly, cap and wires. Mark position of distributor and rotor during removal so that they can be installed in their original position.
4. Disconnect the electrical connections at the engine coolant temperature sensor (12A648), engine temperature sending unit, intake air temperature sensor (12A697), sensor, electrical vacuum regulator (EVR) and Thermactor solenoids.
5. Disconnect the injector wiring harness from main harness assembly.
6. Remove heated oxygen sensor (HO2S)(9F472) ground wire from intake manifold stud.
NOTE: The plated stud and ground wire must be installed in the same position from which it was removed.
7. Perform all pre-service procedures as outlined to relieve any fuel system pressure.
8. Disconnect fuel supply and return line retaining clips. Disconnect fuel supply and return lines from fuel rails, using Disconnect Tool D87L-9280-A and D87L-9280-B or equivalent. Refer to Fuel Supply Manifold Assembly in this section.
9. Remove upper radiator hose from thermostat housing.
10. Remove water bypass hose.
11. Remove heater outlet hose at intake manifold.
12. Remove nut securing coil bracket and move bracket out of way.

REMOVAL AND INSTALLATION (Continued)

13. Remove intake retaining bolts and studs, noting location of studs and bolts.

14. Remove lower intake manifold assembly.

Lower Intake Manifold

V4795-G

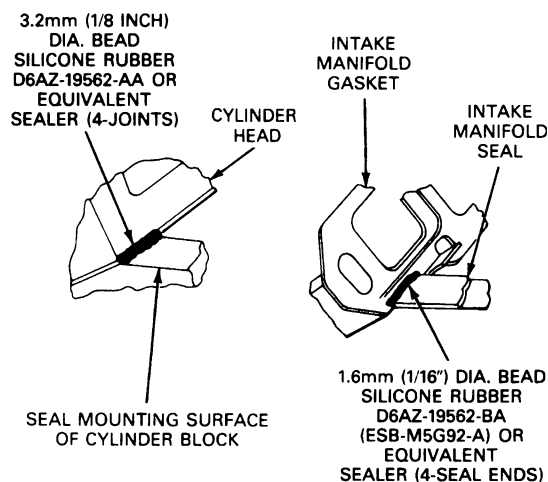
Item	Part Number	Description
1	Ref.	ECT Sensor Location
2	9F593	Fuel Injector Assembly
3	9C968	Fuel Pressure Regulator Assembly
4	9F792	Fuel Supply Manifold Assembly

(Continued)

Item	Part Number	Description
5	9D930	Wiring Harness
6	Ref.	Fuel Return Tube (Part of 9F792 Assembly)
7	Ref.	IAT Sensor Location
8	Ref.	Water Temperature Sender Location
9	Ref.	Pressure Relief Valve

Installation

1. Clean and inspect the mounting faces of the lower intake manifold, cylinder heads and cylinder block surfaces. Refer to Section 03-00.
2. Apply 1.6mm (1/16-inch) bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A) or equivalent sealer to the end seals (junction).

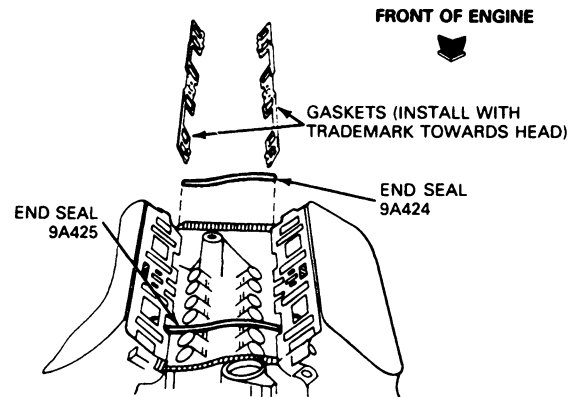


NOTE: THIS SEALER SETS UP WITHIN 15 MINUTES AFTER APPLICATION. TO ASSURE EFFECTIVE SEALING, ASSEMBLY SHOULD PROCEED PROMPTLY.

A3715-J

REMOVAL AND INSTALLATION (Continued)

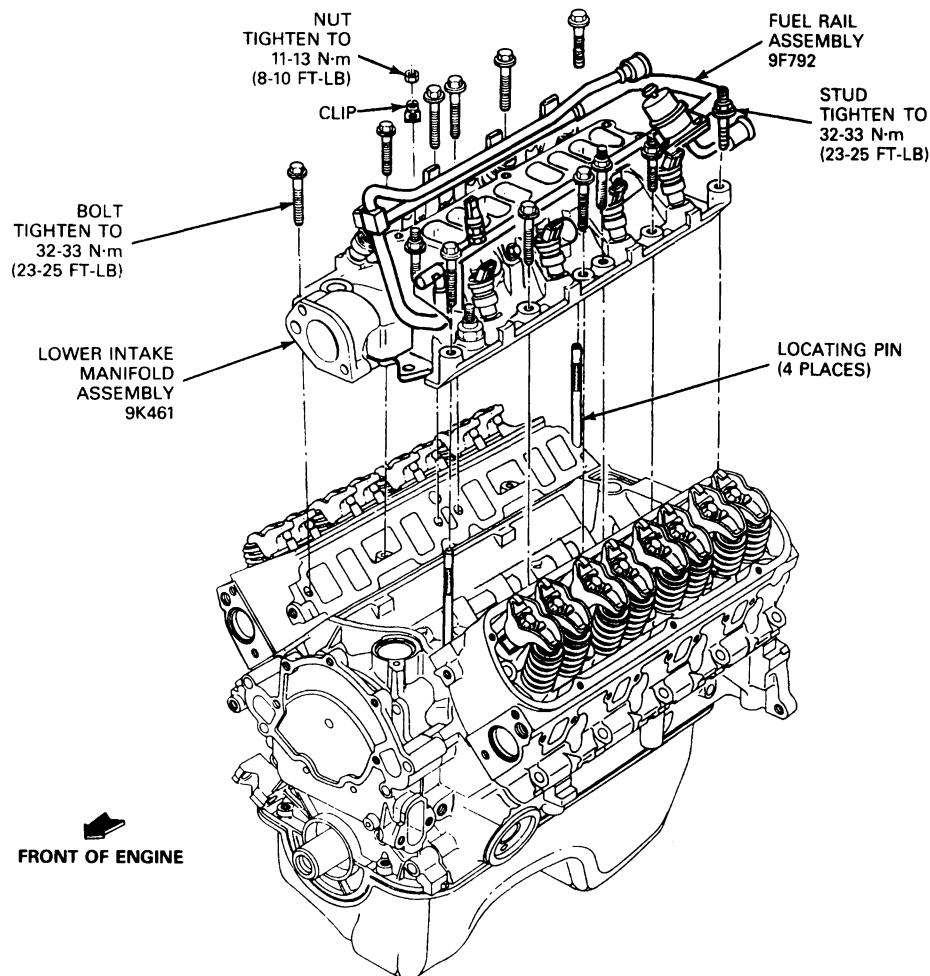
3. Install end seals on the cylinder block and new gaskets on the cylinder heads.
- NOTE: The gaskets must be interlocked with the seal tabs.



V4793-1A

4. Install two locator pins into opposite corners.
5. Carefully lower intake manifold assembly into position.

Lower Intake Manifold



V4792-E

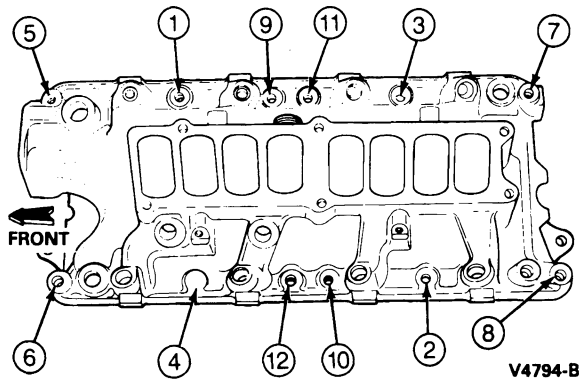
REMOVAL AND INSTALLATION (Continued)

6. Install intake manifold bolts and studs. Tighten all bolts and studs using the sequence shown in three steps as follows:

Step 1. Tighten all to 11 N·m (8- ft-lb).

Step 2. Tighten all to 22 N·m (16 ft-lb).

Step 3. Tighten all to 31-34 N·m (23-25 ft-lb).



7. Install coil and solenoid bracket to intake manifold studs and exhaust manifold stud. Install retaining nuts and tighten to 6-7 N·m (53-62 in-lb).
8. Install upper radiator hose and water bypass hose to thermostat housing.
9. Install heater outlet hose to intake manifold.
10. Connect fuel supply and return lines to fuel rails. These are push-connect fittings. Connect fuel line retaining clips.
11. Connect the electrical connectors to engine coolant temperature sensor, intake air temperature sensor engine temperature sending unit, electrical vacuum regulator (EVR) and Thermactor solenoids.
12. Install distributor assembly in the proper position as noted during removal. Install distributor cap and wires.
13. Install upper intake manifold as outlined.
14. Fill and bleed the cooling system. Refer to Section 03-03.
15. Perform all post-service procedures as outlined.

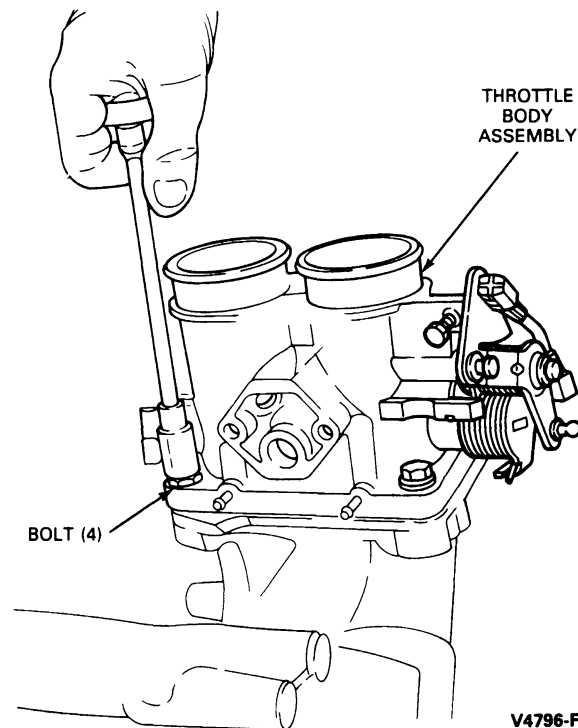
Air Intake Throttle Body

Removal

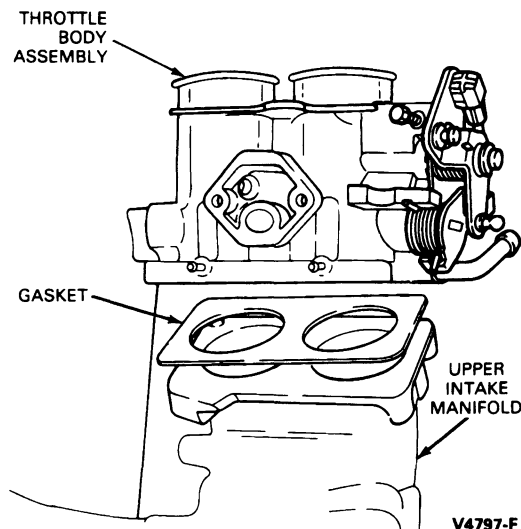
1. Disconnect throttle linkage at throttle ball. Disconnect AOD (5.0L only) or C6 (5.8L only) transmission linkage from throttle body.

CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the stud and pry slowly. Pulling by hand may damage the cable.

2. Disconnect throttle position sensor (9B989) and idle air control valve connectors.
3. Remove four throttle body bolts.



4. Carefully separate air throttle body from upper intake manifold.
5. Remove and discard gasket between throttle body and upper intake manifold.



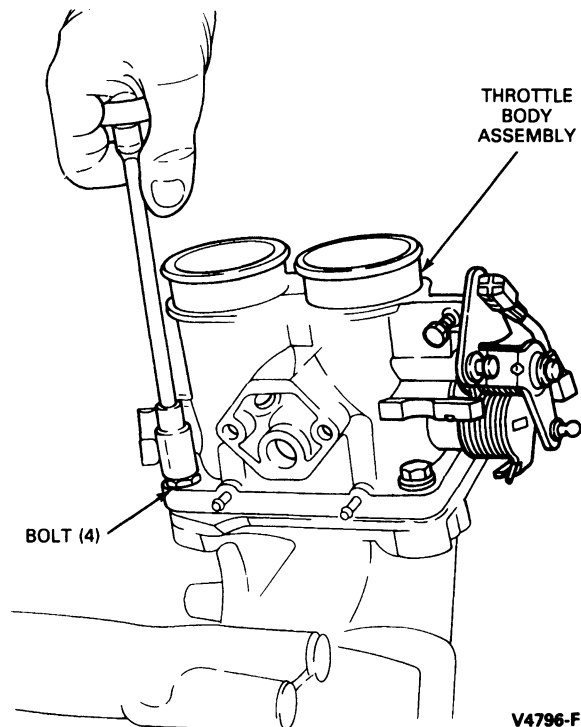
Installation

1. Make sure that both throttle body and upper intake manifold gasket surfaces are clean.

NOTE: If scraping is necessary, be careful not to damage gasket surfaces of throttle body and upper manifold assemblies, or allow material to drop into manifold.

REMOVAL AND INSTALLATION (Continued)

2. Install throttle body gasket on the four studs of the upper intake manifold.
3. Install throttle body to upper intake manifold.
4. Secure throttle body assembly to upper intake manifold with four retaining bolts. Tighten to 16-24 N·m (12-18 ft-lb).
5. Connect idle air control valve and throttle position (TP) sensor electrical connectors.
6. Connect throttle cable and transmission linkage to throttle body.

**Throttle Position (TP) Sensor****Removal**

1. Disconnect throttle position (TP) sensor from wiring harness.
2. Scribe a reference mark across the edge of the throttle position sensor and to the throttle body, if the same TP sensor is to be installed, to make sure correct position during installation is achieved.

3. Remove two throttle position sensor retaining screws.
4. Remove throttle position sensor.

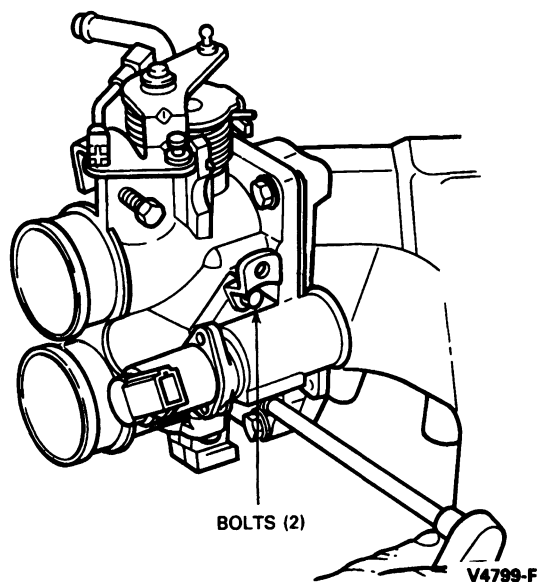
Installation

1. Position the throttle position sensor so that the scribe mark on the sensor and throttle body are on the same side and aligned. Then, rotate throttle position sensor clockwise to align scribe marks.
2. Secure sensor to throttle body assembly with two retaining screws. Tighten to 1-2 N·m (9-18 in-lb).
3. Connect electrical connector to harness.
4. Adjust throttle position sensor as described in the Powertrain Control / Emissions Diagnosis Manual.²

Idle Air Control Valve Assembly (IAC)**Removal**

1. Disconnect the idle air control valve assembly connector from the wiring harness.
2. Remove the two idle air control valve retaining bolts.

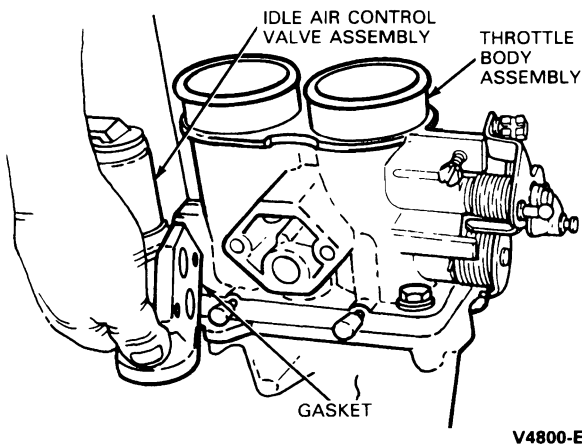
NOTE: 5.0L shown, 5.8L similar.



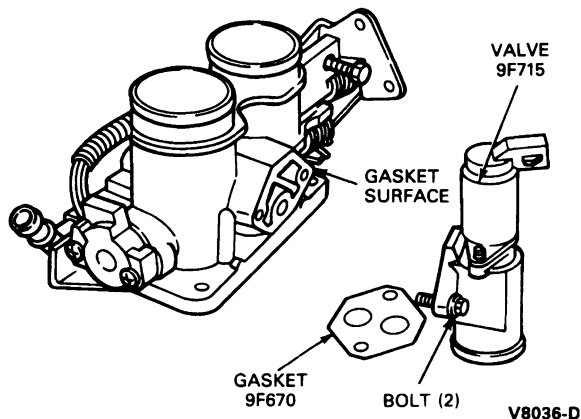
² Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

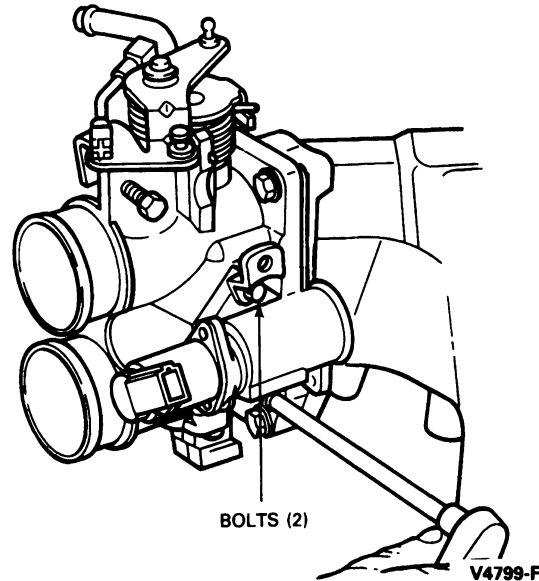
3. Remove the idle air control valve and gasket.

**Installation**

1. Make sure that both throttle body and idle air control valve gasket surfaces are clean.
NOTE: If scraping is necessary, be careful not to damage idle air control valve or throttle body gasket surfaces, or drop material into throttle body.
2. Install gasket and idle air control valve on throttle body surfaces.
NOTE: 5.0L shown, 5.8L similar.



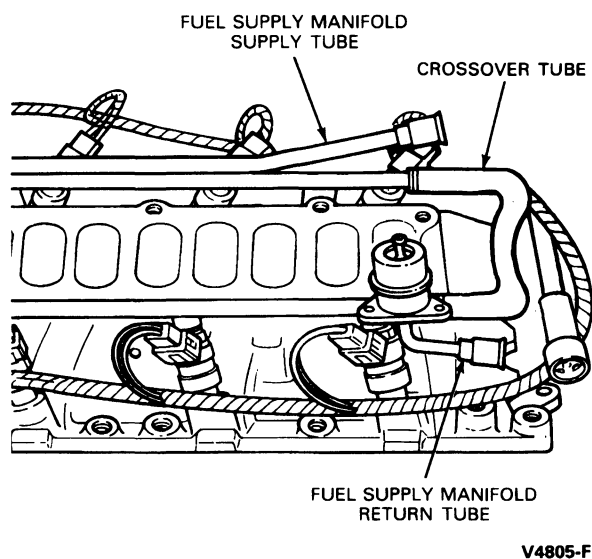
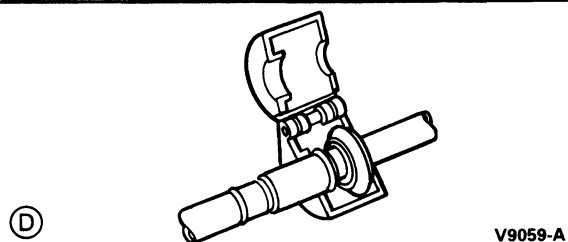
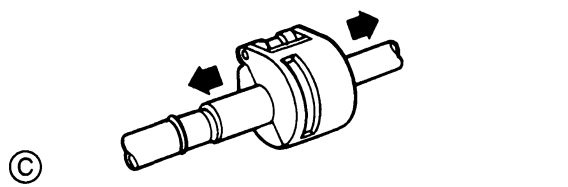
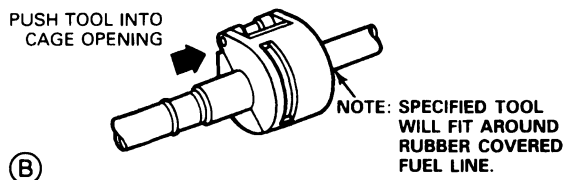
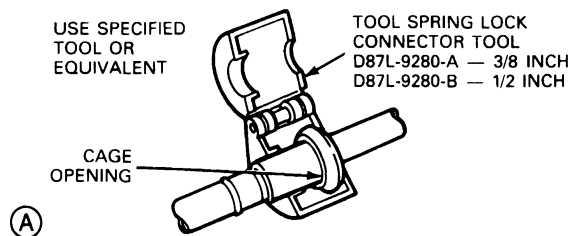
3. Install retaining screws. Tighten to 8-12 N·m (71-106 in·lb).
4. Connect electrical connector for the idle air control valve.

**Fuel Supply Manifold Assembly****Removal**

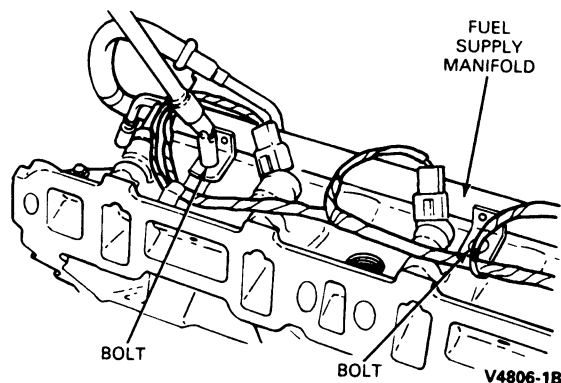
1. Perform all pre-service procedures as outlined.
2. Remove upper manifold assembly as outlined /
3. Disconnect fuel supply and return line retaining clips.
4. Using Disconnect Tool D87L-9280-A or -B or equivalent, disconnect the fuel chassis inlet and outlet fuel hoses from the fuel supply manifold as follows:
 - a. Fit tool to coupling so that tool can enter cage opening to release the garter spring.
 - b. Push the tool into the cage opening to release the female fitting from the garter spring.
 - c. Pull the coupling male and female fittings apart.

REMOVAL AND INSTALLATION (Continued)

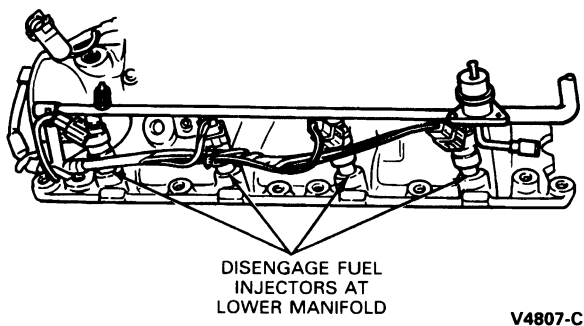
- d. Remove the tool from the disconnected coupling.



5. Remove four (two per group) fuel supply manifold retaining bolts.

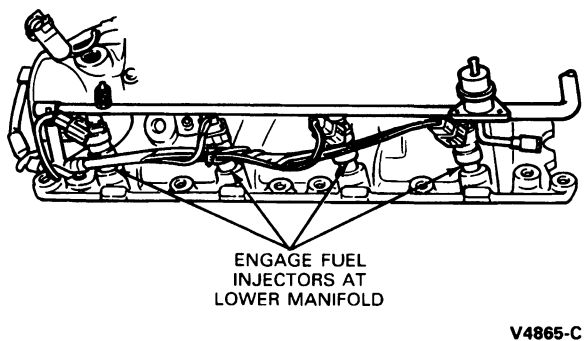


6. Remove manifold.
NOTE: Fuel injectors will stay in fuel supply manifold when removed.



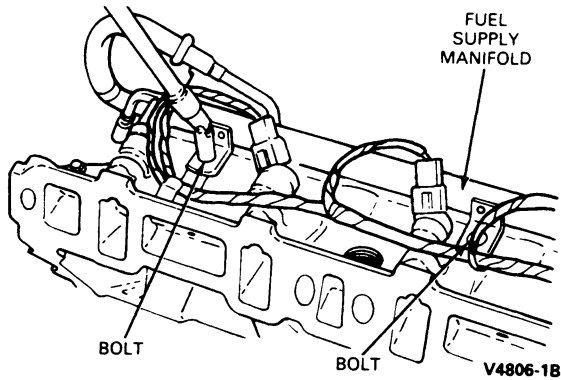
Installation

1. Make sure injector caps are clean and free of contamination.
2. Install injectors into fuel supply manifold then seat injectors into pockets in lower intake manifold. Make sure the injectors are properly seated.

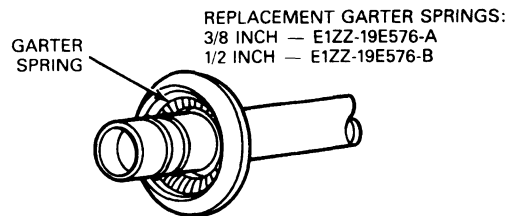


REMOVAL AND INSTALLATION (Continued)

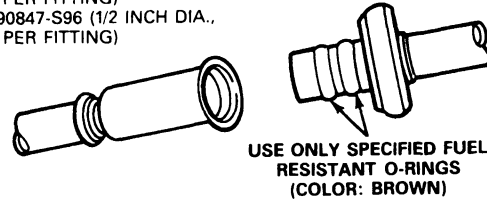
3. Secure the fuel manifold assembly using four retaining bolts. Tighten to 8-12 N·m (71-105 in-lb).



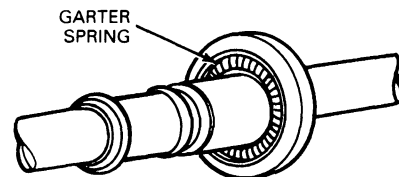
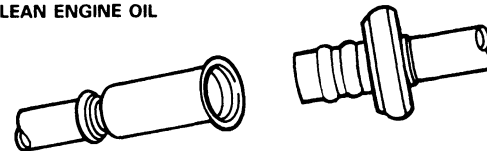
4. Connect the fuel inlet and outlet lines at the fuel rail connections as follows:
- Check for missing or damaged garter spring, remove damaged spring with small hooked wire, and install new spring.
 - Clean fittings with solvent. Check for missing or damaged O-rings. Replace missing O-rings. If either O-ring is damaged, replace both.
 - Assemble fitting by pushing with a slight twisting motion.
 - To ensure coupling engagement, pull on fitting and visually check to be sure garter spring is over flared end of female fitting.



REPLACEMENT O-RINGS
390846-S96 (3/8 INCH DIA.,
2 PER FITTING)
390847-S96 (1/2 INCH DIA.,
2 PER FITTING)



LUBRICATE O-RINGS WITH
CLEAN ENGINE OIL



V9058-A

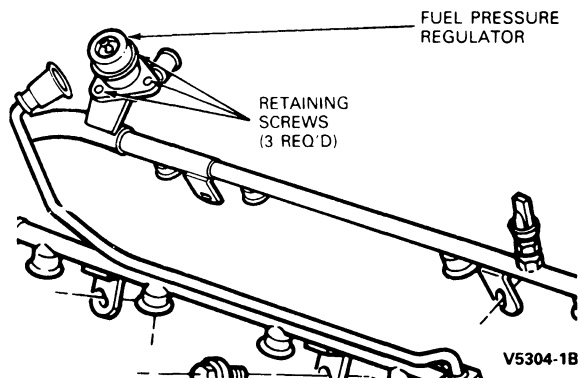
- Connect fuel line retaining clips.
- Install upper intake manifold as outlined.

Fuel Pressure Regulator**Removal**

- Perform all pre-service procedures if removing fuel pressure regulator while fuel supply manifold is installed on engine.
- Remove vacuum line at pressure regulator.
- Remove three Allen head retaining screws from regulator housing.
- Remove pressure regulator assembly, gasket and O-ring. Discard gasket and inspect O-ring for signs of cracks or deterioration.

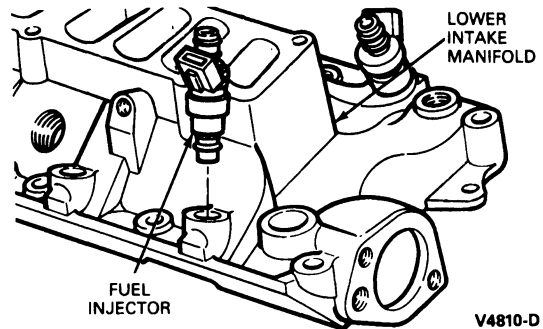
REMOVAL AND INSTALLATION (Continued)

5. If scraping is necessary, be careful not to damage fuel pressure regulator or fuel supply line gasket surfaces.

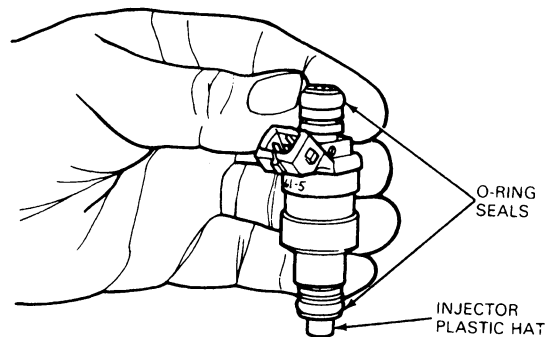


Installation

1. Lubricate fuel pressure regulator O-ring with 10W-30 oil WSE-M2C903-A2 or equivalent.
2. Make sure gasket surfaces of fuel pressure regulator and fuel injector manifold are clean.
3. Install O-ring and new gasket on regulator.
4. Install fuel pressure regulator on injector manifold. Tighten three retaining screws to 3-5 N·m (27-44 in-lb).
5. Install vacuum line to regulator.
6. Perform all post-service procedures, if fuel supply manifold is installed on engine.



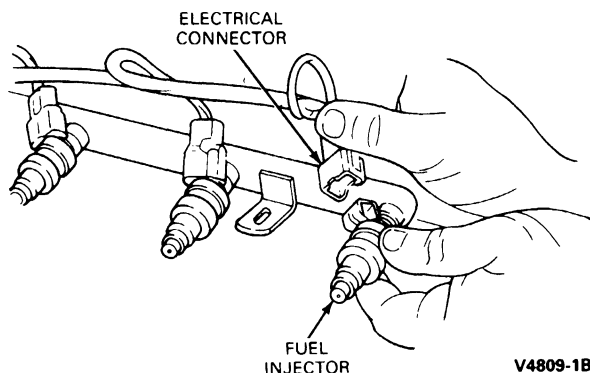
5. Inspect injector O-rings (two per injector) for signs of deterioration. Replace as required.
NOTE: Deposit resistant injectors (DRI) do not need to be cleaned.



Fuel Injector

Removal

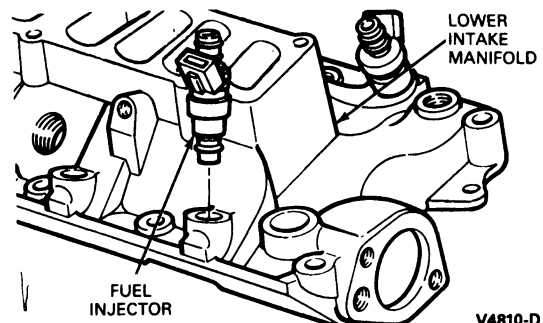
1. Perform all pre-service procedures as outlined.
2. Remove upper intake manifold and fuel supply manifold as outlined.
3. Carefully remove electrical harness connectors from individual injectors as required.



4. Grasping injector body, pull up while gently rocking injector from side to side.

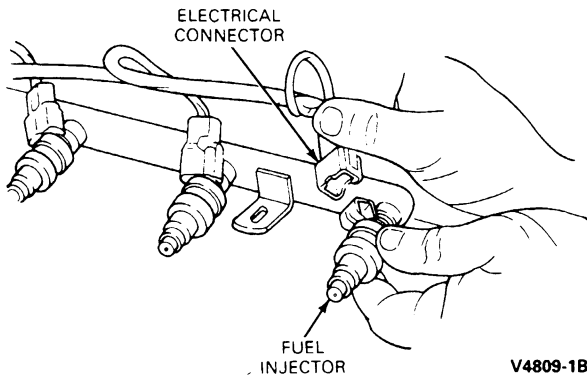
Installation

1. Lubricate new O-rings with light 10W-30 oil WSE-M2C903-A2 or equivalent and install two on each injector.
CAUTION: Never use silicone grease. It will clog the injectors.
2. Install injector(s) using light, twisting, pushing motion.
3. Install fuel supply manifold as outlined in this section.



REMOVAL AND INSTALLATION (Continued)

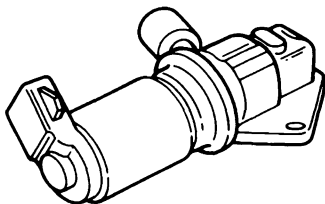
4. Install electrical harness connectors to injectors.
5. Install upper intake manifold as outlined in this section. Perform all post-service procedures as outlined.



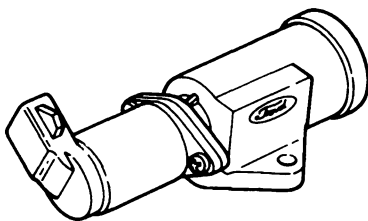
CLEANING AND INSPECTION

Idle Air Control Valve Cleaning

CAUTION: This cleaning procedure may be used with sludge tolerant bodies which are identified with a yellow/black "attention" label. No attempt should be made to clean the throttle body bore/plate area by directly spraying or scrubbing. Do not run vehicles with air flow meters during the cleaning procedure.



5.8L NON-CLEANABLE



5.0L CLEANABLE

A19019-A

1. Plug the actuator into the connector in Rotunda Cleaner / Tester 113-00009 or equivalent.
2. Remove the air duct to the throttle body inlet.
3. Disconnect the idle air control valve signal lead.
4. Attach the actuator harness plug to the idle air control valve.

5. Start the actuator and then start the engine.

CAUTION: Do not start engines that have air flow meters.

6. Spray Carburetor Tune-up Cleaner D9AZ-19579-AA for about five seconds into the idle air control valve inlet passage while the actuator is operating.

CAUTION: Avoid direct spraying on throttle plate/bore area.

7. Stop the engine and actuator. Let everything soak for 15 minutes.

8. Start the actuator and then start the engine.

CAUTION: Do not start engines that have air flow meters.

9. Spray the Carburetor Tune-up Cleaner into the idle air control valve passage leading to the inlet of the valve for up to one minute.

CAUTION: Do not spray for longer than six continuous seconds on engines that have air flow meters and are not running.

10. Stop the actuator and stop the engine if running.

11. Reinstall the air duct.

12. Start and run the engine for about one minute to dry out the solvent residue.

13. Operate the actuator to make sure the solvent is purged from the idle air control valve.

14. Disconnect the actuator from the idle air control valve.

15. Reattach the control signal lead to the idle air control valve.

16. Check the engine for normal operation.

Alternate Cleaning Procedure

NOTE: To be used only when tools for the preferred method are not available.

Remove the idle air control valve from the throttle body assembly. Remove the electrical solenoid assembly from the mechanical portion of the idle air control valve by removing the two screws, then sliding the mechanical portion away from the solenoid.

Soak the mechanical portion in Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A) or equivalent for two to three minutes maximum.

CAUTION: Do not exceed three minutes soak time, and do not use choke cleaner as an internal O-ring may begin to deteriorate.

With the mechanical portion completely submerged, shake in all directions: up, down, right and left. Then push in on the rod that mates with the solenoid assembly, and again shake in all directions with the unit submerged and the rod held in as far as possible.

Remove the unit from the cleaning fluid and dry out thoroughly with shop air.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Lb-Ft
Lower Intake Manifold to Head	31-34	23-25
EGR Tube	34-47	25-35
EGR Valve to Upper Intake Manifold	17-25	13-19
Cooling Manifold	4-5.6	35-50 In-Lb
Upper Intake Manifold to Lower Intake Manifold Bolts	16-24	12-18
Throttle Body to Upper Intake Manifold	16-24	12-18
Idle Air Control Valve (IAC) to Throttle Body	8-12	7 1-106 In-Lb
Throttle Position (TP) Sensor to Throttle Body	1-2	9-18 In-Lb
Fuel Pressure Regulator to Injector Manifold	3-5	27-44 In-Lb
Fuel Supply Manifold to Lower Intake Manifold	8-12	7 1-105 In-Lb
Coil Bracket to Manifold Stud	6-7	53-62 In-Lb
Throttle Cable Bracket to Manifold	11-13	8-10

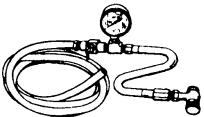
Tool Number	Description
D87L-9280-B	Disconnect Tool, 1/2-Inch
D87L-9280-A	Disconnect Tool, 3/8-Inch

D87L-9280-B	Disconnect Tool, 1/2-Inch
D87L-9280-A	Disconnect Tool, 3/8-Inch

ROTUNDA EQUIPMENT

Tool Number	Description
113-00001	Injector Cleaner / Tester
113-00009	Air Bypass Actuator

SPECIAL SERVICE TOOLS / EQUIPMENT

Tool Number / Description	Illustration
T80L-9974-B MFI Fuel Pressure Test Gauge	 <p>T80L-9974-B</p>

SECTION 03-04B Fuel Charging and Controls, 4.9L

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		REMOVAL AND INSTALLATION (Cont'd.)	
Idle Air Control Valve	03-04B-24	Fuel Injection Wiring Harness	03-04B-22
Throttle Body Assembly.....	03-04B-24	Fuel Injector	03-04B-23
DESCRIPTION AND OPERATION		Fuel Pressure Regulator	03-04B-21
Air Intake Manifold	03-04B-3	Fuel Supply Manifold Assembly	03-04B-19
Fuel Injectors	03-04B-4	Idle Air Control Valve Assembly.....	03-04B-18
Fuel Pressure Regulator	03-04B-4	Post-Service Procedures	03-04B-6
Fuel Supply Manifold Assembly	03-04B-5	Pre-Service Procedures.....	03-04B-6
Throttle Body Assembly.....	03-04B-4	Pressure Relief Valve	03-04B-22
DIAGNOSIS AND TESTING		Throttle Position Sensor	03-04B-18
Tips to Avoid Lean Air-Fuel Conditions	03-04B-5	Upper Intake Manifold and Throttle Body	
REMOVAL AND INSTALLATION		Assembly	03-04B-13
Air Intake Throttle Body.....	03-04B-17	SPECIAL SERVICE TOOLS/EQUIPMENT	03-04B-25
Fuel Charging Assembly	03-04B-6	SPECIFICATIONS	03-04B-25
		VEHICLE APPLICATION	03-04B-1

VEHICLE APPLICATION

Vehicles Equipped with 4.9L MFI Engines

DESCRIPTION AND OPERATION

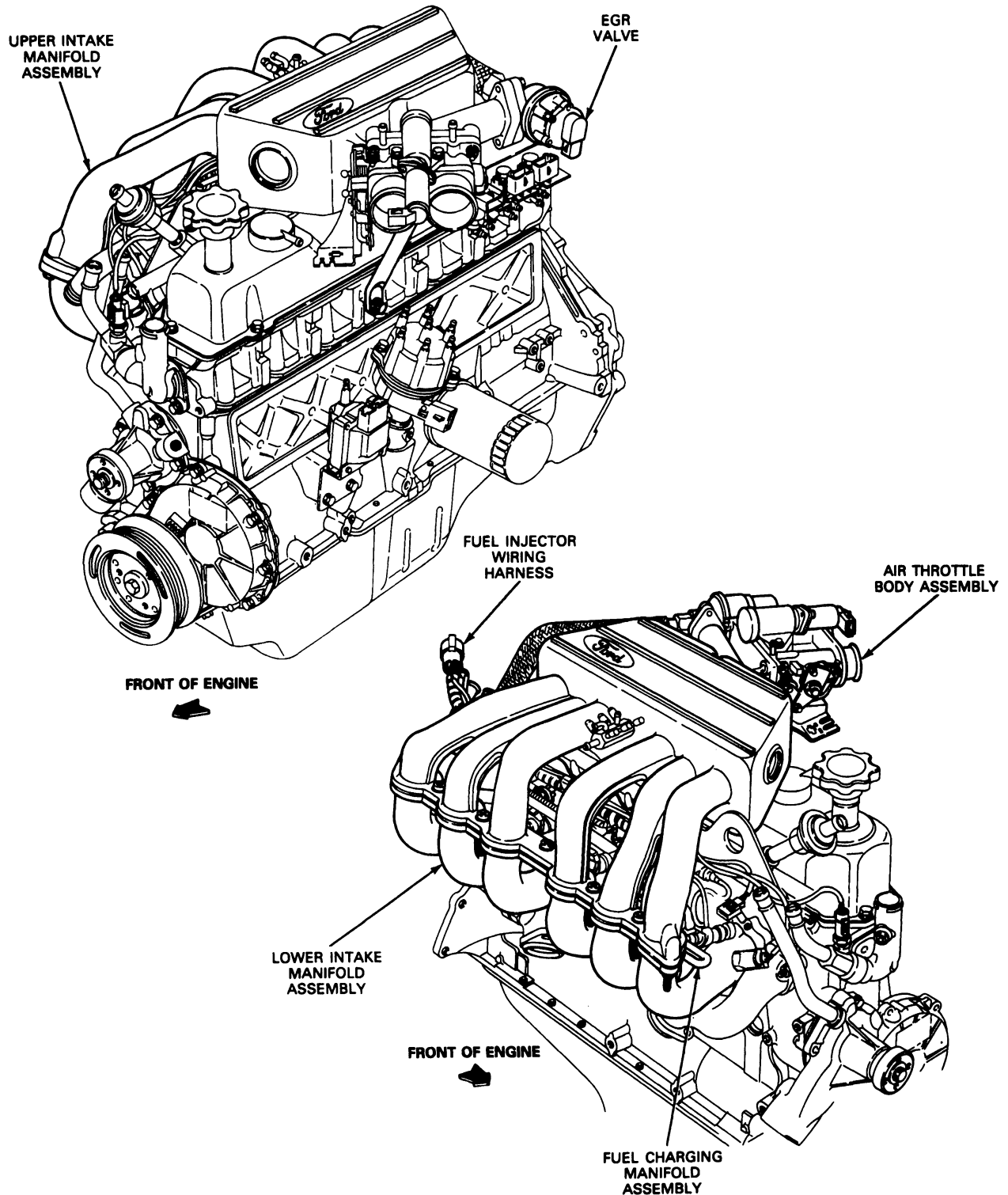
The Multiport Fuel Injection system (MFI) is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered into each intake port in a sequential firing order. Injectors pulse to follow engine firing order in accordance with engine demand through injectors mounted on a tuned intake manifold.

A powertrain control module (PCM)(12A650) accepts input from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio throughout the entire engine operational range. The computer then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

The powertrain control module also determines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude and will also permit push-starting the vehicle should it become necessary (manual transmission only).

The fuel delivery subsystem consists of a high-pressure in-tank mounted fuel pump and a fuel filter / reservoir delivering fuel from the fuel tank through a 20 micron fuel filter to a fuel charging manifold assembly.

The fuel charging manifold assembly incorporates electrically actuated fuel injectors directly above each of the engine's intake ports. The injectors, when energized, spray a metered quantity of fuel into the intake air stream. The amount of fuel entering the cylinder is increased or decreased by varying the time the injector is held open. The injector opening area or injector fuel pressure (psi) does not vary.

DESCRIPTION AND OPERATION (Continued)**4.9L Multiport Fuel Injection Engine**

V5838-E

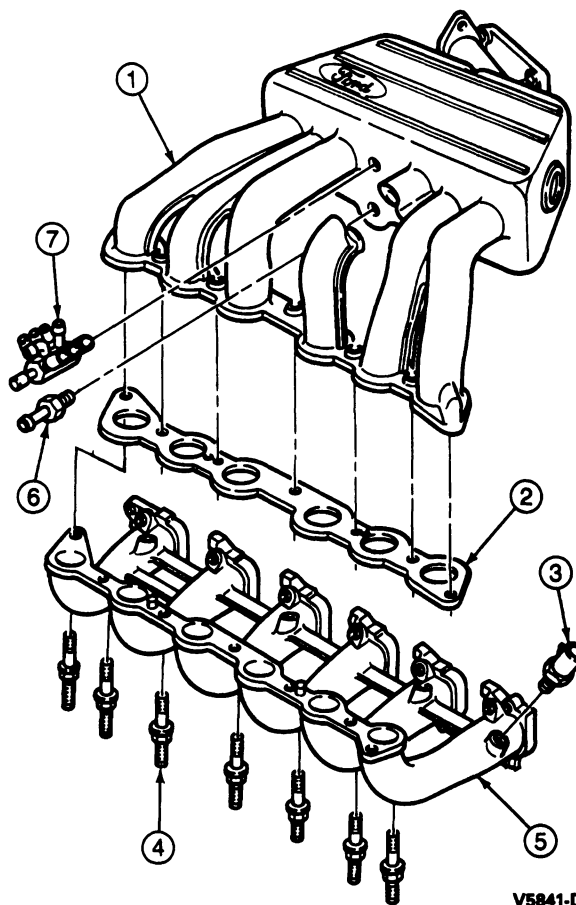
DESCRIPTION AND OPERATION (Continued)

A constant fuel pressure drop is maintained across the injector nozzles by a pressure regulator. The regulator is connected in series with the fuel injectors and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator and returns to the fuel tank through a fuel return line.

The injectors are energized in two sets of three injectors, 1-3-5 in one set and 2-4-6 in the other, with one set energized every crankshaft revolution. The period of time that the injectors are energized (injector "on time" or pulse width) is controlled by the powertrain control module. Input from various engine sensors is used to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio for the given engine operation. The computer determines the needed injector pulse width and outputs a command to the injector to meter the exact quantity of fuel.

Air Intake Manifold

The air intake manifold is a two-piece (upper and lower intake manifold) aluminum casting. Runner lengths are tuned to optimize engine torque and power output. The manifold provides mounting flanges for the air throttle body assembly, fuel supply manifold and accelerator control bracketry and the EGR valve and supply tube. Vacuum taps are provided to support various engine accessories. Pockets for the fuel injectors are machined to prevent both air and fuel leakage. The pockets in which the injectors are mounted are placed to direct the injector fuel spray immediately in front of each engine intake valve.



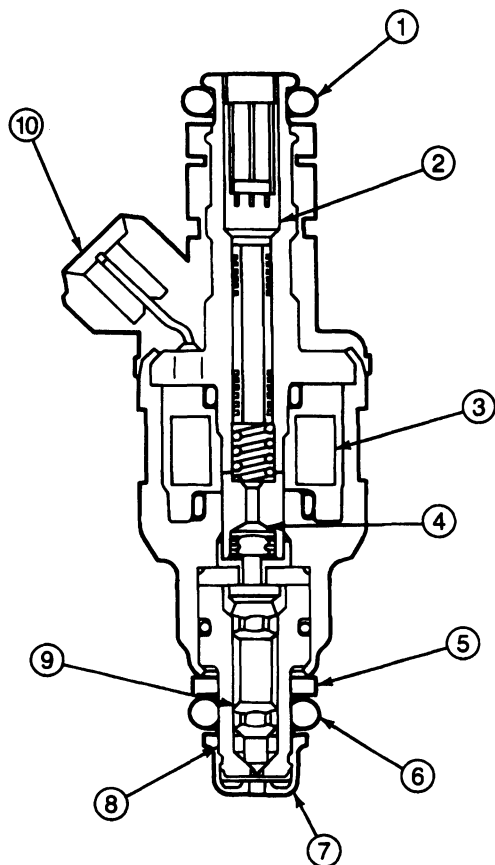
Item	Part Number	Description
1	9424	Upper Intake Manifold
2	9H486	Gasket
3	12A967	Intake Air Temperature Sensor
4	—	Stud (7 Req.) 5/16-18 x 2.505 16-24 N·m (12-18 Ft·Lb)
5	9K641	Lower Intake Manifold
6	390659-S100	PCV Connector
7	9D446	Vacuum Tree

TV5841A

DESCRIPTION AND OPERATION (Continued)

Fuel Injectors

The fuel injector nozzles are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The MFI injectors are mounted in the lower intake manifold and are positioned so that their tips are directing fuel just before the engine intake valves. The valve body consists of a solenoid-actuated valve assembly, therefore, fuel flow to the engine is regulated only by how long the solenoid is energized. An electrical signal from the powertrain control module activates the solenoid, causing the needle to move inward, off the seat, allowing the fuel to flow through the orifice. Atomization of the fuel is obtained by director / metering plate and the pintle at the point where the fuel separates.



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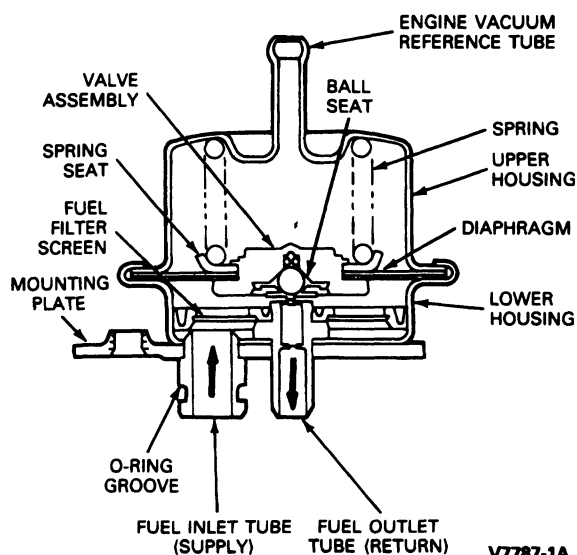
Item	Description
1	Supply Manifold O-ring
2	Integral Filter
3	Coil
4	Armature
5	Washer
6	Lower Intake Manifold O-ring
7	Pintle Protection Cap
8	Stainless Steel Valve Body

(Continued)

Item	Description
9	Stainless Steel Needle (Pintle)
10	Electrical Connector

Fuel Pressure Regulator

The fuel pressure regulator is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the injectors. The regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the injectors. Fuel, in excess of that used by the engine, is bypassed through the regulator and returns to the fuel tank.



V7787-1A

Throttle Body Assembly

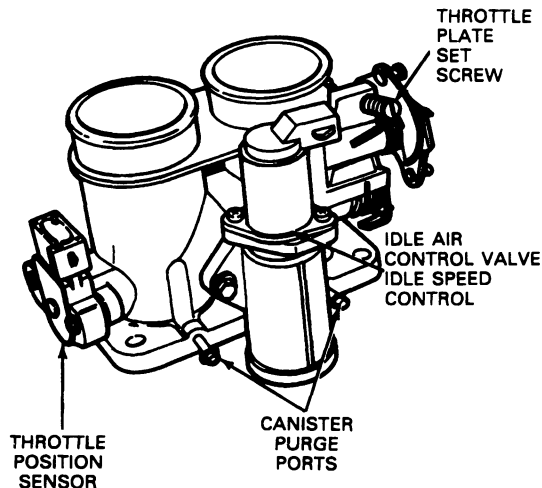
The throttle body assembly controls airflow to the engine through a double butterfly-type valve. The throttle position is controlled by multiple-link, progressive opening, throttle linkage. The body is a single-piece die casting made of aluminum. It has a dual bore with an air bypass channel around the throttle plate. This bypass channel controls both cold and warm engine idle control as regulated by an idle air control valve (9F7 15) assembly mounted directly to the throttle body. The valve assembly is an electro-mechanical device controlled by the powertrain control module. It incorporates a linear actuator which positions a variable area metering valve. Engine coolant is diverted through the throttle body mounting pad to improve cold weather operation.

DESCRIPTION AND OPERATION (Continued)

Other features of the air throttle body assembly include:

1. A pre-set stop to locate the WOT position.
2. A throttle body-mounted throttle position sensor (9B989).
3. Two canister purge ports for evaporative emission control.

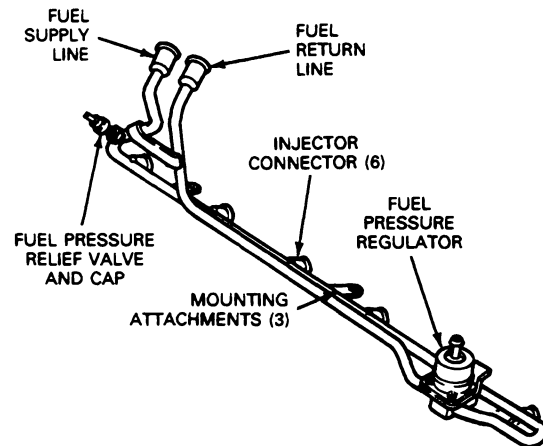
AIR THROTTLE BODY ASSEMBLY



V4762-F

Fuel Supply Manifold Assembly

The fuel supply manifold assembly delivers high-pressure fuel from the vehicle fuel supply line to the six fuel injectors. The assembly consists of a preformed tube for fuel supply and one for fuel return. The fuel manifold assembly has six injector connectors, a mounting flange for the fuel pressure regulator, and mounting attachments which locate the fuel manifold assembly and provide fuel injector retention. The manifold also is equipped with a fuel pressure relief valve on the fuel supply tube.



V5840-1B

DIAGNOSIS AND TESTING

Tips to Avoid Lean Air-Fuel Conditions

Rough idle, hesitation, poor throttle response, induction backfire and stalls during cold start / warm-up may be caused by the poor volatility of some high octane premium grade unleaded fuels (91 octane or higher ($(R+M)/2$). When compared to regular grade unleaded fuel (87 octane), high octane premium grade unleaded fuel may cause long crank time.

Use a regular grade unleaded fuel in all vehicles, except where a premium unleaded fuel is recommended in the Owner Guide. If lean air-fuel type symptoms are experienced, determine the grade and brand of fuel used and offer the following service tips.

- Advise those using a higher octane grade fuel to switch to a regular grade unleaded fuel. For those using a regular grade fuel, advise them to try another brand.
- Do not advise using a higher octane unleaded fuel than is recommended for that specific engine. Ford engines are designed to perform best using a high quality regular grade unleaded fuel.
- Advise using a higher octane unleaded fuel to avoid potentially damaging spark knock or ping, but do so only after mechanical repairs are ineffective.

NOTE: All unleaded gasolines used should contain detergent additives that are advertised as having "keep clean" or "clean up" performance for both intake valves and fuel injectors.

REMOVAL AND INSTALLATION

Pre-Service Procedures

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

NOTE: If subassemblies are to be serviced and/or removed with the fuel charging assembly mounted on the engine, the following steps must be taken:

1. Open hood and install protective covers.
2. Make sure ignition is off.
3. Disconnect battery ground cable and secure it out of the way.
4. Remove fuel filler cap to relieve fuel tank pressure.
5. Release pressure from fuel system at the fuel pressure relief valve using Pressure Gauge T80L-9974-B. The fuel pressure relief valve is located on the fuel supply manifold assembly near the rear of the engine. To gain access to the fuel pressure relief valve, the valve cap must first be removed.

Post-Service Procedures

After the service is complete and the fuel charging assembly is installed onto engine, the following steps must be taken:

1. Install fuel cap at tank.
2. Connect battery ground cable.
3. Add engine coolant, if necessary.
4. Turn ignition switch on and off several times without starting engine to check for fuel leaks.

NOTE: Check all connections at fuel rails, push-connect fittings, etc.

CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

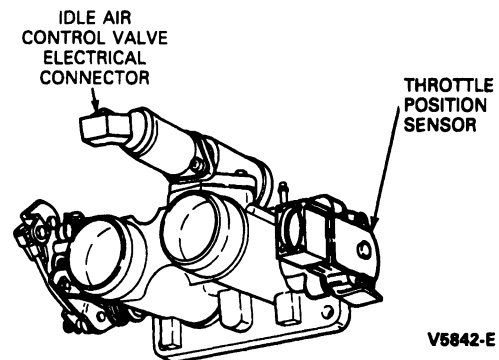
5. Start engine and warm to operating temperature. Check for coolant leak if coolant was removed.
6. Perform EEC-IV Self Test to check systems function. Refer to Powertrain Control/Emissions Diagnosis Manual.

Fuel Charging Assembly

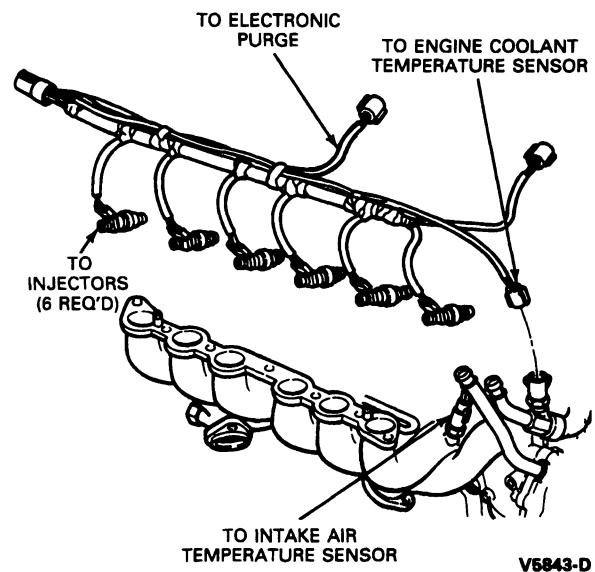
Removal

NOTE: Not all assemblies may be serviceable while on the engine. In some cases, removal of the fuel charging assembly may ease service of the various subassemblies. To remove the entire fuel charging assembly, the following procedure should be performed.

1. Perform all Pre-Service Procedures as outlined. Drain approximately two to three quarts of coolant from radiator.
2. Disconnect electrical connectors at:
 - throttle position sensor.
 - idle air control valve.



- EVP sensor, located on the EGR valve.
- injector wiring harness to main engine harness.
- electronic purge valve (if equipped).

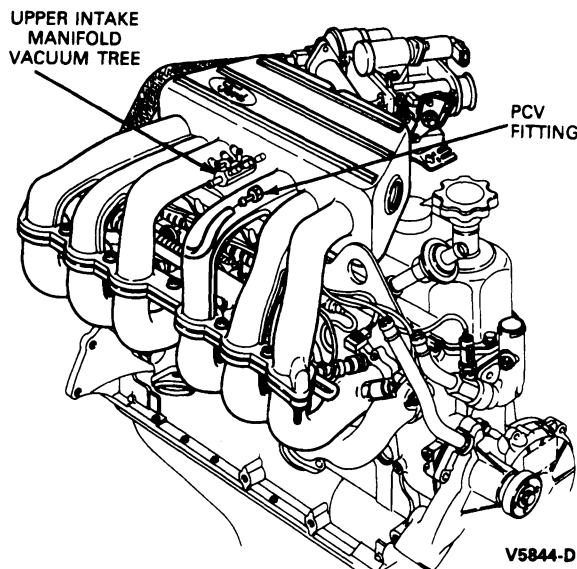


3. Disconnect the following vacuum connections:
 - vacuum line at the EGR valve.
 - vacuum lines at the secondary air bypass valve.
 - Evaporative Emission Shed System (EESS) evaporative lines to the throttle body.
 - vacuum line at the fuel pressure regulator.

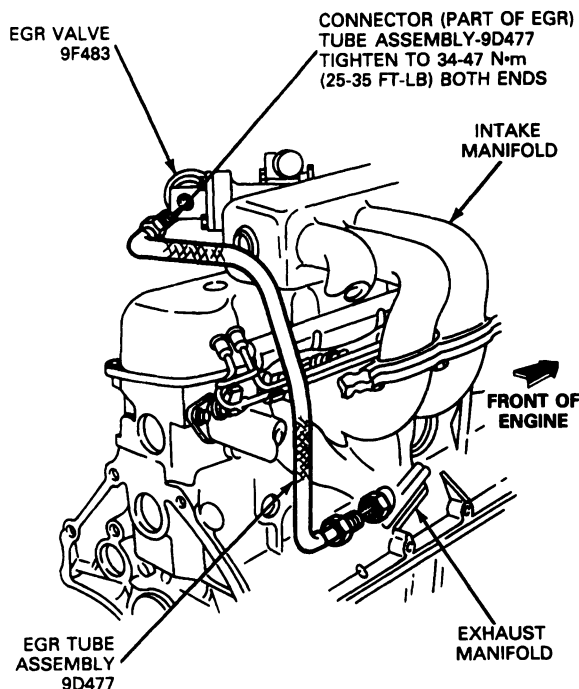
1 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

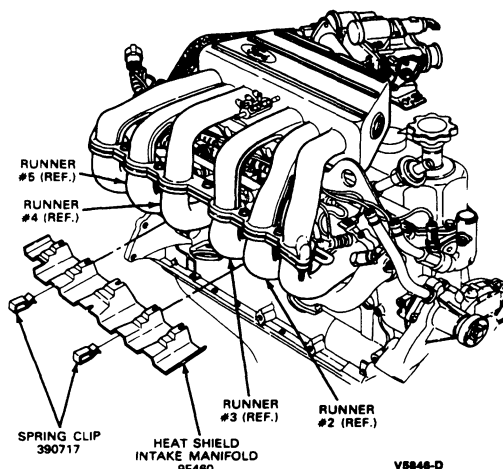
- vacuum lines to the upper intake manifold vacuum tree. Labeling the hose locations with tape is recommended to aid installation.



4. Disconnect the PCV hose from the fitting located on the underside of the upper intake manifold.
 5. Remove the throttle linkage shield and disconnect the throttle linkage and speed control cables. Unbolt the accelerator cable from the bracket and position the cable away from the engine.
- CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the ball stud to pry off. Removing by hand may damage the cable.**
6. Disconnect the air inlet hoses from the throttle body.
 7. Disconnect the EGR tube from the EGR valve and the rear exhaust manifold. Remove the tube from the engine.

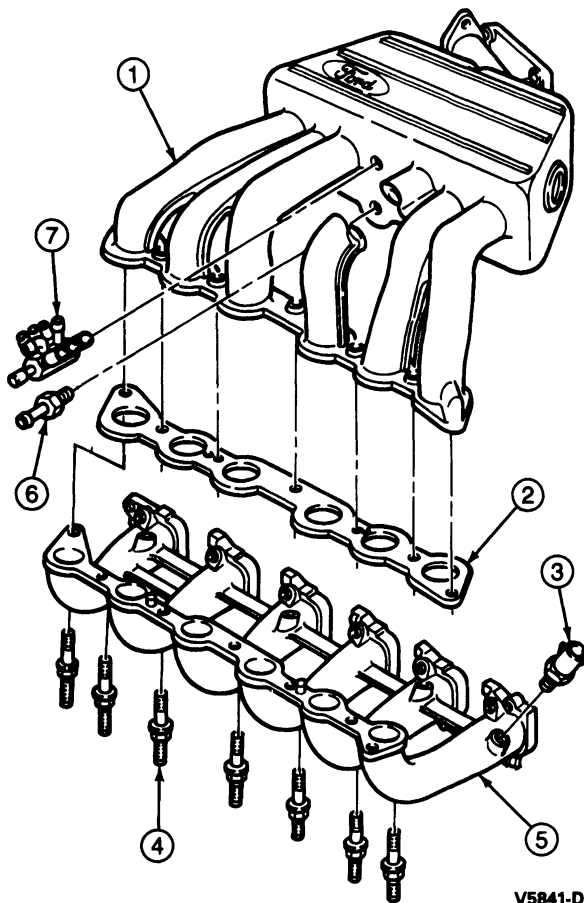


8. Remove the secondary air bypass tube assembly from the lower intake manifold by removing the two nuts retaining the tube. Remove the nut which attaches the secondary air injection air bypass valve bracket to the lower intake manifold.
9. For E-Series applications only, remove the nut which attaches the transmission fill tube. Then remove the tube bracket off the intake manifold stud.
10. Remove the two spring clips attaching the injector heat shield to the lower intake manifold and the exhaust manifolds. Remove the shield from between the lower intake manifold and the exhaust manifolds.



REMOVAL AND INSTALLATION (Continued)

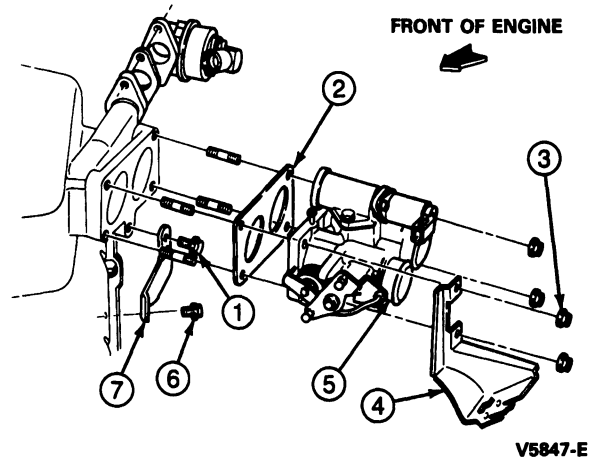
11. Remove the seven studs retaining the upper intake manifold.



Item	Part Number	Description
1	9424	Upper Intake Manifold
2	9H486	Gasket
3	12A967	Intake Air Temperature Sensor
4	—	Stud (7 Req.) 5 / 16-18 x 2.505 16-24 N-m (12-18 Ft-Lb)
5	9K641	Lower Intake Manifold
6	390659-S100	PCV Connector
7	9D446	Vacuum Tree

TV5841A

12. Remove the screw and washer assembly attaching the upper intake manifold support bracket to the upper intake manifold.



V5847-E

Item	Part Number	Description
1	390757	Screw and Washer Assembly 7 / 16-14 x 1.5 30-43 N-m (22-32 Ft-Lb)
2	9E936	Gasket
3	45357	Nut 5 / 16-18 19-27 N-m (14-20 Ft-Lb)
4	9728	Bracket, Accelerator Cable
5	9E926	Throttle Body Assembly
6	56139	Screw and Washer Assembly 3 / 8-16 x .88 30-43 N-m (22-32 Ft-Lb)
7	9J444	Support Bracket

TV5847A

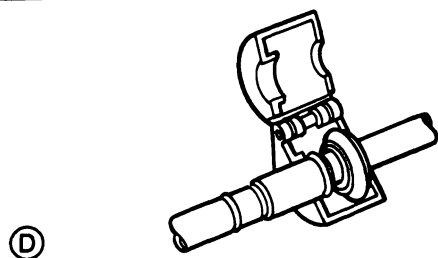
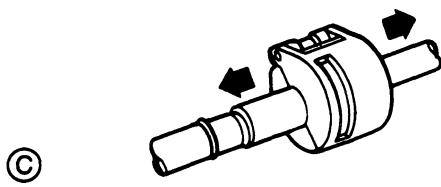
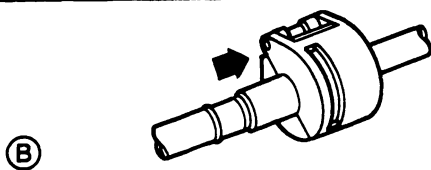
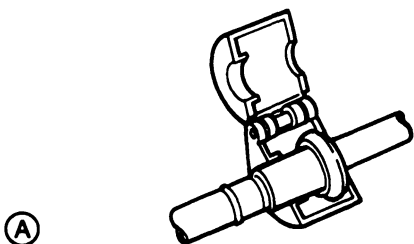
13. Remove the upper intake manifold and throttle body assembly from the lower intake manifold.
14. Move the vacuum harness away from the lower intake manifold.
15. Disconnect fuel line retaining clips.
16. Using Disconnect Tool D87L-9280-A or -B or equivalent disconnect fuel hoses at the fuel rail supply tube and fuel rail return tube.

WARNING: RELIEVE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING COUPLING.

- Fit tool to coupling so tool can enter cage to release garter spring.
- Push the tool into the cage opening to release female fitting from garter spring.
- Pull the coupling male and female fittings apart.

REMOVAL AND INSTALLATION (Continued)

- d. Remove the tool from the disconnected coupling.

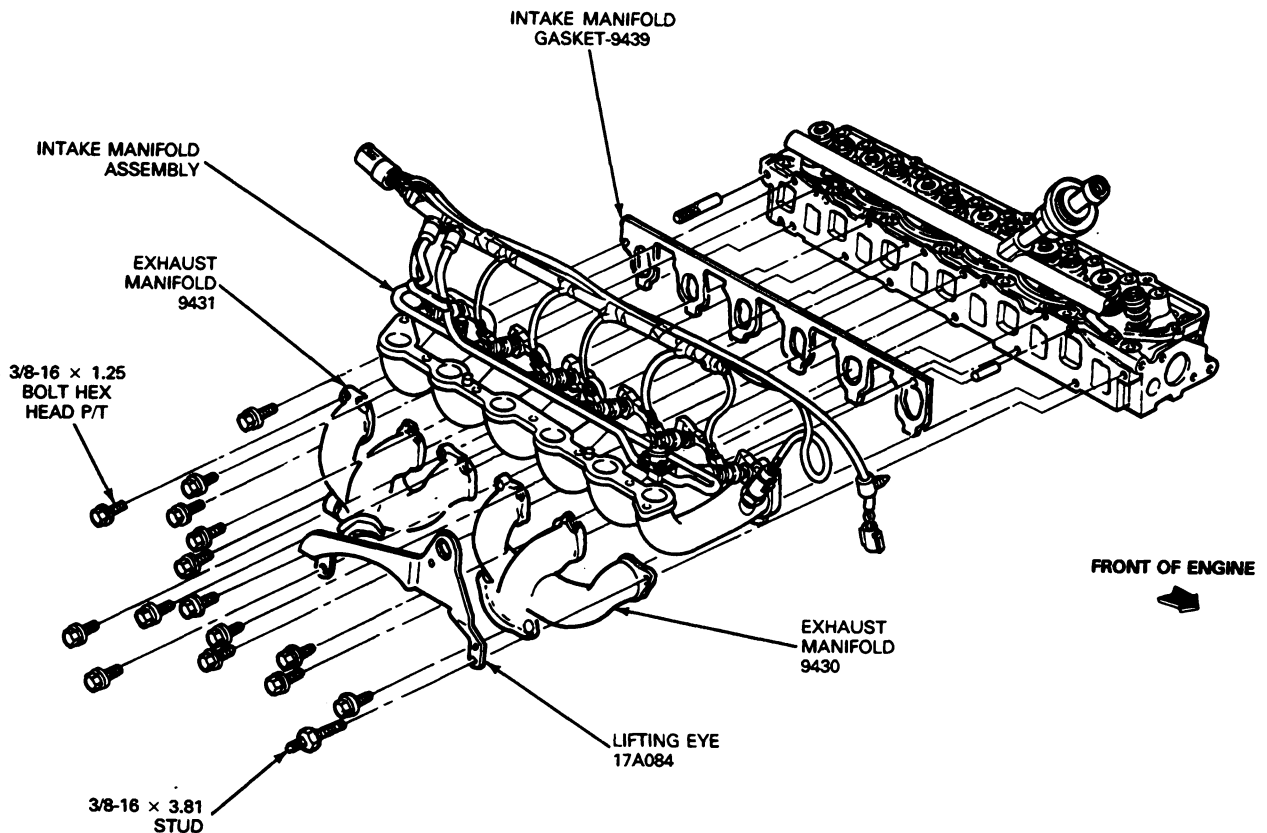


V4803-D

17. Remove 16 bolts attaching both the lower intake manifold and the exhaust manifolds to the cylinder head. Do **not** remove the bolts that attach only the exhaust manifolds.
18. Remove the lower intake manifold assembly from the cylinder head.

REMOVAL AND INSTALLATION (Continued)

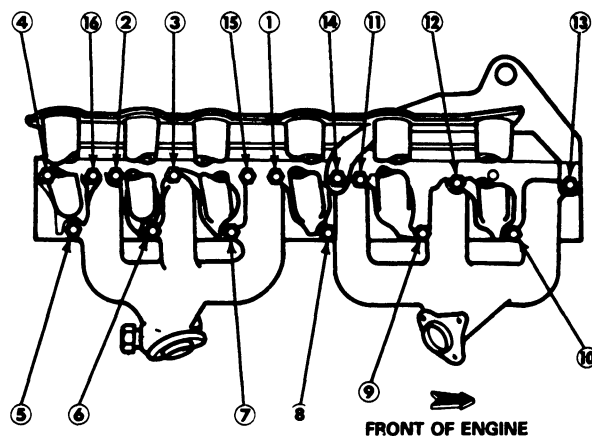
Intake and Exhaust Manifold Installation



V5849-2D

Installation

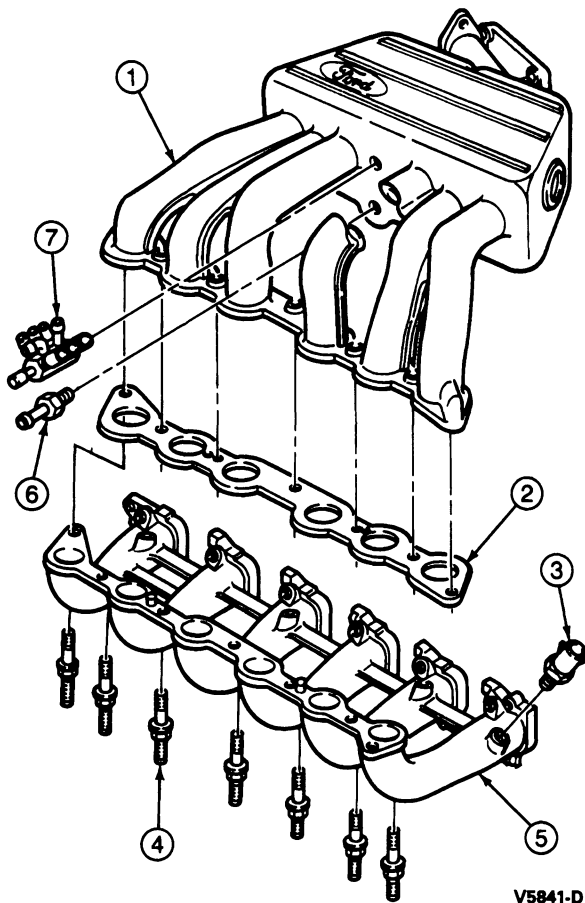
1. Clean and inspect the mounting faces of the lower intake manifold and the cylinder head. Both surfaces must be clean and flat.
2. Clean and oil manifold bolt threads.
3. Position the lower intake manifold and a new gasket to the cylinder head, and install the attachment bolts. Tighten the bolts to 30-43 N·m (22-32 ft-lb) in the sequence shown.



A10704-1A

4. Position the vacuum harness, then attach the vacuum connection to the fuel pressure regulator.
5. Install a new upper intake gasket on the lower manifold, using the lower manifold dowels to position the gasket.

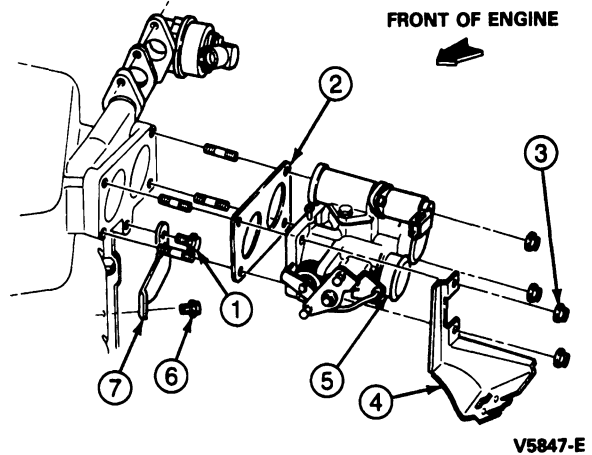
REMOVAL AND INSTALLATION (Continued)



Item	Part Number	Description
1	9424	Upper Intake Manifold
2	9H486	Gasket
3	12A967	Intake Air Temperature Sensor
4	—	Stud (7 Req.) 5/ 16-18 x 2.505 16-24 N-m (12-18 Ft-Lb)
5	9K641	Lower Intake Manifold
6	390659-S100	PCV Connector
7	9D446	Vacuum Tree

TV5841A

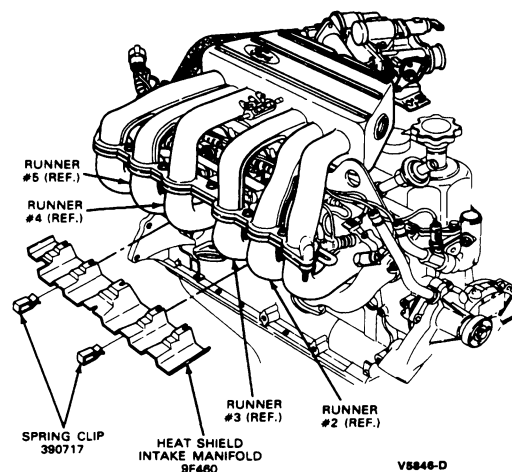
6. Position the upper intake manifold onto the lower intake manifold, using the dowels of the lower intake to locate manifold holes. Install the seven studs attaching the upper intake to the lower intake manifold and hand-tighten. Then tighten the studs to 16-24 N-m (12-18 ft-lb).
7. Position the upper intake manifold support bracket onto the boss of the upper intake, located under the throttle body. Install the retaining screw and tighten to 29.8-43.8 N-m (22-32 ft-lb).



Item	Part Number	Description
1	390757	Screw and Washer Assembly 7 / 16-14 x 1.5 30-43 N-m (22-32 Ft-Lb)
2	9E936	Gasket
3	45357	Nut 5/ 16-18 19-27 N-m (14-20 Ft-Lb)
4	9728	Bracket, Accelerator Cable
5	9E926	Throttle Body Assembly
6	56139	Screw and Washer Assembly 3/8-16 x .88 30-43 N-m (22-32 Ft-Lb)
7	9J444	Support Bracket

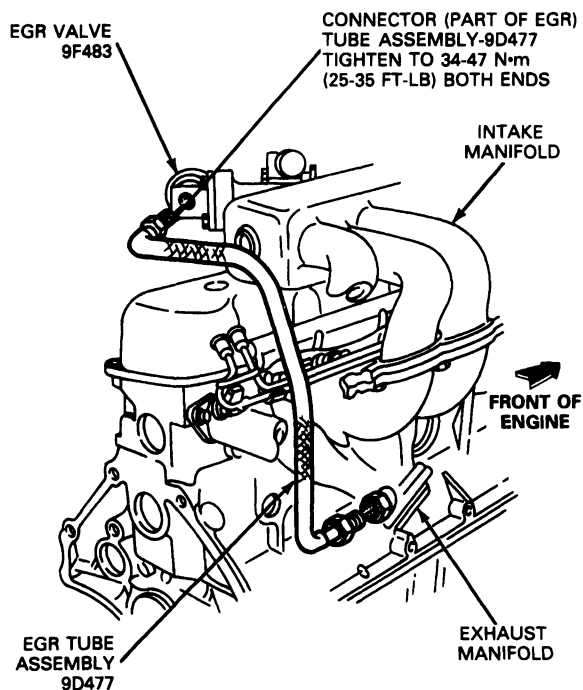
TV5847A

8. Install the injector heat shield between the lower intake manifold and the exhaust manifolds. Secure the shield to the lower intake manifold by installing the two spring clips between the intake runners.



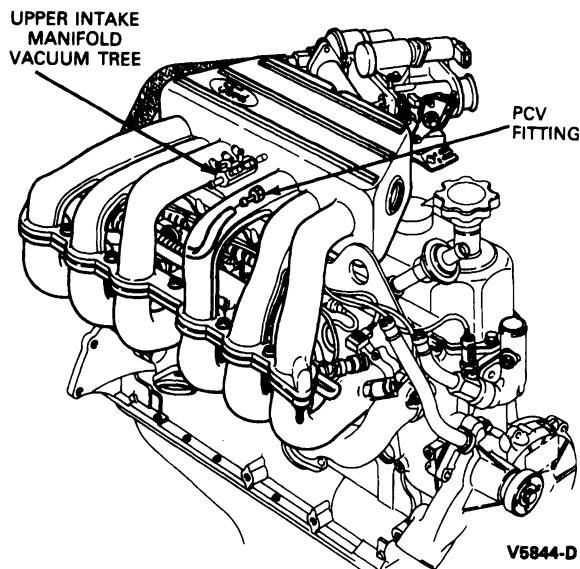
REMOVAL AND INSTALLATION (Continued)

9. Install the EGR tube between the EGR valve and the rear exhaust manifold. The tube is routed between lower intake runners No. 4 and No. 5. Tighten both fittings to 33.8-47.5 N·m (25-35 ft-lb).



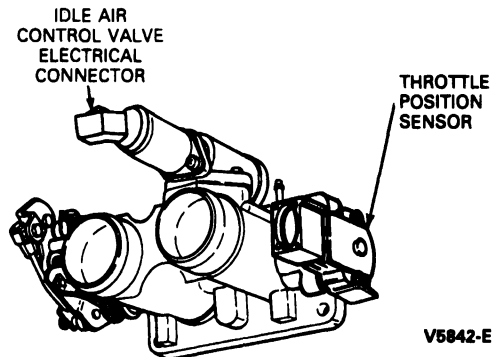
V5845-B

10. Connect the PCV hose to the fitting, located on the underside of the upper intake manifold.



V5844-D

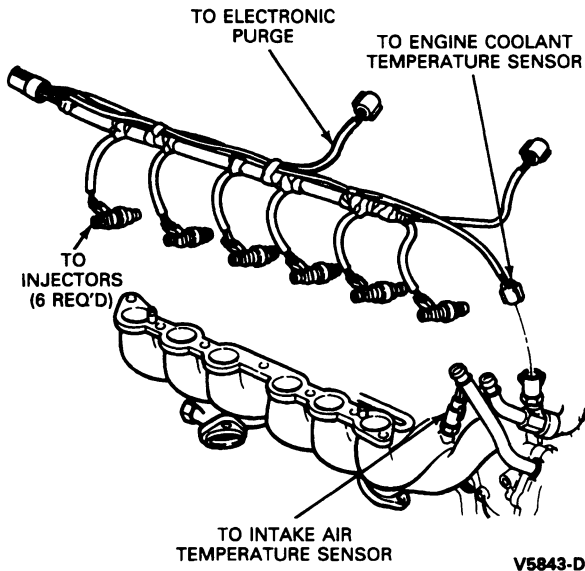
11. Position the secondary air bypass tube assembly onto the studs of the lower intake manifold. Tighten the attachment nuts to 11-16 N·m (8-12 ft-lb).
12. For E-Series applications, position the transmission fill tube onto the stud of the lower intake manifold. Tighten the attachment nut to 11-16 N·m (8-12 ft-lb).
13. Install the accelerator cable and throttle linkage shield onto the accelerator bracket of the throttle body.
14. Connect the air inlet hoses to the throttle body.
15. Connect the following vacuum connections:
- vacuum line to the EGR valve.
 - vacuum lines to the secondary air bypass valve.
 - Evaporative Emissions Shed System (EESS) evaporative lines to the throttle body.
 - vacuum line to fuel pressure regulator.
 - vacuum lines to the upper intake manifold vacuum tree.
16. Connect the following electrical connectors at:
- throttle position sensor.
 - idle air control valve.



V5842-E

REMOVAL AND INSTALLATION (Continued)

- EVP sensor.
- injector wiring harness to main engine harness.
- electronic purge (if equipped).



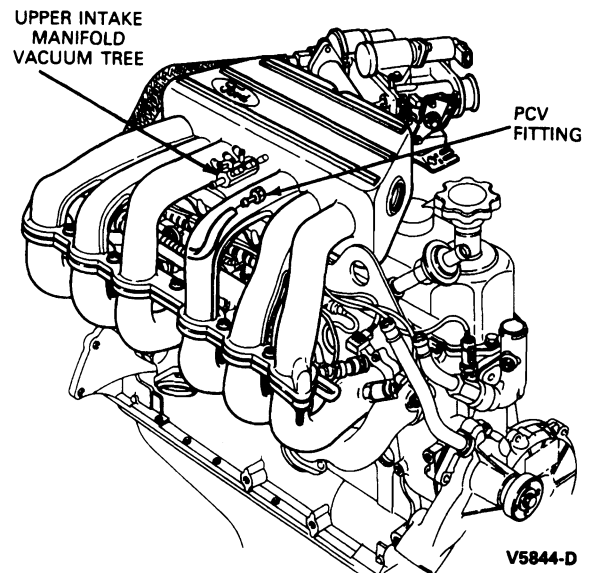
17. Connect air intake hose, air bypass hose, and crankcase vent hose.
18. Connect battery ground cable.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
19. Check and fill radiator. Refer to Section 03-03.
20. Replace fuel pressure relief cap. Build up fuel pressure as follows: without starting the engine, turn ignition switch back and forth at least six times from on to off position, leaving ignition on for five seconds each time. Check for fuel leaks.
21. Start engine and allow to run at idle until engine temperature stabilizes. Check for cooling system leaks.
22. Use Rotunda NGS Scan Tool 007-00500 or equivalent, with EEC self-test connector to check proper powertrain control module system operation. Refer to the Powertrain Control / Emission Diagnosis Manual.²
23. Verify correct engine idle.

² Can be purchased as a separate item.

Upper Intake Manifold and Throttle Body Assembly

Removal

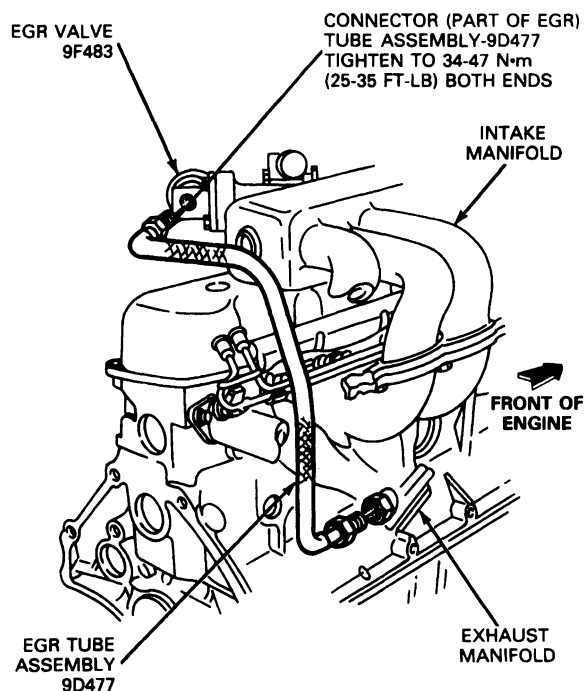
1. Disconnect the electrical connectors at:
 - EVP sensor, located on the EGR valve.
 - throttle position sensor.
 - idle air control valve.
2. Disconnect the following vacuum connections:
 - vacuum line at the EGR valve.
 - Evaporative Emissions Shed System (EESS) evaporative lines to the throttle body and electronic purge, if equipped.
 - vacuum lines to the upper intake manifold vacuum tree. Labeling the hose locations with tape is recommended to aid installation.



3. Disconnect the PCV hose from the fitting, located on the underside of the upper intake manifold.
4. Remove the throttle linkage shield, and disconnect the throttle linkage and speed control cables. Unbolt the accelerator cable from the bracket and position the cable away from the engine.
CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the ball stud to pry off. Removing by hand may damage the cable.
5. Disconnect the air inlet hoses from the throttle body.

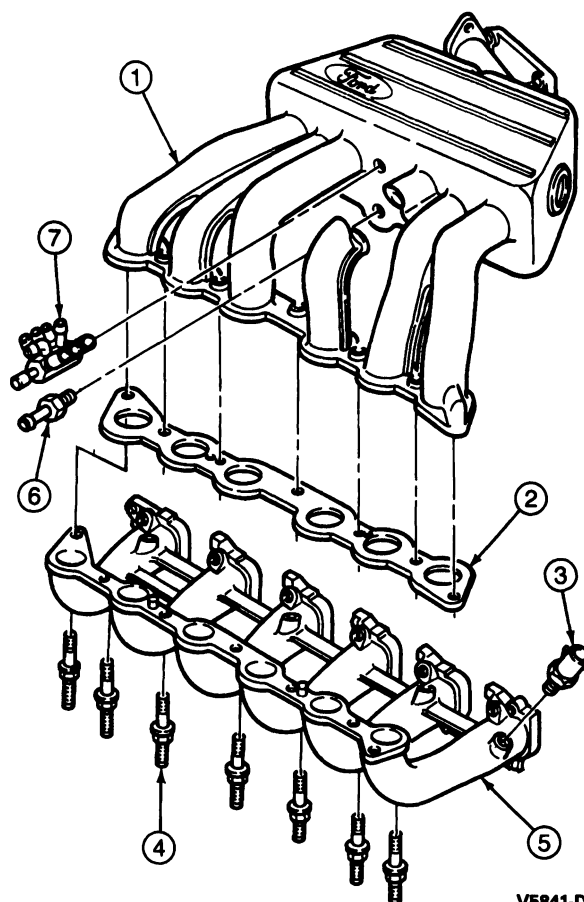
REMOVAL AND INSTALLATION (Continued)

6. Disconnect the EGR tube from the EGR valve and the rear exhaust manifold. Remove the tube from the engine.



V5845-B

7. Remove the secondary air bypass tube assembly from the lower intake manifold by removing the two nuts retaining the tube. Remove the nut attaching the secondary air bypass valve bracket to the lower intake manifold.
8. For E-Series applications only, remove the nut attaching the transmission fill tube. Then remove the tube bracket off the intake manifold stud.
9. Remove the seven studs that retain the upper intake manifold.



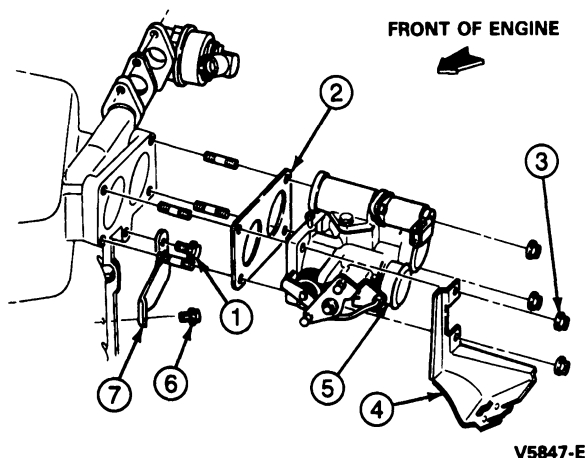
V5841-D

Item	Part Number	Description
1	9424	Upper Intake Manifold
2	9H486	Gasket
3	12A967	Intake Air Temperature Sensor
4	—	Stud (7 Req.) 5 / 16-18 x 2.505 16-24 N·m (12-18 Ft-Lb)
5	9K641	Lower Intake Manifold
6	390659-S100	PCV Connector
7	9D446	Vacuum Tree

TV5841A

10. Remove the screw and washer assembly attaching the upper intake manifold support bracket to the upper intake manifold.
11. Remove the upper intake manifold and throttle body assembly from the lower intake manifold.

REMOVAL AND INSTALLATION (Continued)



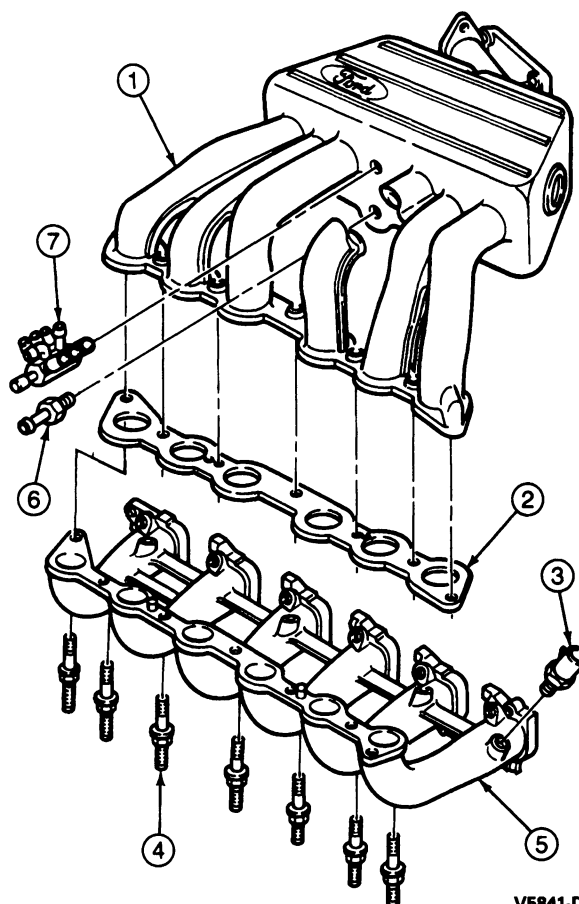
V5847-E

Item	Part Number	Description
1	390757	Screw and Washer Assembly 7 / 16-14 x 1.5 30-43 N·m (22-32 Ft-Lb)
2	9E936	Gasket
3	45357	Nut 5 / 16-18 19-27 N·m (14-20 Ft-Lb)
4	9728	Bracket, Accelerator Cable
5	9E926	Throttle Body Assembly
6	56139	Screw and Washer Assembly 3 / 8-16 x .88 30-43 N·m (22-32 Ft-Lb)
7	9J444	Support Bracket

TV5847A

Installation

1. Position a new upper intake gasket on the lower manifold, using the lower manifold dowels to position the gasket.



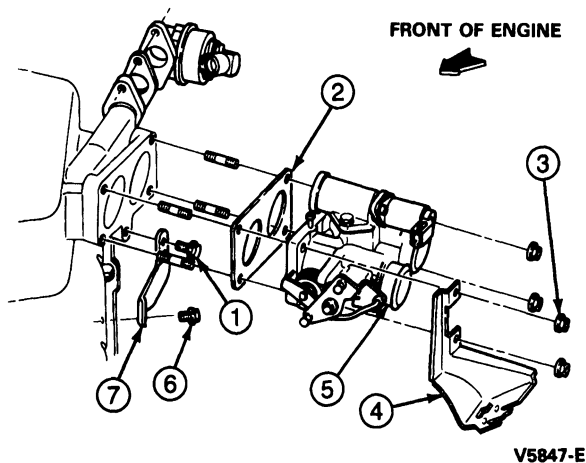
V5841-D

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4	—	Stud (7 Req.) 5 / 16-18 x 2.505 16-24 N·m (12-18 Ft-Lb)
5	9K641	Lower Intake Manifold
6	390659-S100	PCV Connector
7	9D446	Vacuum Tree

TV5841A

2. Position the upper intake manifold onto the lower intake manifold, using the dowels of the lower intake to locate manifold holes. Install the seven studs to attach the upper intake to the lower intake manifold and hand-tighten.
3. Tighten the seven studs attaching the upper intake to the lower intake manifold to 16-24 N·m (12-18 ft-lb).
4. Position the upper intake manifold support bracket onto the boss of the upper intake, located under the throttle body. Install the retaining screw and tighten to 30-43 N·m (22-32 ft-lb).

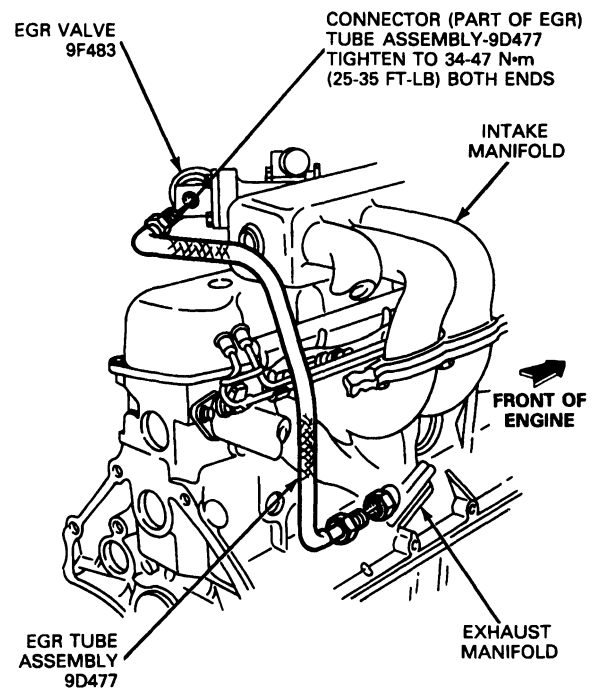
REMOVAL AND INSTALLATION (Continued)



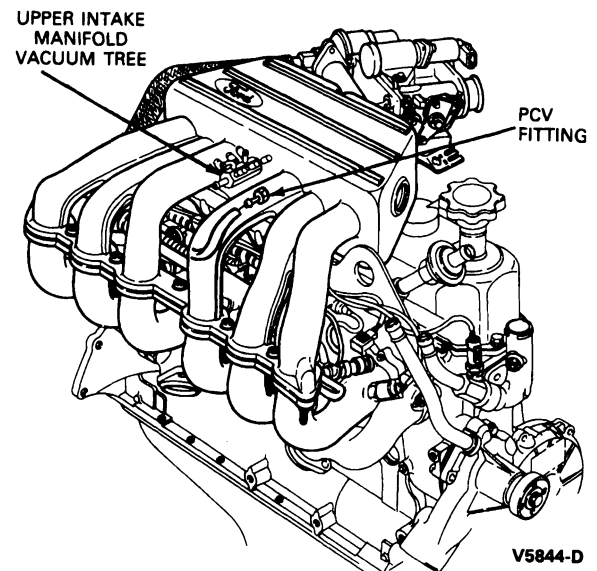
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6	56139	Screw and Washer Assembly 3 / 8-16 x .88 30-43 N·m (22-32 Ft-Lb)
7	9J444	Support Bracket

TV5847A

5. Install the EGR tube between the EGR valve and the rear exhaust manifold. The tube is routed between lower intake runners No. 4 and No. 5. Tighten both fittings to 34-47 N·m (25-35 ft-lb).



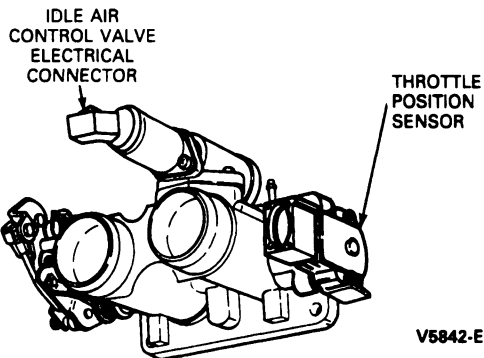
6. Connect the PCV hose to the fitting, located on the underside of the upper intake manifold.



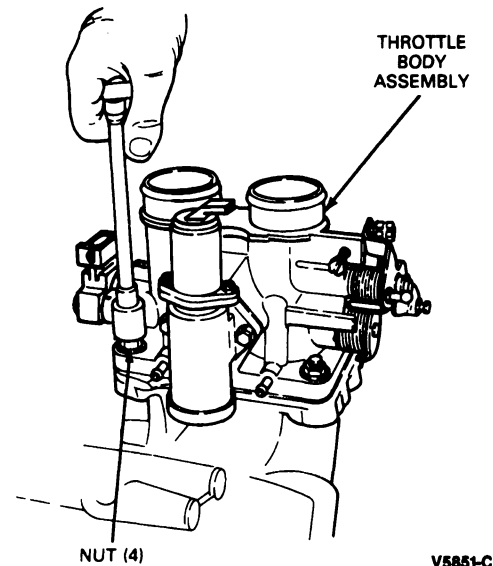
7. Position the secondary air bypass tube assembly onto the studs of the lower intake manifold, and tighten the attachment nuts to 11-16 N·m (8-12 ft-lb).
8. For E-Series applications, position the transmission fill tube onto the stud of the lower intake manifold. Tighten the attachment nut to 11-16 N·m (8-12 ft-lb).

REMOVAL AND INSTALLATION (Continued)

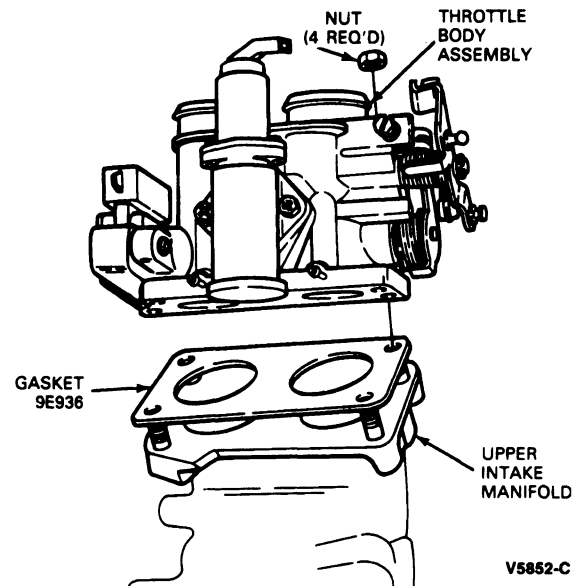
9. Install the accelerator cable and throttle linkage shield onto the accelerator bracket of the throttle body.
10. Connect the air inlet hoses to the throttle body.
11. Connect the following vacuum connections:
 - vacuum line to the EGR valve.
 - Evaporative Emission Shed System (EESS) evaporative lines to the throttle body.
 - vacuum lines to the upper intake manifold vacuum tree.
12. Connect the following electrical connectors at:
 - throttle position sensor.
 - idle air control valve.
 - EVP sensor.
 - electronic purge valve, if equipped.

**Air Intake Throttle Body****Removal**

1. Disconnect throttle position sensor and idle air control valve connectors.
 2. Disconnect throttle linkage shield, throttle cable, and speed control cable.
- CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the ball stud to pry off. Removing by hand may damage the cable.**
3. Disconnect the air inlet hoses from the throttle body.
 4. Disconnect the EESS harness from the purge ports of the throttle body.
 5. Remove four throttle body nuts.



6. Carefully separate air throttle body and accelerator bracket from upper intake manifold.
7. Remove and discard gasket between throttle body and upper intake manifold.

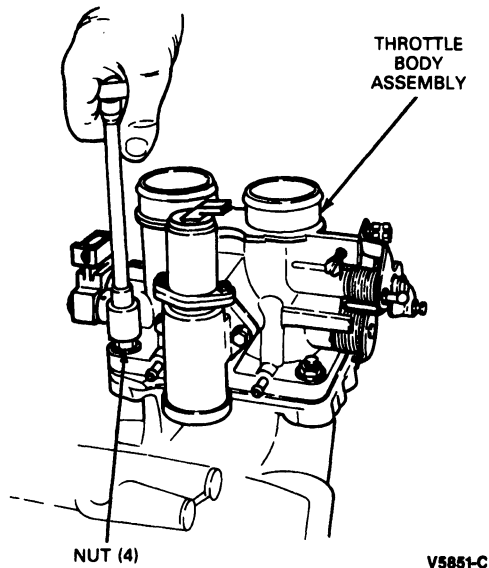
**Installation**

1. Make sure that both throttle body and upper intake manifold gasket surfaces are clean.

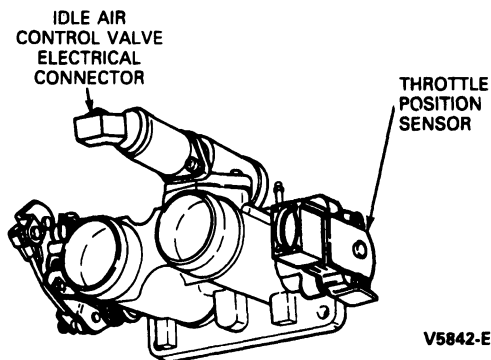
NOTE: If scraping is necessary, be careful not to damage gasket surfaces of throttle body and upper manifold assemblies, or allow material to drop into manifold.
2. Install a new (9E936) throttle body gasket on the four studs of the upper intake manifold.
3. Position the accelerator bracket onto the throttle body.
4. Install throttle body to upper intake manifold.

REMOVAL AND INSTALLATION (Continued)

- Secure throttle body assembly to upper intake manifold with four retaining nuts. Tighten to 16-24 N·m (12-18 ft-lb).



- Connect idle air control valve and throttle position sensor electrical connectors.

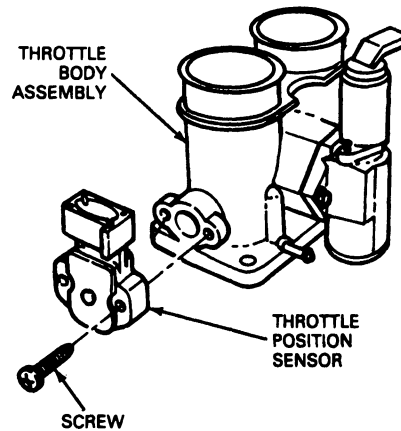


- Connect the EESS harness to the purge ports of the throttle body.
- Connect the throttle linkage and cables to the throttle body and accelerator bracket.
- Connect the air inlet hoses to the throttle body.

Throttle Position Sensor

Removal

- Disconnect throttle position sensor from wiring harness.



- Remove two retaining screws.
- Remove throttle position sensor.

Installation

- Position the throttle position sensor so that the connector points opposite the air valve. Then, rotate throttle position sensor clockwise to align scribe marks.

CAUTION: Slide rotary tangs into position over throttle shaft blade, then rotate throttle position sensor **CLOCKWISE ONLY** to installed position. Failure to install the throttle position sensor in this manner may result in excessive idle speeds.

- Secure sensor to throttle body assembly with two retaining screws. Tighten to 2-3 N·m (18-27 in-lb).

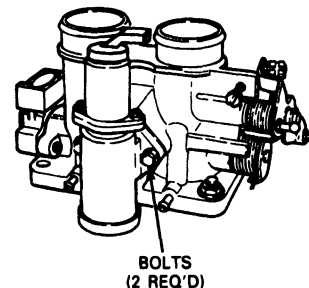
NOTE: When throttle position sensor is installed on the throttle body, the connector will point toward the throttle body inlet.

- Connect electrical connector to harness.

Idle Air Control Valve Assembly

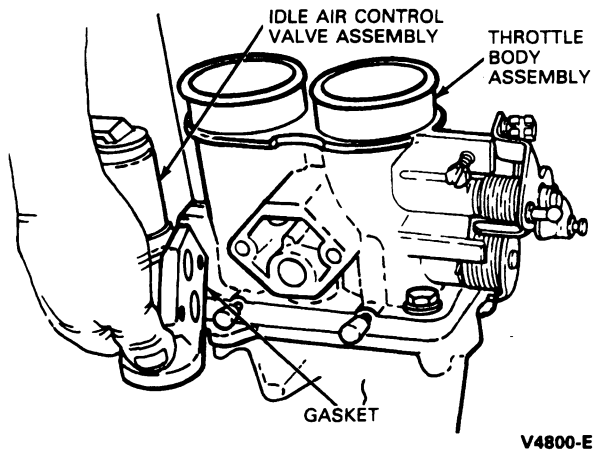
Removal

- Disconnect the idle air control valve assembly connector from the wiring harness.
- Remove the two idle air control valve retaining bolts.

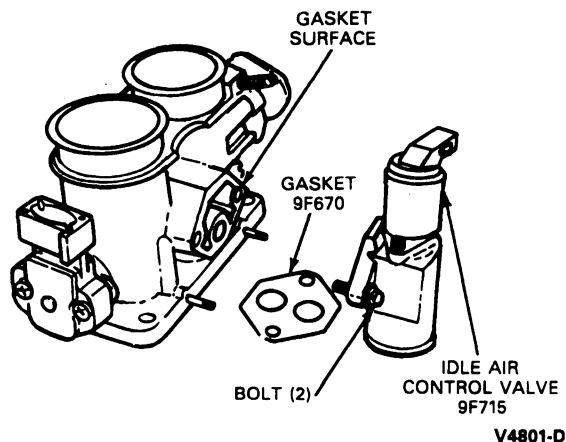


REMOVAL AND INSTALLATION (Continued)

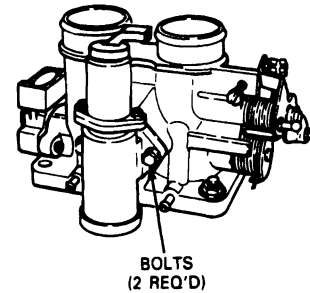
3. Remove the idle air control valve and gasket.

**Installation**

1. Make sure that both throttle body and idle air control valve gasket surfaces are clean.
NOTE: If scraping is necessary, be careful not to damage idle air control valve or throttle body gasket surfaces, or drop material into throttle body.
2. Install gasket and idle air control valve on throttle body surfaces.



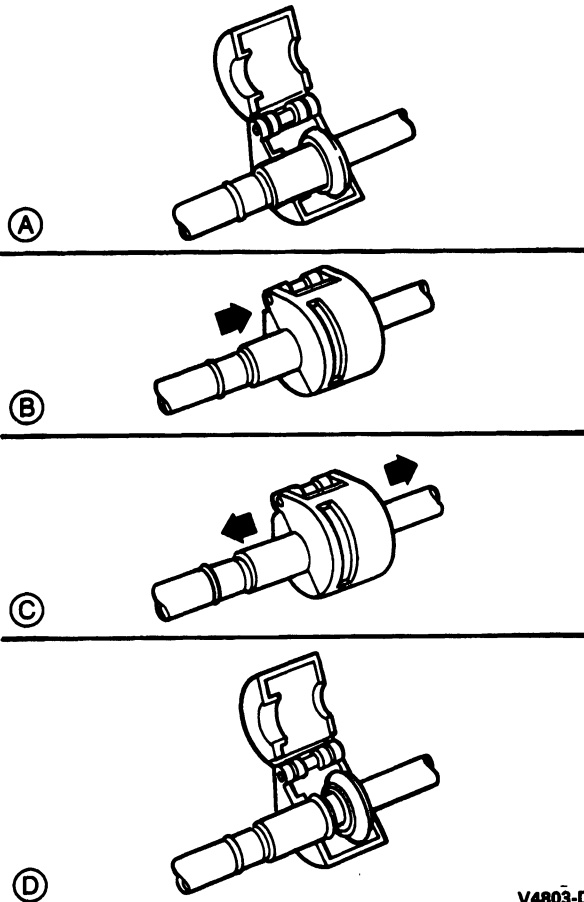
3. Install retaining screws. Tighten to 8-11 N·m (71-97 in·lb).
4. Connect electrical connector for the idle air control valve.

**Fuel Supply Manifold Assembly****Removal**

1. Remove the upper intake manifold assembly as outlined in this section.
2. Disconnect fuel line retaining clips.
WARNING: RELIEVE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING COUPLING.
3. Using Disconnect Tool D87L-9280-A or -B or equivalents disconnect fuel hoses at the fuel rail supply tube and fuel rail return tube.
 - a. Fit tool to coupling so tool can enter cage to release garter spring.
 - b. Push the tool into the cage opening to release female fitting from garter spring.
 - c. Pull the coupling male and female fittings apart.

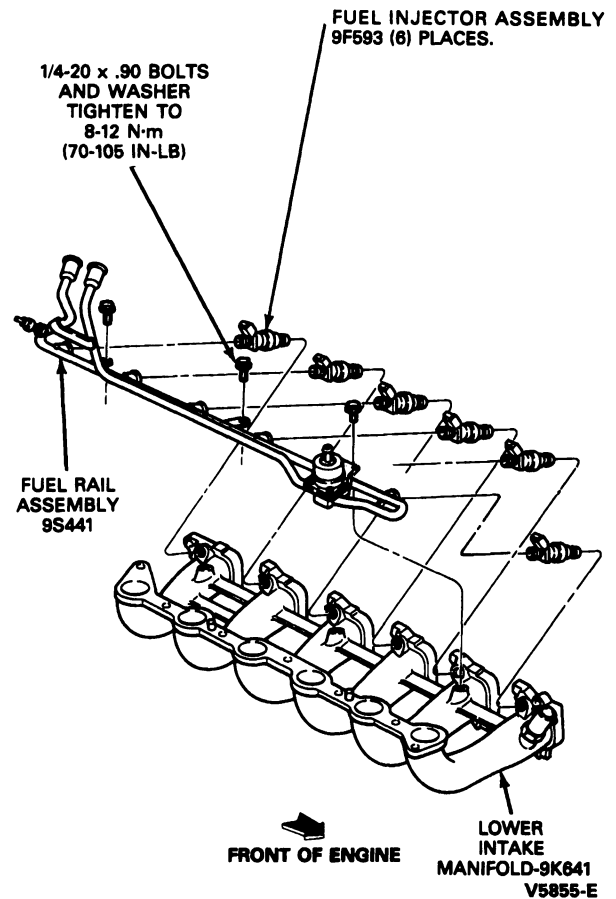
REMOVAL AND INSTALLATION (Continued)

- d. Remove the tool from the disconnected coupling.



V4803-D

4. Disconnect the vacuum line to the fuel pressure regulator.
5. Remove the strap surrounding the fuel manifold, injector electrical harness, and the main vacuum harness.
6. Remove the three fuel supply manifold retaining studs.
7. Remove fuel supply manifold.
8. Grasp injector body and pull up while gently rocking injector from side to side, to remove fuel injector.

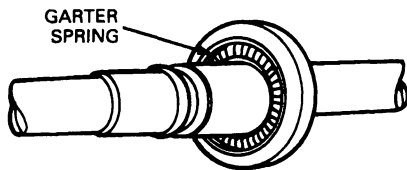
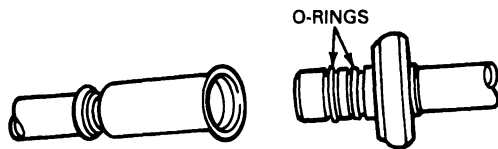
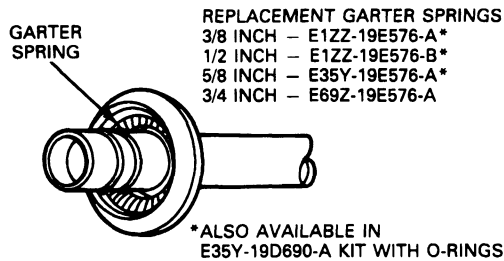


Installation

1. Make sure injector caps are clean and free of contamination.
2. Install the injectors into the fuel rail first to avoid damage to the O-rings.
3. Secure the fuel supply manifold assembly using the three retaining bolts. Tighten to 8-12 N·m (70-105 in-lb).
4. Attach the vacuum line to the fuel pressure regulator.
5. Secure the main vacuum harness and the injector electrical harness to the fuel supply manifold with a strap positioned between the No. 5 and No. 6 intake manifold runners.
6. Connect the electrical connector to the electronic purge valve, if equipped.
7. Connect the fuel inlet and outlet lines at the fuel rail connections. Refer to the following illustration.
 - a. Check for missing or damaged garter spring. Remove damaged spring with small hooked wire.
 - b. Install new spring if damaged or missing.
 - c. Clean fittings.
 - d. Install new O-rings.
 - e. Lubricate with clean engine oil.

REMOVAL AND INSTALLATION (Continued)

- f. Assemble fitting by pushing with a slight twisting motion.
- g. To ensure coupling engagement visually check to be sure garter spring is over flared end of female fitting.
8. Connect fuel line retaining clips.
9. Install the upper intake manifold as outlined.

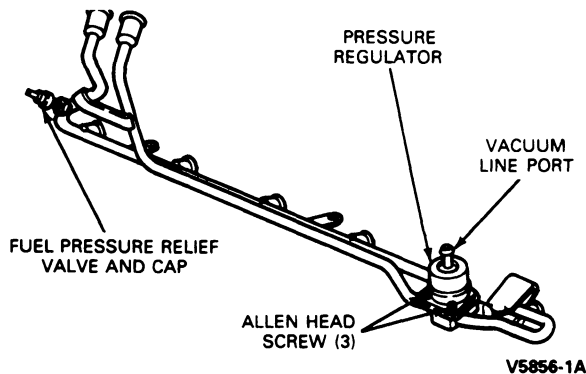


V5908-C

Fuel Pressure Regulator

Removal

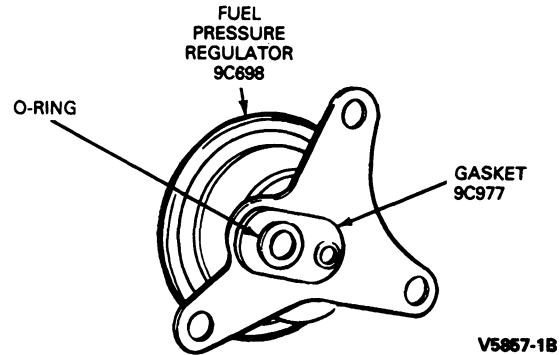
1. Make sure assembly is depressurized by removing fuel filler cap and opening the pressure relief valve on the fuel line in the upper right corner of the engine compartment. Use Fuel Pressure Gauge T80L-9974-B. Refer to Pre-Service Procedures.



V5856-1A

2. Remove vacuum line at pressure regulator.
3. Remove three Allen screws from regulator housing.
4. Remove pressure regulator assembly, gasket and O-ring. Discard gasket and inspect O-ring for signs of cracks or deterioration.

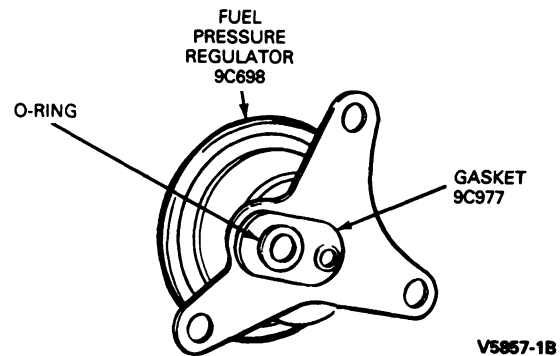
NOTE: If scraping is necessary, be careful not to damage fuel pressure regulator or fuel supply line gasket surfaces.



V5857-1B

Installation

1. Make sure gasket surfaces of fuel pressure regulator and fuel injection manifold are clean.
CAUTION: Never use silicone grease. It will clog the injectors.
2. Lubricate fuel pressure regulator O-ring with light oil 10W-30 (WSE-M2C903-A2) or equivalent.
3. Install O-ring and new gasket on regulator.

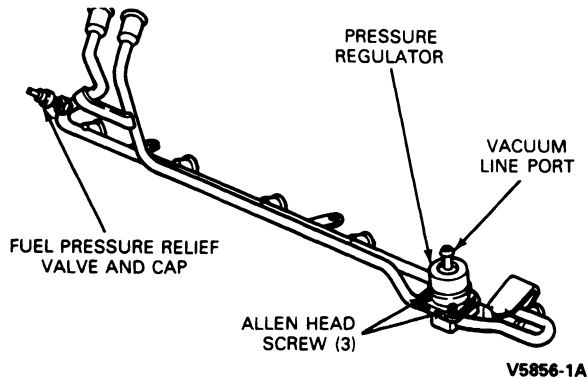


V5857-1B

4. Install fuel pressure regulator on injector manifold. Tighten three Allen screws to 3-5 N·m (27-44 in-lb).
5. Install vacuum line at pressure regulator.

REMOVAL AND INSTALLATION (Continued)

6. Perform Post-Service Procedures as outlined.

**Pressure Relief Valve****Removal**

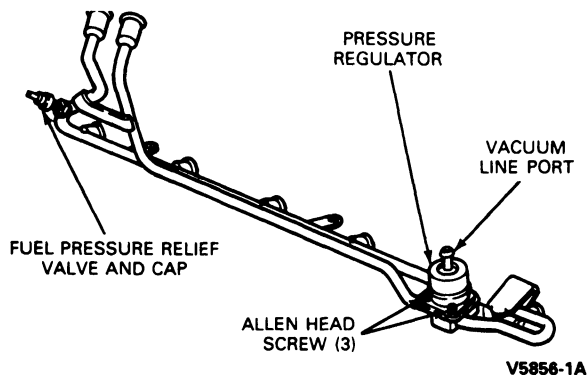
1. If the fuel charging assembly is mounted to the engine, remove fuel filler cap and release pressure from the system by opening the pressure relief valve on the fuel line in the upper right corner of the engine compartment. Use Fuel Pressure Gauge T80L-9974-B. Refer to Pre-Service Procedures.

NOTE: The cap on the relief valve must be removed.

2. Using an open-end wrench, remove pressure relief valve from fuel line.

Installation

1. Install pressure relief valve and cap. Tighten valve to 6-10 N·m (53-88 in-lb). Install and securely tighten cap.

**Fuel Injection Wiring Harness****Removal**

NOTE: Make sure ignition is in OFF position and fuel system is depressurized. Refer to Pre-Service Procedures.

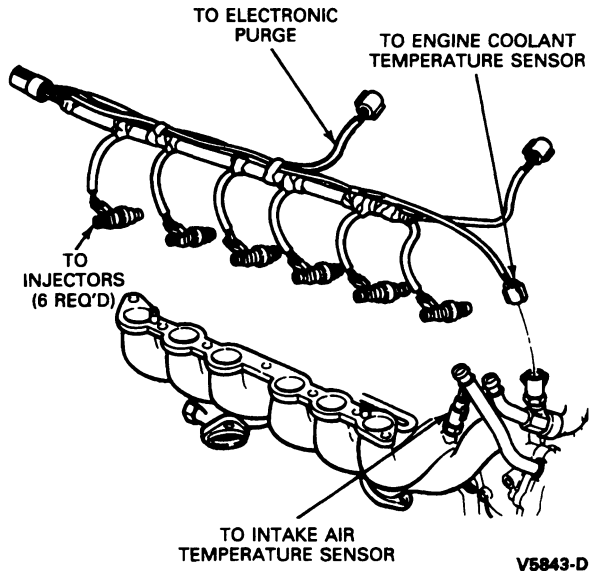
1. Disconnect electrical connectors from all six fuel injectors.
2. Disconnect connector from main wiring harness.
3. Disconnect electrical connectors at electronic purge valve (if equipped), intake air temperature sensor and coolant temperature switch.
4. Remove wiring assembly.

Installation

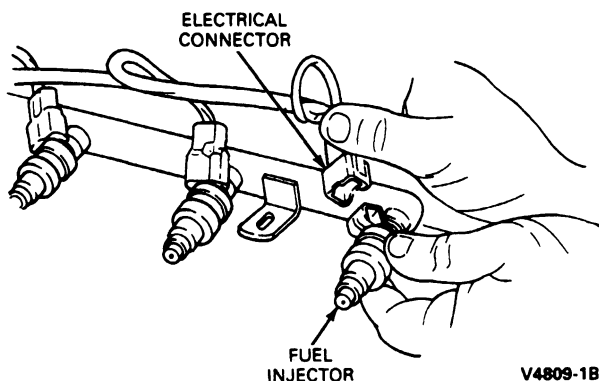
1. Position wiring harness alongside the fuel injectors.
2. Snap electrical connectors into position on all six injectors.
3. Connect main harness connector.
4. Connect electrical connectors at fuel temperature switch, intake air temperature sensor and coolant temperature switch.
5. Verify that all electrical connectors are firmly seated.
6. Perform all Post-Service Procedures as outlined.

REMOVAL AND INSTALLATION (Continued)

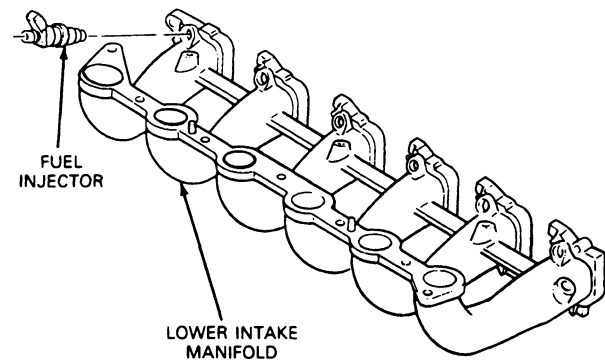
7. Use NGS Scan Tool 007-00500 or equivalent with EEC self-test connector and procedure to check for sensor function. Refer to the Powertrain Control / Emission Diagnosis Manual.³

**Fuel Injector****Removal**

1. Perform all Pre-Service Procedures as outlined.
2. Remove upper intake manifold as outlined.
3. Carefully remove electrical harness connectors from individual injectors as required.
4. Remove fuel supply manifold as outlined.

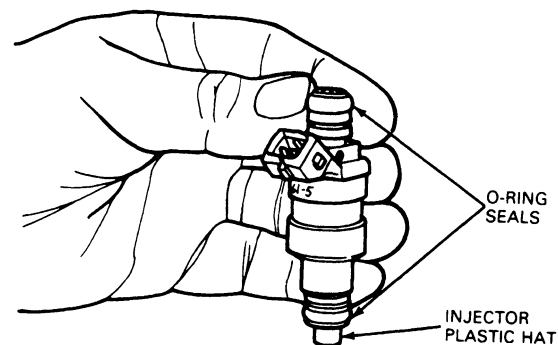


5. Grasping injector body, pull up while gently rocking injector from side-to-side.



V5858-1A

6. Inspect injector O-rings (two per injector) for signs of deterioration. Replace as required.



V5040-1A

Installation

1. Lubricate new O-rings with light grade oil 10W-30 (WSE-M2C903-A2) or equivalent and install two on each injector.

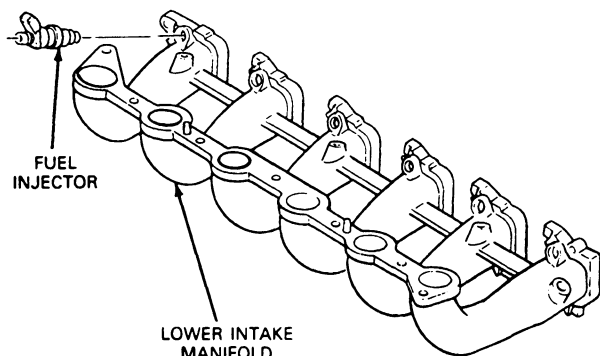
CAUTION: Never use silicone grease. It will clog the injectors.

2. Install injector(s) using a light, twisting, pushing motion.

³ Can be purchased as a separate item.

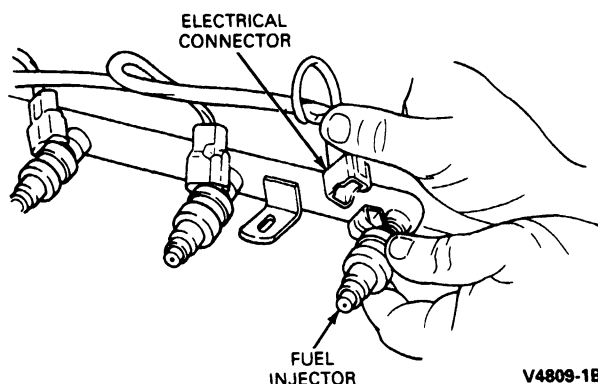
REMOVAL AND INSTALLATION (Continued)

3. Install fuel supply manifold as outlined.



V5858-1A

4. Install electrical harness connectors to injectors.
5. Install upper intake manifold as outlined. Perform all Post-Service Procedures as outlined.



V4809-1B

2. Remove the air duct to the throttle body inlet.
3. Disconnect the idle air control valve signal lead.
4. Attach the Rotunda Idle Air Control Valve Actuator 113-00009 or equivalent plug to the idle air control valve.
5. Start the actuator and then start the engine.
CAUTION: Do not start engines that have air flow meters.
6. Spray Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A) or equivalent for about five seconds into the inlet passage while the actuator is operating.
CAUTION: Avoid direct spraying on throttle plate/bore area.
7. Stop the engine and actuator. Let everything soak for 15 minutes.
8. Start the actuator and then start the engine.
CAUTION: Do not start engines that have air flow meters.
9. Spray the Carburetor Tune-Up Cleaner into the idle air control valve passage leading to the inlet of the valve for up to one minute.
CAUTION: Do not spray for longer than six continuous seconds on engines that have air flow meters and are not running.
10. Stop the actuator and stop the engine if running.
11. Reinstall the air duct.
12. Start and run the engine for about one minute to dry out the solvent residue.
13. Operate the actuator to make sure the solvent is purged from the idle air control valve.
14. Disconnect the actuator from the idle air control valve.
15. Reattach the control signal lead to the idle air control valve.
16. Check the engine for normal operation.

Alternate Cleaning Procedure

NOTE: Method to be used only when the Rotunda Fuel Injector Tester / Cleaner 113-00001 and Idle Air Control Valve Actuator 113-00009 or equivalents for the recommended method are not available.

Remove the idle air control valve from the throttle body assembly. Remove the electrical solenoid assembly from the mechanical portion of the idle air control valve by removing the two screws, then sliding the mechanical portion away from the solenoid.

Soak the mechanical portion in Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A) or equivalent for two to three minutes maximum.

CAUTION: Do not exceed three minutes soak time, and do not use choke cleaner as an internal O-ring may begin to deteriorate.

CLEANING AND INSPECTION

Throttle Body Assembly

NOTE: The throttle body is a sludge resistant design and should not be cleaned.

Idle Air Control Valve

Recommended Cleaning Procedure

CAUTION: This cleaning procedure may be used with sludge tolerant bodies which are identified with a yellow/black "attention" label. No attempt should be made to clean the throttle body bore/plate area by directly spraying or scrubbing. Do not run vehicles with air flow meters during the cleaning procedure.

1. Plug the Rotunda Idle Air Control Valve Actuator 113-00009 or equivalent into the Rotunda Fuel Injector Tester / Cleaner 113-00001 or equivalent.

CLEANING AND INSPECTION (Continued)

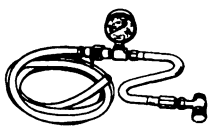
With the mechanical portion completely submerged, shake in all directions: up, down, right and left. Then push in on the rod that mates with the solenoid assembly, and again shake in all directions with the unit submerged and the rod held in as far as possible.

Remove the unit from the cleaning fluid and dry out thoroughly using shop air.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Lb-Ft
Lower Intake Manifold to Head	30-43	22-32
EGR Tube	34-47	25-35
EGR Valve to Upper Intake Manifold	18-26	13-19
Upper Intake Manifold to Lower Intake Manifold Bolts	16-24	12-18
Throttle Body to Upper Intake Manifold	16-24	12-18
Idle Air Control Valve to Throttle Body	8-11	71-97 In-Lb
Throttle Position Sensor to Throttle Body	2-3	18-27 In-Lb
Fuel Pressure Regulator to Fuel Supply Manifold	3-4	27-44 In-Lb
Fuel Supply Manifold to Fuel Charging Assembly	16-20	12-15
Coil Bracket to Block	16-24	12-18
Throttle Cable Bracket to Throttle Body	16-24	12-18
Support Bracket	30-43	22-32
Thermactor Tube Retainer Nuts	11-16	8-12
Transmission Fill Tube Retainer Nut	11-16	8-12
Fuel Supply Manifold-to-Lower Intake Manifold Retainer Bolts	8-12	70-105 In-Lb
Pressure Relief Valve	6-10	53-88 In-Lb

SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number/ Description	Illustration
T80L-9974-B Fuel Pressure Test Gauge	 T80L-9974-B

Tool Number	Description
D87L-9280-A	Disconnect Tool, 1/2 Inch
D87L-9280-B	Disconnect Tool, 3/8 Inch

ROTUNDA EQUIPMENT

Tool Number	Description
007-00041-B	SUPER STAR II
113-00001	Injector Cleaner / Tester
113-00009	Air Bypass Actuator
007-00500	NGS Scan Tool

SECTION 03-04C Fuel Charging and Controls, 7.5L

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		REMOVAL AND INSTALLATION (Cont'd.)	
Idle Air Control Valve	03-04C-14	Fuel Injector	03-04C-14
DESCRIPTION AND OPERATION		Fuel Pressure Regulator	03-04C-13
Air Intake Manifold	03-04C-3	Fuel Supply Manifold Assembly	03-04C-12
Fuel Injectors	03-04C-3	Idle Air Control Valve Assembly	03-04C-12
Fuel Pressure Regulator	03-04C-4	Lower Intake Manifold	03-04C-8
Fuel Supply Manifold Assembly	03-04C-5	Post-Service Procedures	03-04C-6
Idle Air Control Valve Assembly	03-04C-4	Pre-Service Procedures	03-04C-6
Throttle Body Assembly	03-04C-4	Throttle Position (TP) Sensor	03-04C-11
DIAGNOSIS AND TESTING		Upper Intake Manifold and Throttle Body	03-04C-6
Tips to Avoid Lean Air-Fuel Conditions	03-04C-5	SPECIAL SERVICE TOOLS/EQUIPMENT	03-04C-16
REMOVAL AND INSTALLATION		SPECIFICATIONS	03-04C-15
Air Intake Throttle Body	03-04C-10	VEHICLE APPLICATION	03-04C-1

VEHICLE APPLICATION

E-350, F-250-350 and F-Super Duty Vehicles
Equipped with 7.5L MFI V-8 Engines

DESCRIPTION AND OPERATION

The multiport fuel injection system (MFI) is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered into each intake port in a sequential firing order. Injectors pulse to follow engine firing order in accordance with engine demand through injectors mounted on a tuned intake manifold.

A Powertrain Control Module (PCM)(12A650) accepts input from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio throughout the entire engine operational range. The computer then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

The PCM also determines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude (i.e., from sea level to mountains) and also permits push-starting the vehicle should it become necessary (manual transmission only).

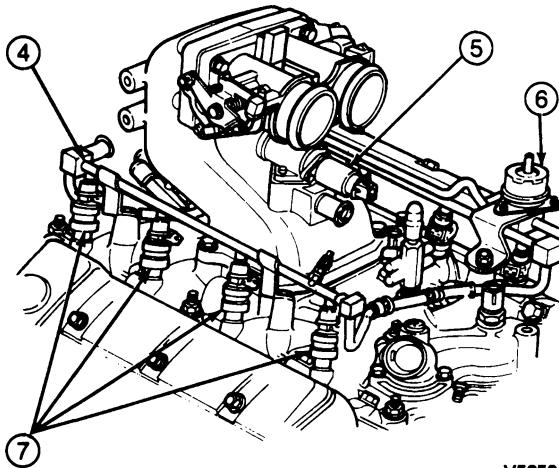
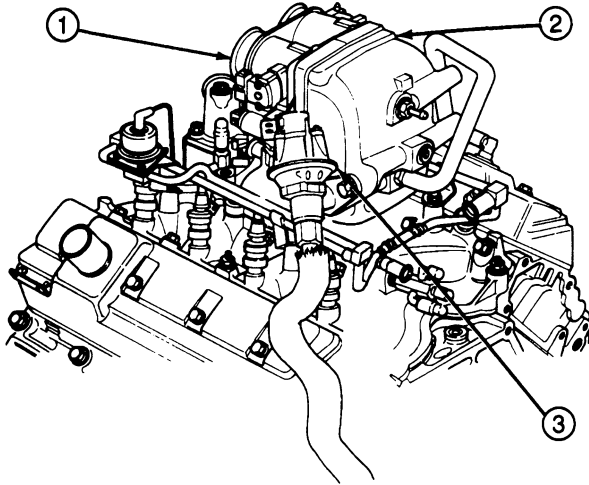
The fuel delivery subsystem consists of a high-pressure in-tank mounted fuel pump, and a fuel filter / reservoir delivering fuel from the fuel tank through a chassis-mounted 20 micron fuel filter to a fuel charging manifold assembly.

The fuel charging manifold assembly incorporates electrically actuated fuel injectors directly above each of the engine's eight intake ports. The injectors, when energized, spray a metered quantity of fuel into the intake air stream.

A constant fuel pressure drop is maintained across the injector nozzles by a pressure regulator. The regulator is connected in series with the fuel injectors and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator reservoir input and returns to the fuel tank through a fuel return line.

DESCRIPTION AND OPERATION (Continued)

7.5L Multiport Fuel Injection Engine



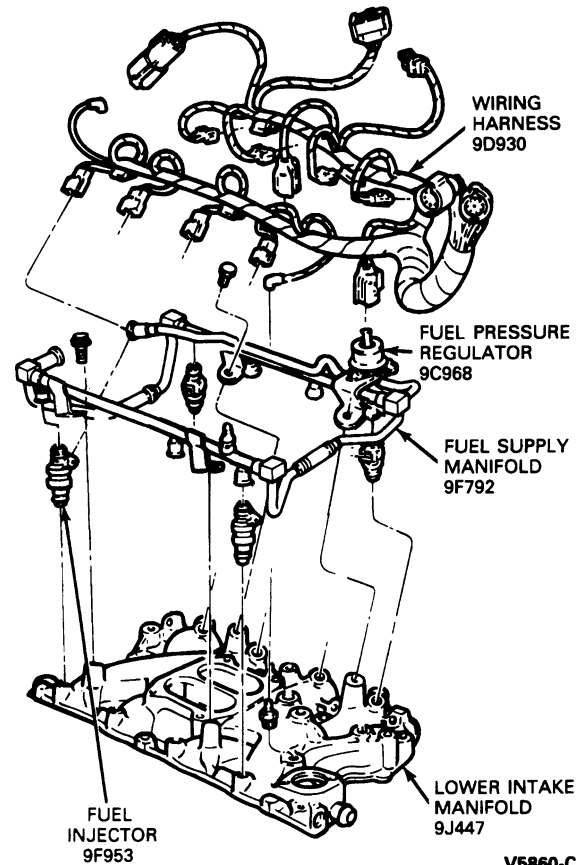
V5859-D

Item	Part Number	Description
1	9E926	Throttle Body Assembly
2	9424	Upper Intake Manifold

(Continued)

Item	Part Number	Description
3	9F483	EGR Valve
4	9F792	Fuel Supply Manifold
5	9F715	Idle Air Control Valve
6	9C968	Fuel Pressure Regulator
7	9F593	Fuel Injectors

Fuel Charging Manifold Assembly

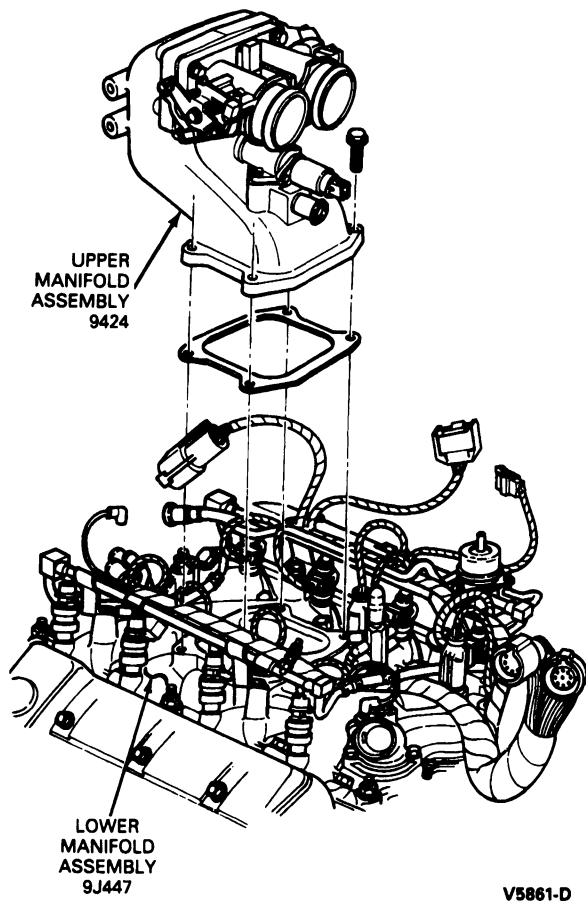


V5860-C

DESCRIPTION AND OPERATION (Continued)

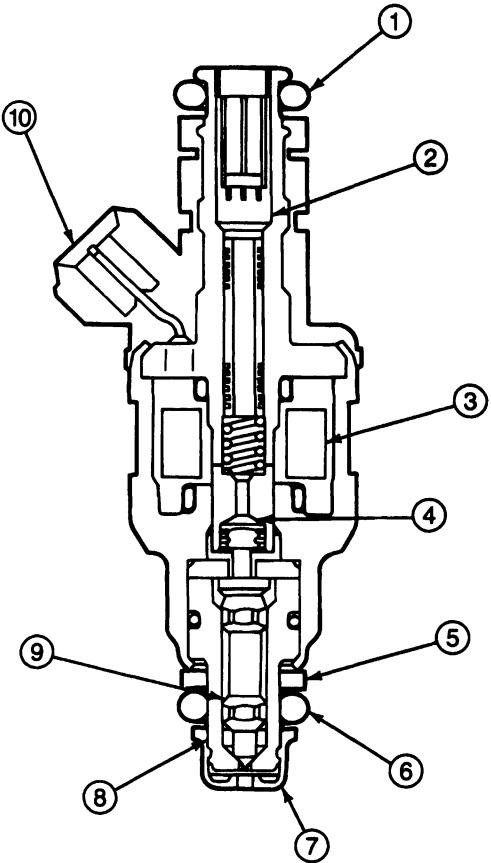
Air Intake Manifold

The air intake manifold is a two-piece (upper and lower intake manifold) aluminum casting. Runner lengths are tuned to optimize engine torque and power output. The manifold provides mounting flanges for the air throttle body assembly, fuel supply manifold and accelerator control bracketry, idle air control valve (9F7 15) and the EGR valve. Vacuum taps are provided to support various engine accessories. Pockets for the fuel injectors are machined to prevent both air and fuel leakage. The pockets in which the injectors are mounted are placed to direct the injector fuel spray immediately in front of each engine intake valve.



Fuel Injectors

The fuel injector is a solenoid-operated valve that meters fuel flow to the engine. The injector is opened and closed a constant number of times per crankshaft revolution. The amount of fuel is controlled by the length of time the injector is held open. The injector is normally closed and is operated by a signal from the PCM.

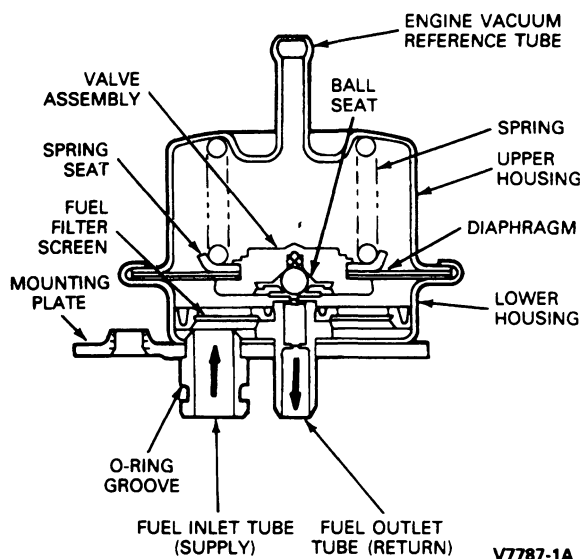


Item	Description
1	Supply Manifold O-Ring
2	Integral Filter
3	Coil
4	Armature
5	Washer
6	Lower Intake Manifold O-Ring
7	Pintle Protection Cap
8	Stainless Steel Valve Body
9	Stainless Steel Needle (Pintle)
10	Electrical Connector

DESCRIPTION AND OPERATION (Continued)

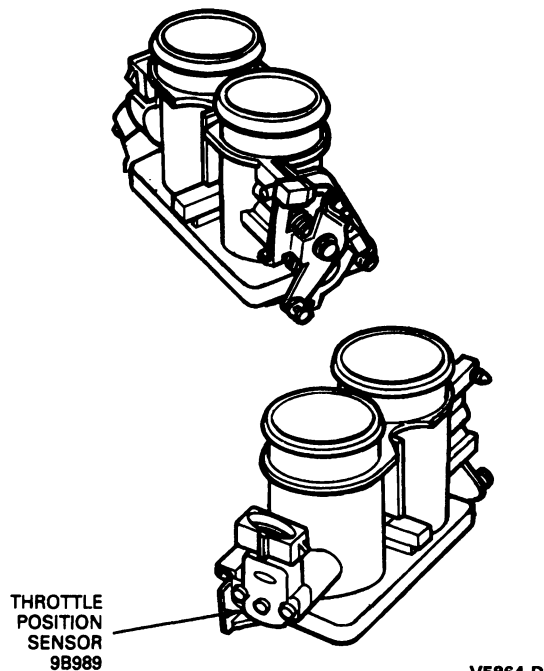
Fuel Pressure Regulator

The fuel pressure regulator is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the injectors. The regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the injectors. Fuel in excess of that used by the engine is bypassed through the regulator and returns to the fuel tank.



1. A preset stop to locate the WOT position.
2. A throttle body-mounted throttle position (TP) sensor.

AIR THROTTLE BODY ASSEMBLY 9E926



Throttle Body Assembly

The throttle body assembly controls airflow to the engine through a double butterfly-type valve. The throttle position is controlled by a four-bar link, progressive opening, throttle linkage. The body is a single-piece die casting made of aluminum.

Other features of the air throttle body assembly include:

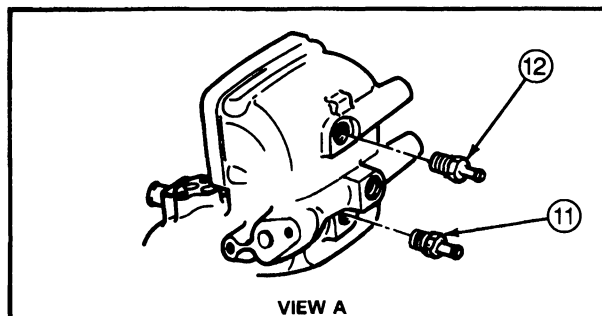
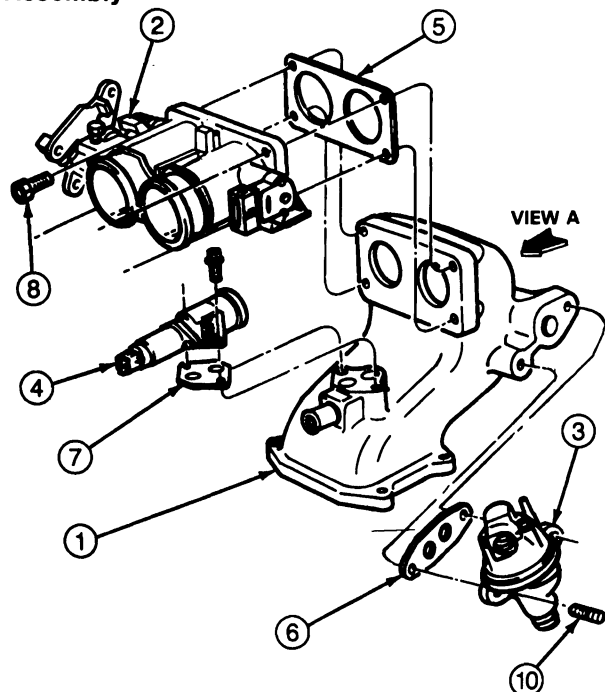
Idle Air Control Valve Assembly

The upper intake manifold has a mounting pad on which the idle air control valve assembly is located. The intake manifold has an air bypass channel downstream of the throttle body with external filtered air supplied from the air cleaner.

The valve assembly is an electro-mechanical device controlled by the PCM. It uses a linear actuator which positions a variable area metering valve. This controls the engine airflow for both cold and warm engine idle.

DESCRIPTION AND OPERATION (Continued)

Throttle Body and Upper Intake Manifold Assembly



V5863-E

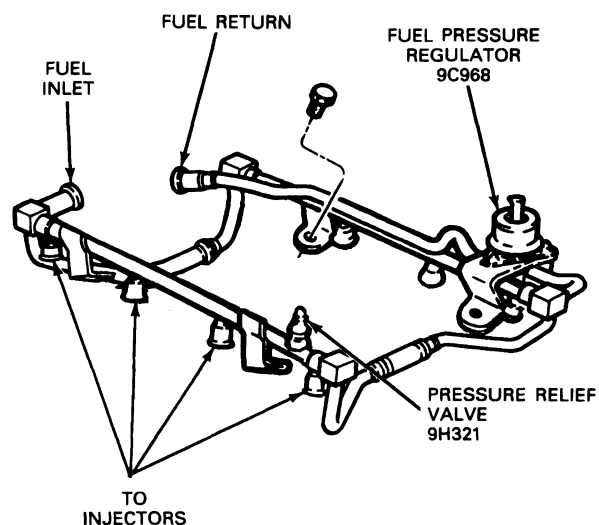
Item	Part Number	Description
1	9424	Manifold Assembly — Intake
2	9E926	Body Assembly — Air Intake Charge Throttle
3	9F483	Valve Assembly — EGR Vacuum External
4	9F715	Valve Assembly — Idle Air Control
5	9E936	Gasket — Throttle Body
6	9D476	Gasket — EGR Valve
7	9F670	Gasket — Idle Air Control
8	390774-S8	Bolt 5/16 x 1.5 Hex Head UBS (6 Req'd)
9	N605893-S8	Bolt M6 x 25mm Hex Head UBS (2 Req'd)
10	390715-S36	Stud 5/16-18 x 2.505 Hex Head Shoulder
11	389642-S8	Connector 3/8 Hose x 3/8 External Pipe

(Continued)

Item	Part Number	Description
12	386153-S101	Connector 1/4 Hose x 3/8 External Pipe

Fuel Supply Manifold Assembly

The fuel supply manifold assembly delivers high-pressure fuel from the vehicle fuel supply line to the eight fuel injectors. The assembly consists of two banks of tubular fuel rails connected by two permanent crossover connections, eight injector connectors, a mounting flange to the fuel pressure regulator and mounting attachments which locate the fuel manifold assembly and provide fuel injector retention. The fuel inlet and return have push-connect fittings. The unit is serviced as an assembly only.



V5865-C

DIAGNOSIS AND TESTING

Tips to Avoid Lean Air-Fuel Conditions

Rough idle, hesitation, poor throttle response, induction backfire and stalls during cold start / warm-up may be caused by the poor volatility of some high octane premium grade unleaded fuels (91 octane or higher $[R+M]/2$). When compared to regular grade unleaded fuel (87 octane $[R+M]/2$), high octane premium grade unleaded fuel may cause long crank time.

Use a regular grade unleaded fuel in all vehicles, except where a premium unleaded fuel is recommended in the Owner Guide. If lean air-fuel type symptoms are experienced, determine the grade and brand of fuel used and offer the following service tips.

DIAGNOSIS AND TESTING (Continued)

- Advise those using a higher octane grade fuel to switch to a regular grade unleaded fuel. For those using a regular grade fuel, advise them to try another brand.
- Do not advise using a higher octane unleaded fuel than is recommended for that specific engine. Ford engines are designed to perform best using a high quality regular grade unleaded fuel.
- Only advise using a higher octane unleaded fuel to avoid potentially damaging spark knock or ping, but do so only after mechanical repairs are ineffective.

NOTE: All unleaded gasolines used should contain detergent additives that are advertised as having "keep clean" or "clean up" performance for both intake valves and fuel injectors.

1. Install fuel cap at tank.
2. Connect battery ground cable.
3. Add coolant, if it was removed.
4. Turn ignition switch on/off several times without starting engine to check for fuel leaks.

NOTE: Check all connections at fuel rails, push-connect fittings, etc.

WARNING: THE FUEL SYSTEM IS NORMALLY PRESSURIZED TO 276 KPA (40 PSI).

5. Start engine and warm to operating temperature. Check for coolant leak if coolant was removed.
6. Perform EEC-IV Self Test to check systems function. Refer to Powertrain Control/Emissions Diagnosis Manual.¹

REMOVAL AND INSTALLATION**Pre-Service Procedures**

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

WARNING: THE FUEL SYSTEM IS NORMALLY PRESSURIZED TO 276 KPA (40 PSI).

The fuel charging assembly consists of the air throttle body and the upper and lower intake manifolds. Prior to service or removal of the fuel charging assembly, the following steps must be taken:

1. Open hood and install protective covers.
2. Make sure ignition is in off position.
3. Disconnect battery ground cable and secure it out of the way.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

4. Remove fuel filler cap to relieve fuel tank pressure.
5. Release pressure from fuel system at the fuel pressure relief valve using MFI Pressure Gauge T80L-9974-B. The fuel pressure relief valve is located on the fuel line in the upper right corner of the engine compartment. To gain access to the fuel pressure relief valve, the valve cap must first be removed.

Post-Service Procedures

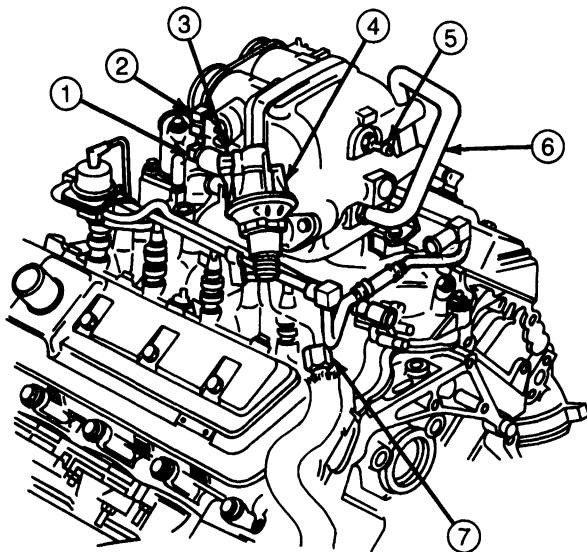
After the service is complete and the fuel charging assembly is installed to engine, the following steps must be taken:

Upper Intake Manifold and Throttle Body**Removal**

1. On F-250-350 vehicles, remove air inlet tubes. On E-350 vehicles, remove air inlet tubes and air cleaner assembly.
2. Disconnect battery ground cable.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the PCM relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
3. On E-350 vehicles, remove oil filler tube and inside engine cover.
4. Disconnect throttle linkage at throttle ball and automatic transmission linkage, if equipped, from throttle body. Remove two bolts securing bracket to intake and position bracket with cables out of the way.
5. Disconnect electrical connectors at:
 - a. idle air control valve
 - b. throttle position sensor
 - c. EGR position sensor
6. Disconnect upper intake manifold vacuum fitting connections by disconnecting:
 - a. vacuum line to MAP sensor
 - b. vacuum line to EGR valve
7. Disconnect EGR and PCV systems by disconnecting:
 - a. EGR valve flange nut
 - b. PCV hose at rear of upper manifold
8. Disconnect idle air control valve clean air supply hose, connected to idle air control valve port.

¹ Can be purchased as a separate item.

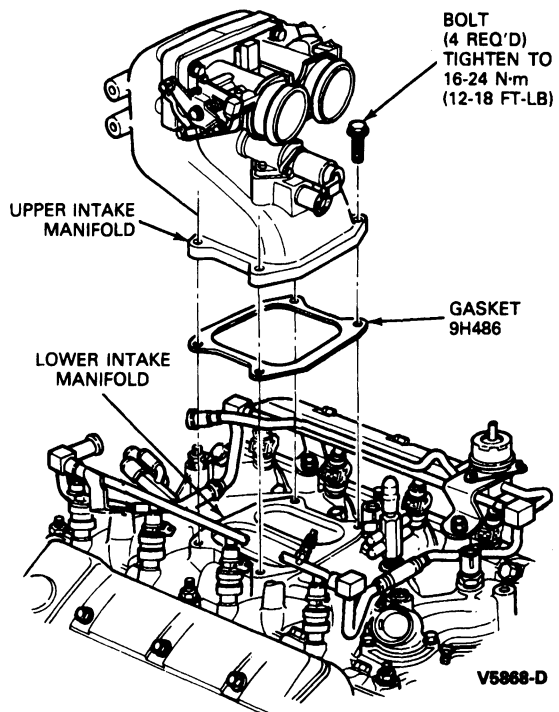
REMOVAL AND INSTALLATION (Continued)



V5866-C

Item	Part Number	Description
1	9F715	Idle Air Control Valve
2	9B989	Throttle Position Sensor
3	9G428	EGR Position Sensor
4	9F483	EGR Valve Assembly
5	386153-S101	Nipple for EGR Vacuum Supply Hose
6	9C342	PCV Hose
7	9D477	EGR Tube 34-47 N·m (25-35 Ft·Lb)

9. Remove four upper intake manifold retaining bolts.
10. Remove upper intake manifold and throttle body as an assembly.



V5866-D

Installation

1. Clean and inspect the mounting faces of the lower and upper intake manifolds.
2. Position new gasket on lower intake mounting face. The use of alignment studs may be helpful.
3. Install upper intake manifold and throttle body assembly to lower manifold, making sure gasket remains in place (if alignment studs are not used).
4. Install four upper intake manifold retaining bolts. Tighten to specification.
5. Install EGR tube.
6. Connect PCV hose to rear of upper manifold.
7. Connect vacuum lines to MAP sensor and EGR valve.
8. Position throttle linkage bracket with cables to upper intake manifold. Install two attaching bolts and tighten to specification. Connect throttle cable and automatic transmission kickdown cable to throttle body.
9. Connect electrical connectors at idle air control valve, TP sensor, and EGR position sensor.
10. Connect idle air control valve clean air supply hose.

NOTE: If lower intake manifold was removed, fill and bleed cooling system as outlined. Refer to Section 03-03.

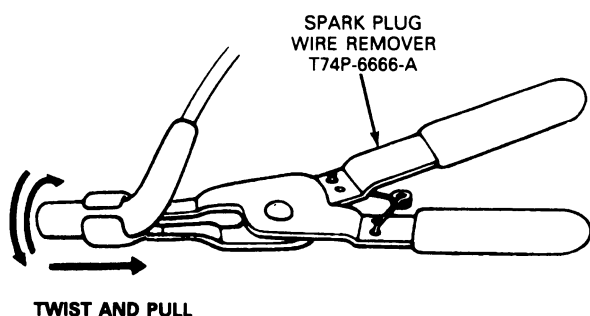
REMOVAL AND INSTALLATION (Continued)

Lower Intake Manifold

Removal

NOTE: On F-250-350 and Bronco vehicles, it is possible to remove upper and lower intake manifolds as an assembly. On E-350 vehicles it is necessary to remove the upper intake manifold first, then the lower intake manifold.

1. Remove air inlet tubes and air cleaner assembly.
2. Disconnect battery ground cable.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the PCM relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
3. Position a drain pan and drain radiator.
4. On E-350 vehicles, remove oil filler tube and inside engine cover.
5. Remove Thermactor system from right side of engine.
6. Remove ignition coil mounting bracket from engine and remove high tension lead at the coil.
7. Disconnect and remove external EGR tube.
8. Disconnect upper radiator hose at engine.
9. Disconnect heater hoses at intake manifold and water pump. Loosen water bypass hose at intake manifold.
10. Disconnect PCV valve and hose (right cover). Disconnect all the vacuum lines at rear of intake manifold and tag them for reference during installation.
11. Disconnect wires at the spark plugs using Spark Plug Wire Remover T74P-6666-A and move out of the way. Disconnect and remove the distributor cap and wires as an assembly.



B3496-E

12. Remove distributor. Refer to Section 03-07.
13. On E-350 vehicles, remove upper intake manifold as outlined in this section.
On F-250-350 and Bronco vehicles, disconnect accelerator linkage and transmission kickdown linkage at the throttle body. Remove speed control linkage bracket, if so equipped, from the intake manifold and disconnect it from the throttle body. Remove bolts holding accelerator linkage cable, and position linkage out of way.
14. Perform all pre-service procedures as described in this section. Using Disconnect Tool D87L-9280-A or -B or equivalents, disconnect fuel lines at fuel supply manifold.
15. Disconnect wiring harness from main wiring harness. Wiring harness and lower intake manifold to be removed as an assembly.
16. Remove attaching bolts. Remove intake manifold using engine lifting eyes. **If necessary to pry manifold away from the cylinder heads, do not damage the gasket sealing surfaces.**
17. Remove and discard intake manifold gaskets and seals.
18. Transfer components as required.
19. Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.
20. Inspect the manifold for cracks, damaged gasket surfaces, or other wear of damage that would make it unfit for further service. Replace all fasteners that are stripped or otherwise damaged. Remove all filings and foreign matter that may have entered the manifold as a result of repairs.

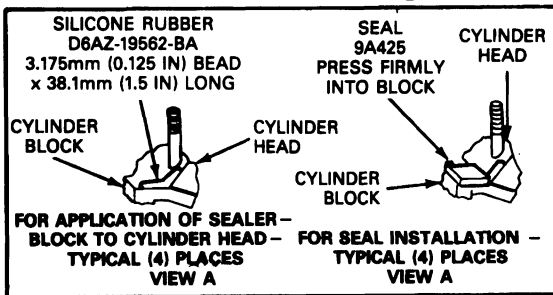
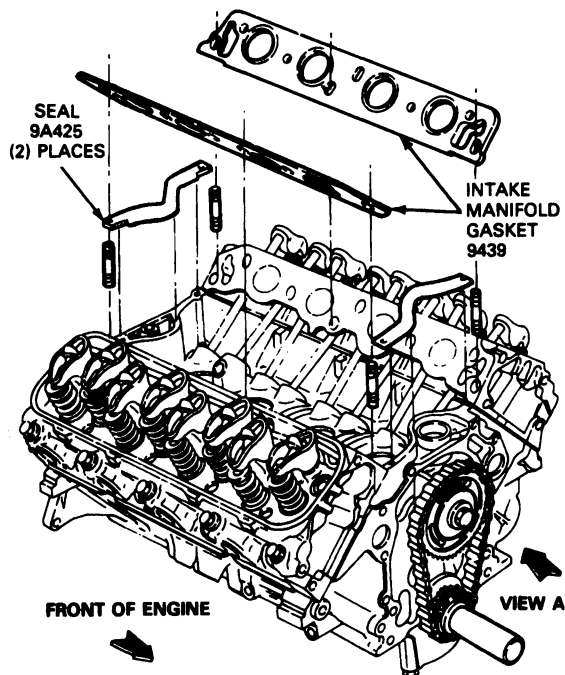
Installation

1. Clean mating surfaces of intake manifold, cylinder heads, and cylinder block. Use a solvent such as Ford Spot Remover B7A-19521-A (ESR-M5B 197-A) or equivalent degreasing agent.
2. Apply a 3.2mm (1/8-inch) diameter bead of Silicone Rubber D6AZ-19562-AA (ESE-M4G 195-A) in and along the joint, the full width of the cylinder block seal mounting surface (four corners) as shown in the following illustration.

REMOVAL AND INSTALLATION (Continued)

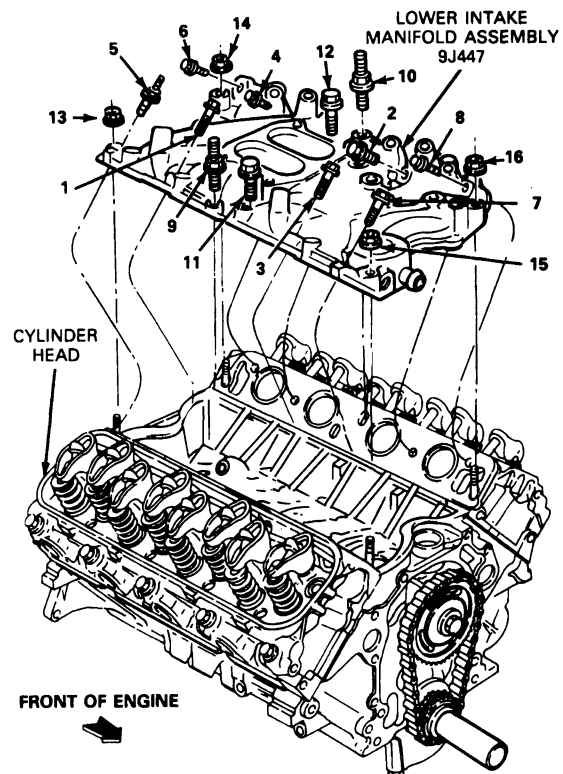
3. Install the intake manifold gasket and the front and rear intake manifold to cylinder block seals. Apply a 1.6mm (1/16-inch) bead of Silicone Rubber D6AZ-19562-AA (ESE-M4G195-A) at the outer end of each intake manifold seal for the full width of the seal.

NOTE: This sealer sets up within 15 minutes after application. Assemble promptly.



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4. Carefully lower intake manifold into position over four studs in ends of cylinder heads. **When intake manifold is in place, run finger around seal area to make sure seals are in place. If seals have shifted, remove manifold and re-position seals.**
5. Make sure intake manifold gaskets are properly aligned. Then, install attaching bolts and stud bolts into holes 1 through 10.



NOTE: LOWER INTAKE MANIFOLD ASSEMBLY SHOWN SIMPLIFIED TO CLARIFY INSTALLATION

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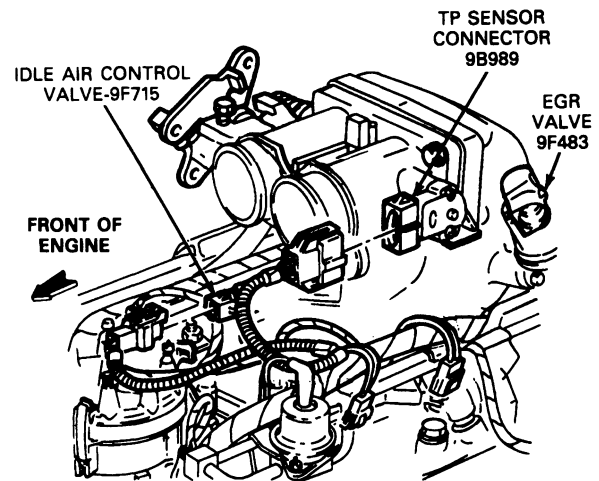
6. Install bolts into holes 11 and 12.
7. The lower intake manifold fasteners are secured following a three-step rundown procedure.
- Install nuts onto studs 13 through 16. Tighten bolts 1 through 12 in sequence to 11-16 N·m (8-12 ft-lb). Tighten nuts 13 through 16 in sequence to 11-16 N·m (8-12 ft-lb).
 - Tighten bolts and nuts 1 through 16 in sequence to 16-30 N·m (12-22 ft-lb).
 - Tighten manifold bolts and nuts 1 through 16 in sequence to 30-47 N·m (22-35 ft-lb).
8. Install EGR tube and Thermactor exhaust air supply tubes.
9. Install water pump bypass hose to intake manifold fitting and heater hot water tube.
10. Connect radiator upper hose to coolant outlet housing.
11. On E-350 vehicles, install upper intake manifold as outlined in this section.
12. Rotate crankshaft damper until No. 1 piston is at TDC at end of compression stroke. Install the distributor. Refer to Section 03-07.
13. Connect heater hoses at intake manifold and water pump.
14. Install accessory drive belts and tighten to specification.

REMOVAL AND INSTALLATION (Continued)

15. Connect PCV valve and hose to right valve rocker arm cover.
16. Connect fuel lines to fuel supply manifold.
17. Install ignition coil mounting brackets.
18. Complete all electrical connections.
19. Position accelerator linkage on manifold. Attach accelerator linkage cable. Attach speed control linkage bracket to intake manifold, if so equipped. Install accelerator and kickdown linkage to throttle body.
20. Connect the vacuum lines to their respective ports at rear of intake manifold.
21. Secure distributor cap to distributor. Connect spark plug wires to spark plugs. connect coil high tension lead to coil.
22. Fill and bleed the cooling system. Refer to Section 03-03.
23. Connect the battery ground cable.
24. Start engine. Check and adjust ignition timing, if necessary. Connect distributor vacuum lines.
25. Operate engine at fast idle and check for coolant leaks. Check coolant level and refill as necessary.
26. Start the engine and allow it to reach normal operating temperature. Then, while hot, tighten the manifold attaching nuts and bolts to 30-47 N·m (22-35 ft·lb).
27. Install air cleaner and intake duct assembly.

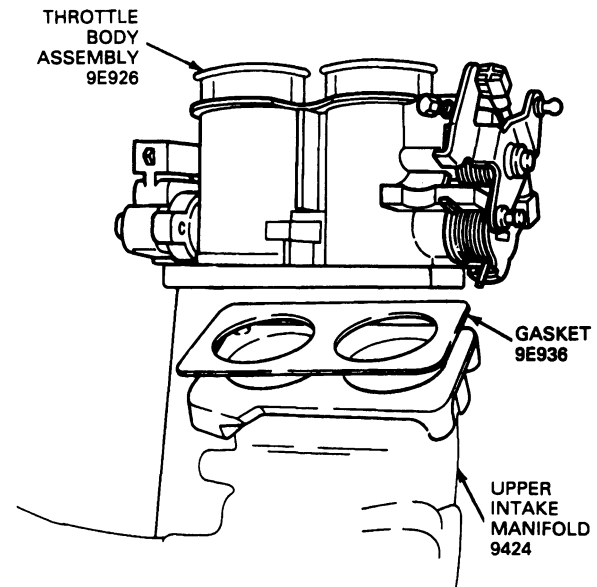
Air Intake Throttle Body**Removal**

1. On F-250-350, remove air inlet hoses. On E-350, remove air inlet hoses and air filter assembly.
2. Disconnect throttle linkage at throttle ball and automatic transmission linkage, if equipped, from throttle body. Remove two bolts securing bracket to intake and position bracket with cable(s) out of the way.
3. Disconnect electrical connector at throttle position sensor.



V5869-F

4. Remove four throttle body bolts.
5. Carefully separate air throttle body from upper intake manifold.



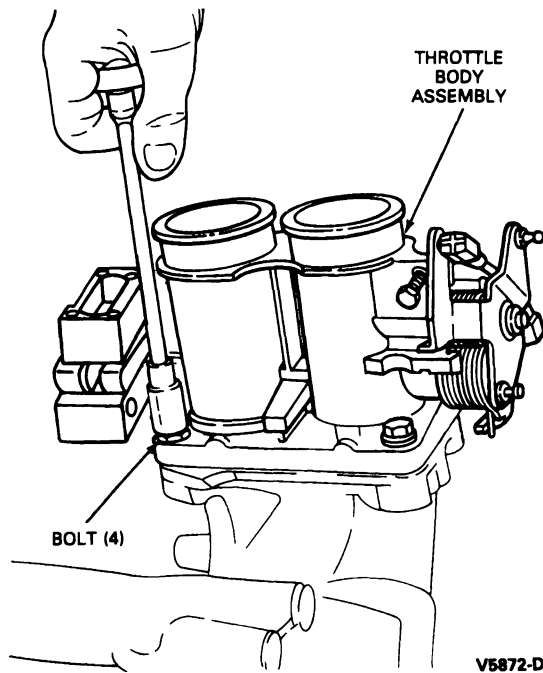
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Installation

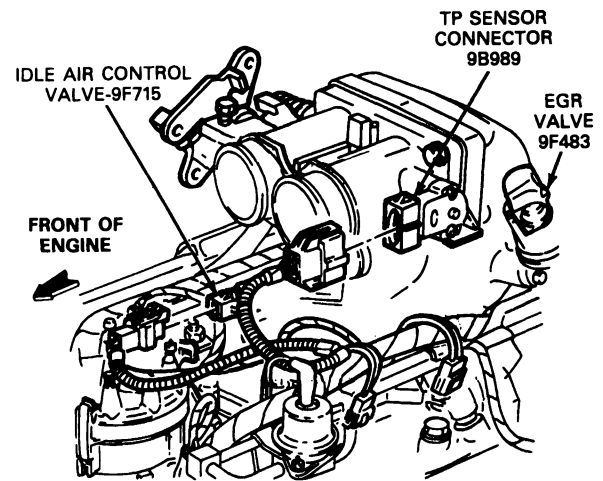
Refer to Section 03-04 for throttle body cleaning and inspection procedures.

REMOVAL AND INSTALLATION (Continued)

1. Make sure that both throttle body and upper intake manifold gasket surfaces are clean.
NOTE: If scraping is necessary, be careful not to damage gasket surfaces of throttle body and upper manifold assemblies, or allow material to drop into manifold.
2. Install throttle body gasket between upper intake manifold and throttle body. Make sure gasket stays in place if alignment studs are not used.
3. Install throttle body to upper intake manifold.
4. Secure throttle body assembly to upper intake manifold with four retaining bolts. Tighten to 15-24 N·m (12-18 ft·lb).



5. Connect TP sensor electrical connectors.

**Throttle Position (TP) Sensor****Removal**

1. Disconnect throttle position sensor from wiring harness.
2. Scribe a reference mark across the edge of the sensor and to the throttle body to make sure correct position is achieved during installation.
NOTE: If a new TP sensor is to be installed, do not scribe a reference mark.
3. Remove two throttle position sensor retaining screws.
4. Remove throttle position sensor.

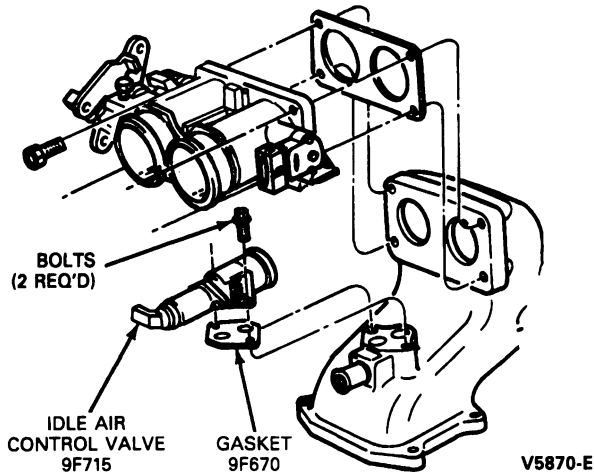
Installation

1. Position throttle position sensor so that wiring connector is parallel to the venturi boxes. Then, rotate throttle position sensor clockwise to align scribe marks.
NOTE: When throttle position sensor is installed on the throttle body, the wiring connector should be pointing forward on the engine.
2. Secure sensor to throttle body assembly with two retaining screws. Tighten to 1-2 N·m (9-17 in·lb).
NOTE: When throttle position sensor is installed on the throttle body, the wiring connector should be pointing forward on the engine.
3. Connect electrical connector to harness.
4. Adjust throttle position sensor as described in Section 4A of the Powertrain Control/Emissions Diagnosis Manual.²

² Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)**Idle Air Control Valve Assembly****Removal**

1. Disconnect idle air control valve assembly connector from wiring harness.
2. Remove two idle air control valve retaining bolts.
3. Remove idle air control valve and gasket.

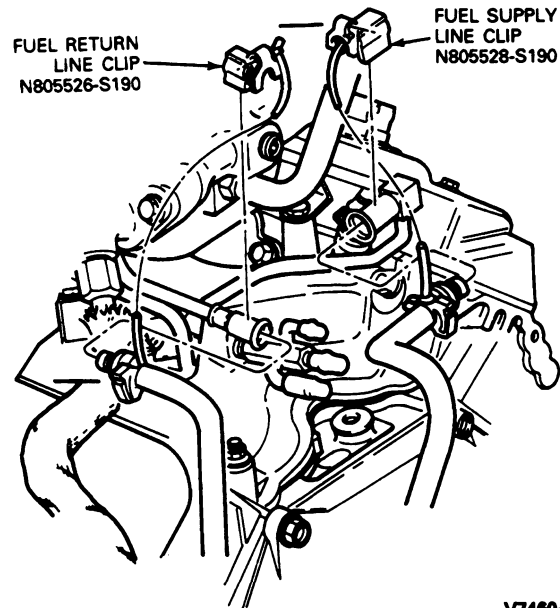
**Installation**

1. Make sure that upper intake manifold and idle air control valve gasket surfaces are clean.
NOTE: If scraping is necessary, be careful not to damage idle air control valve or intake manifold gasket surfaces, or drop material into intake manifold.
2. Install gasket and idle air control valve on upper intake manifold surfaces.
3. Install retaining screws. Tighten to 8-11 N·m (71-97 in-lb).
4. Connect electrical connector for the idle air control valve.

Fuel Supply Manifold Assembly**Removal**

1. Perform pre-service procedures as outlined in this section.

2. Remove upper manifold assembly as outlined.
3. Remove fuel line-to-fuel supply manifold retainer clips.
4. Disconnect vacuum hose to fuel pressure regulator at fuel pressure regulator.



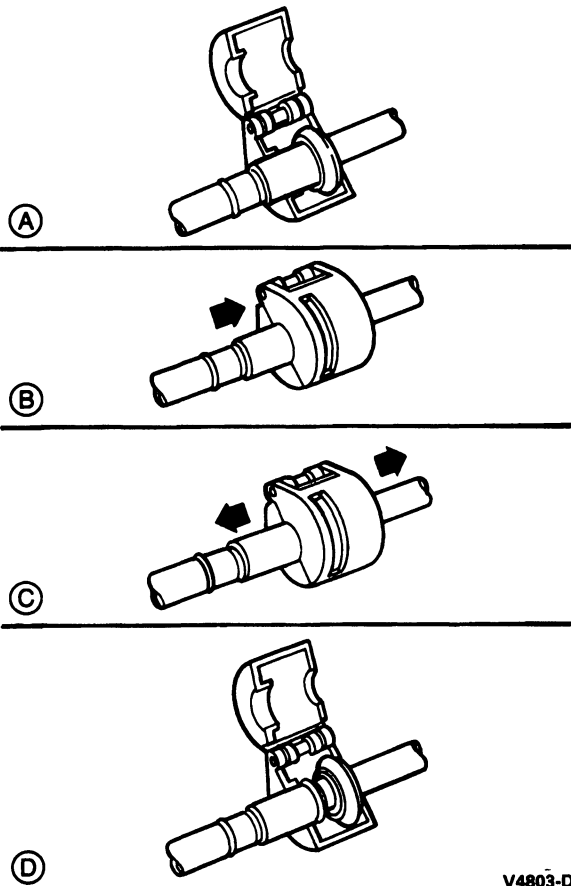
5. Using Disconnect Tool D87L-9280-A or -B or equivalent, disconnect fuel hoses at the fuel supply manifold supply tube and fuel supply manifold return tube.

WARNING: RELIEVE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING COUPLING.

- a. Fit tool to coupling so tool can enter cage to release garter spring.
- b. Push the tool into the cage opening to release female fitting from garter spring.
- c. Pull the coupling male and female fittings apart.

REMOVAL AND INSTALLATION (Continued)

- d. Remove the tool from the disconnected coupling.



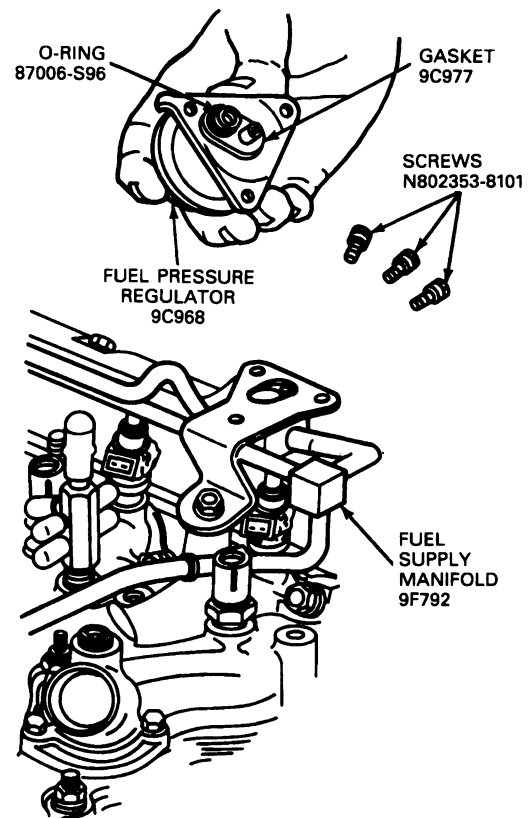
6. Remove four fuel supply manifold retaining bolts.
7. Carefully disengage manifold from fuel injectors and remove manifold.

Installation

1. Make sure injector caps are clean and free of contamination.
2. Place the fuel supply manifold over each of the injectors and seat injectors into fuel supply manifold. Make sure injectors are properly seated.
3. Secure fuel supply manifold assembly using four retaining bolts. Tighten to 8-12 N·m (7 1-106 in-lb).
4. Connect fuel inlet and outlet lines at fuel supply manifold connections. Push in to connect.
5. Install fuel line-to-fuel supply manifold retaining clips.
6. Connect vacuum hose to fuel pressure regulator.
7. Install upper intake manifold as outlined in this section.
8. Perform all post-service procedures as described in this section.

Fuel Pressure Regulator**Removal**

1. Perform all pre-service procedures as described in this section if removing fuel pressure regulator while fuel supply manifold is installed on engine.
2. Remove vacuum line at pressure regulator.
3. Remove three socket head retaining screws from regulator housing.
4. Remove pressure regulator assembly, gasket and O-ring. Discard gasket and O-ring.
5. If scraping is necessary, be careful not to damage fuel pressure regulator or fuel supply line gasket surfaces.

**Installation**

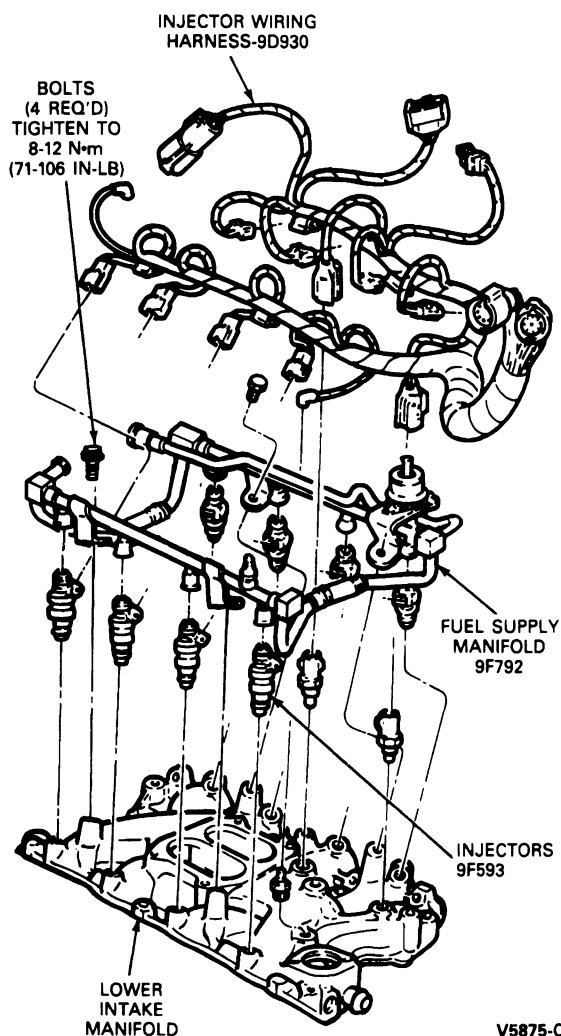
1. Lubricate fuel pressure regulator O-ring with light oil 10W-30 (WSE-M2C903-A2) or equivalent.
NOTE: Never use silicone grease. It will clog the injectors.
2. Make sure gasket surfaces of fuel pressure regulator and fuel injection manifold are clean.
3. Install a new O-ring and new gasket on regulator.
4. Install fuel pressure regulator on injector manifold. Tighten three retaining screws to 3-5 N·m (27-42 in-lb).

REMOVAL AND INSTALLATION (Continued)

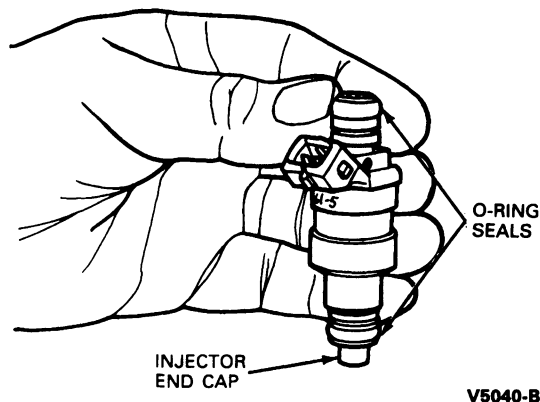
5. Install vacuum line to regulator.
6. Perform all post-service procedures.

Fuel Injector**Removal**

1. Perform pre-service procedures as described in this section.
2. Remove fuel supply manifold as outlined.
3. Carefully remove electrical harness connectors from individual injectors as required.
4. Grasping injector body, pull up while gently rocking injector from side-to-side.



5. Inspect injector O-rings (two per injector) for signs of deterioration. Replace as required.
6. Inspect injector end cap and washer for signs of deterioration. Replace complete injector as required. If end cap is missing, look for it in intake manifold.



NOTE: End cap is not available as a separate part.

Installation

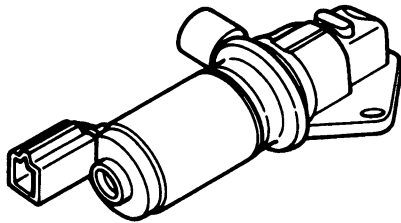
1. Lubricate new O-rings with light grade oil 10W-30 (WSE-M2C903-A2) or equivalent and install two on each injector.
- NOTE:** Never use silicone lubricant. It will clog the injectors.
2. Install injector(s). Use a light, twisting, pushing motion to install them.
 3. Install fuel supply manifold as outlined in this section.
 4. Install electrical harness connectors to injectors.
 5. Install upper intake manifold as outlined. Perform all post-service procedures as outlined in this section.

CLEANING AND INSPECTION**Idle Air Control Valve****Recommended Cleaning Procedure**

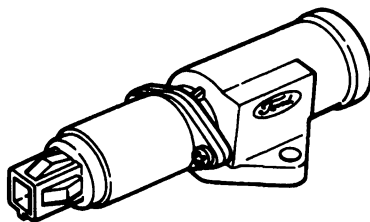
CAUTION: Use only specified cleaner. Do not spray directly on throttle plate or use any type of scrubbing method.

CLEANING AND INSPECTION (Continued)

CAUTION: Refer to the following illustration to identify those valves which may or may not be cleaned. Do not attempt to clean non-cleanable idle air control valves.



NON-CLEANABLE



CLEANABLE

A19020-A

1. Make sure control valve actuator is operating properly. Refer to Powertrain Control / Emissions Diagnosis Manual.³
2. Remove throttle inlet air tube.
3. Disconnect idle air control valve connector.
4. Connect Rotunda Air Bypass Actuator 113-00009 and Injector Tester / Cleaner 113-00001 or equivalents.
5. Start the actuator and then start the engine.
6. Spray Carburetor Tune-Up Cleaner D9AZ-19579-AA (ESR-M14P9-A) or equivalent into idle air control valve for five seconds while actuator is operating.
7. Turn off the actuator and stop engine. Allow solvent to soak for 15 minutes.
8. Turn on actuator and start engine.
9. Spray carburetor cleaner into idle air control valve passage for up to one minute.
10. Turn off actuator and stop engine, if running.
11. Install intake air tube. Start actuator and engine and run engine for one minute.
12. Disconnect actuator from idle air control valve. Connect idle air control valve electrical connector.
13. Start engine and check for normal operation.

Alternate Cleaning Procedure

NOTE: To be used only when tools for the recommended method are not available.

Remove the idle air control valve from the throttle body assembly. Remove the electrical solenoid assembly from the mechanical portion of the idle air control valve by removing the two screws, then sliding the mechanical portion away from the solenoid.

Soak the mechanical portion in Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A) or equivalent for two to three minutes.

CAUTION: Do not exceed three minutes soak time and do not use choke cleaner, as an internal O-ring may begin to deteriorate.

With the mechanical portion completely submerged, shake in all directions: up, down, right and left. Then push in on the rod that mates with the solenoid assembly, and again shake in all directions with the unit submerged and the rod held in as far as possible.

Remove the unit from the cleaning fluid and dry out thoroughly with shop air.

SPECIFICATIONS

TORQUE SPECIFICATIONS

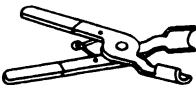
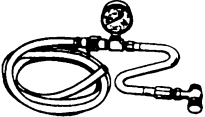
Description	N·m	Lb·Ft
EGR Tube	34-47	25-35
EGR Valve to Upper Intake Manifold	8-11	70-97 (In-Lb)
Air Supply Tube Clamps	1.3-2.25	12-20 (In-Lb)
Upper Intake Manifold to Lower Intake Manifold Bolts	16-24	12-18
Throttle Body to Upper Intake Manifold	8-11	71-97 (In-Lb)
Idle Air Control Valve to Lower Manifold	8-11	71-97 (In-Lb)
Throttle Position Sensor to Throttle Body	2.0-3.0	18-27 (In-Lb)
Fuel Pressure Regulator to Fuel Supply Manifold	3-5	27-42 (In-Lb)
Fuel Supply Manifold Retaining Bolts	8-12	71-106 (In-Lb)
Coil Bracket to Platform	6-10	53-89 (In-Lb)
Throttle Cable Bracket to Manifold	11-13	8-10

NOTE: For lower intake manifold to cylinder heads, tighten in the following steps:

- tighten bolt and nuts in sequence to 11-16 N·m (8-12 ft-lb),
- tighten in sequence to 16-30 N·m (12-22 ft-lb),
- tighten in sequence to 30-47 N·m (22-35 ft-lb).

³ Can be purchased as a separate item.

SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number/ Description	Illustration
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A
T80L-9974-B MFI Pressure Gauge	 T80L-9974-B
Tool Number	Description
D87L-9280-B	Disconnect Tool (1/2 inch)
D87L-9280-A	Disconnect Tool (3/8 inch)

ROTUNDA EQUIPMENT

Tool Number	Description
113-00001	Injector Tester / Cleaner
113-00009	Air Bypass Actuator

SECTION 03-04D Fuel Charging and Controls, 5.8L Lightning Engine

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		REMOVAL AND INSTALLATION (Cont'd.)	
Alternate Cleaning Procedure.....	03-04D-14	Fuel Injector.....	03-04D-13
Idle Air Control Valve Cleaning.....	03-04D-14	Fuel Pressure Regulator	03-04D-13
DESCRIPTION AND OPERATION		Fuel Supply Manifold Assembly	03-04D-12
Air Intake Manifold	03-04D-2	Idle Air Control Valve	03-04D-11
Fuel Injectors	03-04D-2	Lower Intake Manifold	03-04D-8
Fuel Pressure Regulator	03-04D-3	Post-Service Procedures	03-04D-5
Fuel Supply Manifold Assembly	03-04D-4	Pre-Service Procedures.....	03-04D-5
Throttle Body Assembly	03-04D-3	Throttle Position (TP) Sensor	03-04D-11
DIAGNOSIS AND TESTING		Upper Intake Manifold and Throttle Body	03-04D-6
Tips to Avoid Lean Air-Fuel Conditions.....	03-04D-4	SPECIAL SERVICE TOOLS/EQUIPMENT.....	03-04D-15
REMOVAL AND INSTALLATION		SPECIFICATIONS.....	03-04D-15
Air Intake Throttle Body.....	03-04D-10	VEHICLE APPLICATION.....	03-04D-1

VEHICLE APPLICATION

Lightning Truck Equipped with 5.8L Lightning Engine

DESCRIPTION AND OPERATION

The Multiport Fuel Injection system (MFI) is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered from bank to bank. Injectors pulse in accordance with engine demand.

WARNING: DO NOT SMOKE, CARRY LIGHTED SUBSTANCES, OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

A Powertrain Control Module (PCM)(12A650) accepts inputs from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio throughout the entire engine operational range. The Powertrain Control Module then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

The PCM also determines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude (i.e., from sea level to mountains).

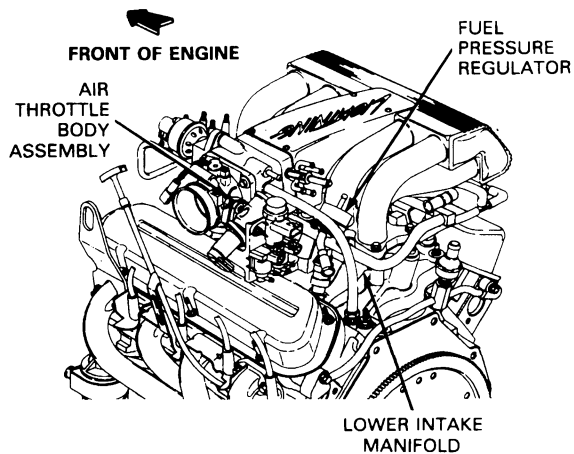
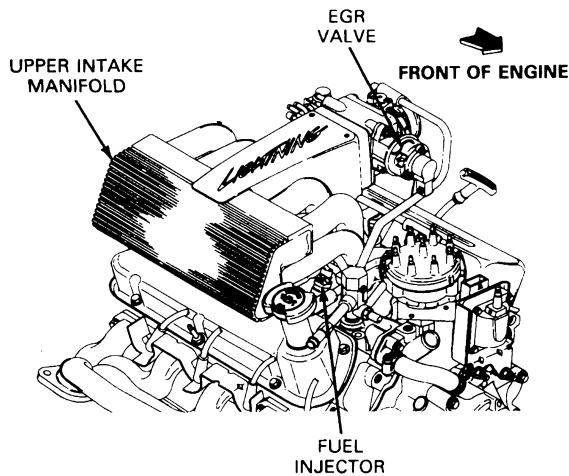
The fuel delivery subsystem consists of a high-pressure in-tank mounted fuel pump and a fuel filter / reservoir delivering fuel from the fuel tank through a 20 micron fuel filter to a fuel charging manifold assembly.

The fuel charging manifold assembly incorporates electrically actuated fuel injectors directly above each of the engine's intake ports. The injectors, when energized, spray a metered quantity of fuel into the intake air stream.

A constant fuel pressure drop is maintained across the injector nozzles by a pressure regulator. The regulator is connected in series with the fuel injectors and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator and returns to the fuel tank through a fuel return line.

DESCRIPTION AND OPERATION (Continued)

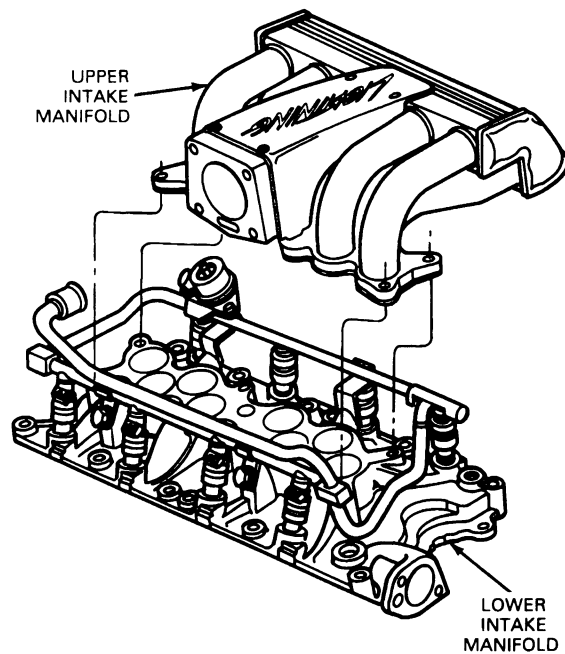
One group of four injectors is energized simultaneously, once every crankshaft revolution followed by the second group of injectors in the next crankshaft revolution. The period of time that the injectors are energized (injector "on time" or pulse width) is controlled by the PCM. The PCM receives input from various engine sensors and uses this information to compute the required fuel flow rate necessary to compute the prescribed air / fuel ratio for the given engine operation. The PCM determines the needed injector pulse width and outputs a command to the injector to meter the exact quantity of fuel.



A17861-A

Air Intake Manifold

The air intake manifold is a two-piece (upper and lower intake manifold) assembly. The lower manifold is cast aluminum. The upper manifold is of a welded tubular design. Runner lengths are tuned to optimize engine torque and power output. The manifold provides mounting flanges for the air throttle body (9E926) assembly, fuel supply manifold and accelerator control bracketry and the EGR external pressure valve (9F483). Vacuum taps are provided to support various engine accessories. Pockets for the fuel injectors are machined to prevent both air and fuel leakage. The pockets in which the injectors are mounted are placed to direct the injector fuel spray immediately in front of each engine intake valve.

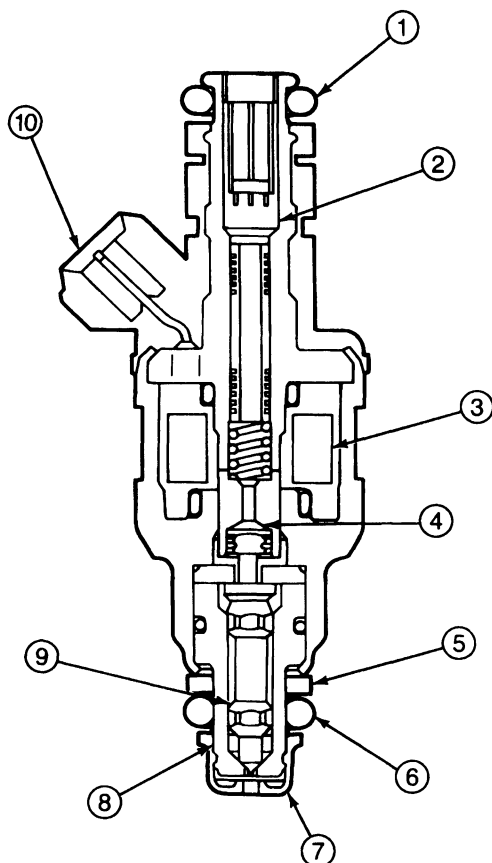


A17862-A

Fuel Injectors

The eight fuel injector nozzles are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The MFI injectors are mounted in the lower intake manifold and are positioned so that their tips direct fuel just ahead of the engine intake valves. The injector consists of a solenoid and valve assembly. An electrical control signal from the PCM activates the injector solenoid, causing the needle to move inward off the seat, allowing fuel to flow. Since the injector flow orifice is fixed and the fuel pressure drop across the injector tip is constant, fuel flow to the engine is regulated by how long the solenoid is energized. Atomization is obtained by a director metering plate at the point where the fuel separates.

DESCRIPTION AND OPERATION (Continued)



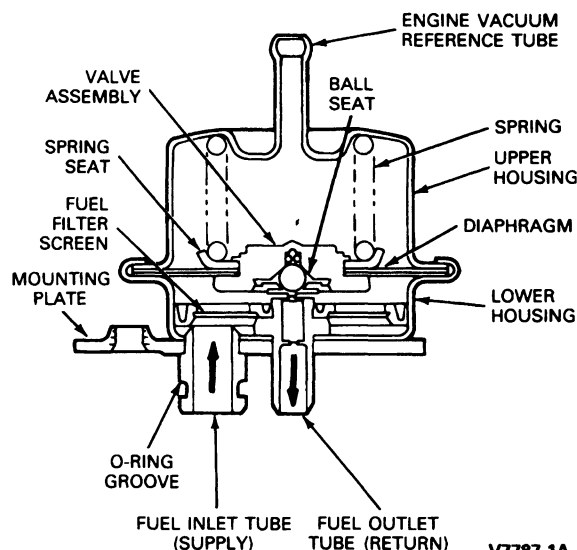
A19017-A

Item	Description
1	Supply Manifold O-Ring
2	Integral Filter
3	Coil
4	Armature
5	Washer
6	Lower Intake Manifold O-Ring
7	Pintle Protection Cap
8	Stainless Steel Valve Body
9	Stainless Steel Needle (Pintle)
10	Electrical Connector

The 5.8L Lightning Engine is equipped with Deposit Resistant Injectors (DRI). This injector is designed to eliminate the lean fuel delivery concerns which occur with conventional multiport fuel injectors when low-grade, non-detergent fuels are used.

Fuel Pressure Regulator

The fuel pressure regulator is attached to the fuel supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the injectors. The regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the injectors. Fuel in excess of that used by the engine is bypassed through the regulator and returns to the fuel tank.



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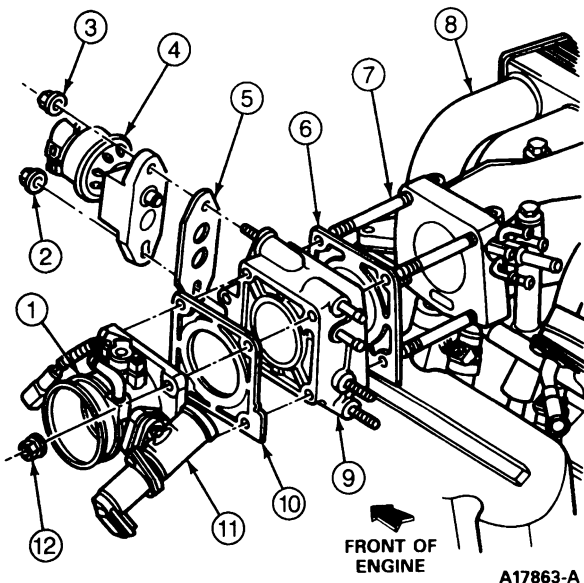
Throttle Body Assembly

The throttle body assembly controls air flow to the engine through a butterfly-type valve. The body is a single-piece die casting made of aluminum. It has a single bore with an air bypass channel around the throttle plate. This bypass channel controls both cold and warm engine idle air flow as regulated by an air bypass valve assembly mounted directly to the throttle body. The air bypass valve assembly is an electro-mechanical device, controlled by the PCM, that meters the amount of air bypassed around the throttle plates in order to control engine idle speed. Engine coolant is diverted through the EGR spacer to improve cold weather operation.

Other features of the air throttle body assembly include:

1. A pre-set stop to locate the WOT position.
2. A throttle body-mounted throttle position sensor.
3. Sludge resistant coating on throttle plate.

DESCRIPTION AND OPERATION (Continued)



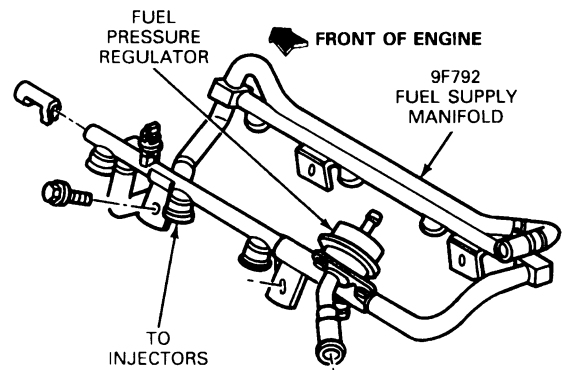
A17863-A

Item	Part Number	Description
1	9E926	Throttle Body Assembly
2	—	Nut and Washer Assembly 3/8-16 17-24 N·m (12-18 Ft-Lb) Lower EGR-To-EGR Spacer
3	—	Nut and Washer Assembly 5/16-18 17-24 N·m (12-18 Ft-Lb) Upper EGR-To-EGR Spacer
4	9F483	EGR Valve Assembly
5	9D476	Gasket, EGR-To-EGR Spacer Plate
6	9E464	Gasket, EGR Spacer Plate-To-Upper Intake
7	—	Stud, 5/16-18-18 x 4.12 (4 Req.) Throttle Body and EGR Spacer Plate Mount 17-24 N·m (12-18 Ft-Lb)
8	9425	Manifold, Upper Intake
9	9H474	EGR Spacer Plate
10	9E933	Gasket, Throttle Body-To-EGR Spacer Plate
11	9F115	Idle Air Control Valve
12	45357	Nut, 5/16-18 17-24 N·m (12-18 Ft-Lb) (4 Req.) Throttle Body-To-EGR Spacer

TA17863A

Fuel Supply Manifold Assembly

The fuel supply manifold assembly delivers high pressure fuel from the vehicle fuel supply line to the eight fuel injectors. The assembly consists of two banks of tubular fuel rails connected by two permanent crossover connections, eight injector connectors, a mounting flange to the fuel pressure regulator and mounting attachments which locate the fuel manifold assembly and provide fuel injector retention. The fuel inlet and outlet connections have push-connect fittings. The unit is serviced as an assembly only.



A17864-A

DIAGNOSIS AND TESTING

Tips to Avoid Lean Air-Fuel Conditions

Rough idle, hesitation, poor throttle response, induction backfire and stalls during cold start / warm-up may be caused by the poor volatility of some high octane premium grade unleaded fuels (91 octane or higher $[R+M]/2$). When compared to regular grade unleaded fuel (87 octane $[R+M]/2$), high octane premium grade unleaded fuel may cause long crank time.

Use a regular grade unleaded fuel except where a premium unleaded fuel is recommended in the Owner Guide. If lean air-fuel type symptoms are experienced, determine the grade and brand of fuel used and offer the following service tips.

- Advise those using a higher octane grade fuel to switch to a regular grade unleaded fuel. For those using a regular grade fuel, advise them to try another brand.
- Do not advise using a higher octane unleaded fuel than is recommended for that specific engine. The 5.8L Lightning engine is designed to perform best using a high quality regular grade unleaded fuel.

DIAGNOSIS AND TESTING (Continued)

- Only advise using a higher octane unleaded fuel to avoid potentially damaging spark knock or ping, but do so only after mechanical repairs are ineffective.

NOTE: All unleaded gasolines used should contain detergent additives that are advertised as having "keep clean" or "clean up" performance for both intake valves and fuel injectors.

The 5.8L Lightning engine is designed to run on regular unleaded fuel under normal driving operations. For maximum performance or while towing a trailer or carrying a load, the engine will run most effectively on premium fuel (91 octane or higher is recommended). Using a fuel with a lower octane rating can cause persistent and heavy knocking, which can damage the engine.

3. Remove fuel cap and release tank pressure.
4. Release pressure from fuel system at the fuel pressure relief valve using MFI Pressure Gauge T80L-9974-B. The fuel pressure relief valve is located on the fuel line in the upper right corner of the engine compartment. To gain access to the fuel pressure relief valve, the valve cap must first be removed.

NOTE: Not all assemblies may be serviceable while on the engine. In some cases, removal of the fuel charging assembly may ease service of the various subassemblies.

REMOVAL AND INSTALLATION

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Pre-Service Procedures

The fuel charging assembly consists of the throttle body, and the upper and lower intake manifolds. Prior to service or removal of the fuel charging assembly, the following steps must be taken:

1. Open hood and install protective covers.
2. Disconnect battery ground cable and secure it out of the way. Be sure ignition is in the off position.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

Post-Service Procedures

After the service is complete and the fuel charging assembly is installed onto the engine, the following steps must be taken:

1. Install fuel cap at tank.
2. Connect battery ground cable.
3. Add engine coolant, if necessary.
4. Turn ignition switch on and off several times without starting engine to check for fuel leaks.

NOTE: Check all connections at fuel rails, push connect fittings, etc.

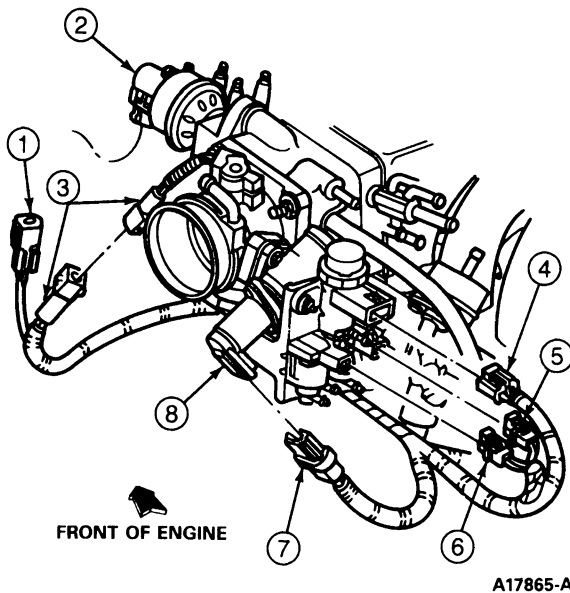
CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

5. Start engine and warm to operating temperature. Check for coolant leak if coolant was removed.
6. Perform EEC-IV Self Test to check systems function. Refer to Powertrain Control / Emissions Diagnosis Manual.¹

¹ Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)**Upper Intake Manifold and Throttle Body****Removal**

1. Open hood, disconnect battery negative cable and remove air intake tube.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
2. Remove snow / ice shield from throttle body.
3. Disconnect electrical connectors from:
 - a. Throttle position sensor (9B989)
 - b. Idle air control valve (9F7 15)
 - c. EVP sensor
 - d. Emission vacuum control regulator (9F490)
 - e. Secondary Air Injection Bypass / Secondary Air Injection Diverter (AIRB / AIRD) solenoids



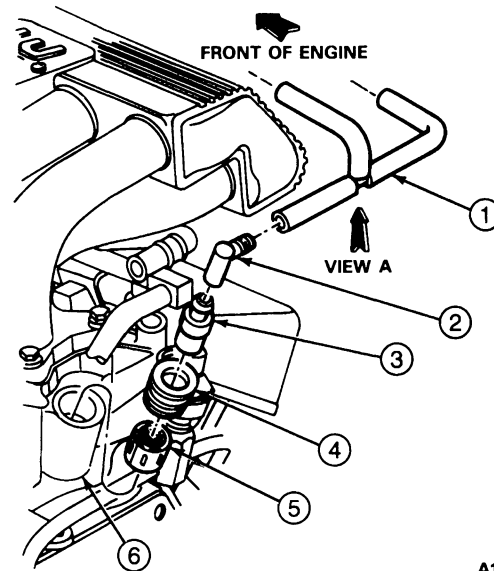
A17865-A

Item	Description
1	EGR Valve Position Sensor Connector
2	EGR Valve
3	TP Sensor Connector
4	EVR Connector
5	AIRB Connector
6	AIRD Connector
7	Idle Air Control Valve Connector
8	Idle Air Control Valve

TA17865A

4. Disconnect vacuum lines from:
 - a. EGR external pressure valve

- b. EVP sensor
- c. AIRB / AIRD solenoids
- d. Vacuum tree
5. Disconnect PCV fresh air hose from throttle body and oil fill tube. Loosen radiator cap (cool engine only) to relieve system pressure.
6. Disconnect and plug coolant hoses from EGR spacer plate.
7. Disconnect throttle cable at throttle ball stud.
CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the stud and pry slowly. Pulling by hand may damage cable.
8. Reach behind upper intake manifold and pull PCV valve from lower intake manifold.



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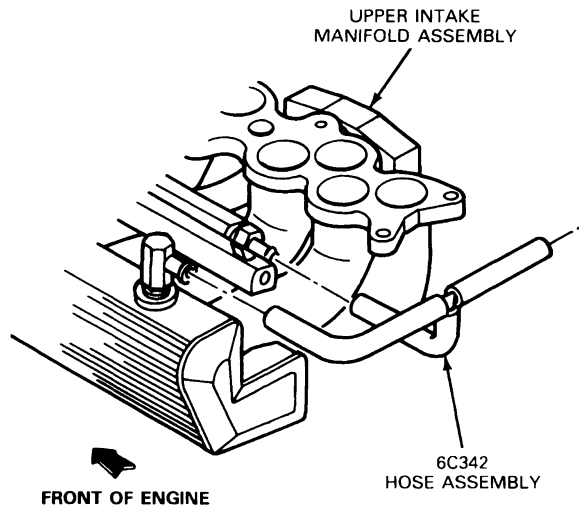
Item	Part Number	Description
1	6C342	Hose Assembly
2	6B892	Elbow
3	6A666	PCV Valve
4	6K780	Grommet
5	6A631	Element
6	9K461	Manifold, Lower Intake

TA17866A

9. Disconnect vacuum hose at brake booster.
10. Remove upper intake manifold mounting bolts.

REMOVAL AND INSTALLATION (Continued)

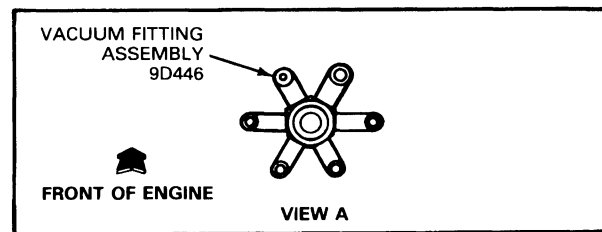
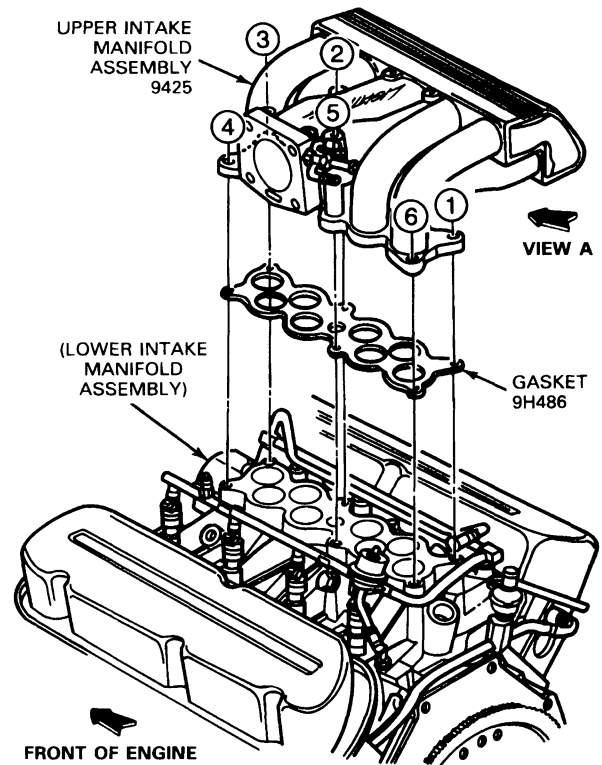
11. To remove upper intake manifold, lift it up and pull it forward to gain access to vacuum hoses located below it. Disconnect vacuum hoses and remove manifold and throttle body.



A17867-A

Installation

1. Clean all gasket surfaces.
NOTE: If scraping is necessary, be careful not to damage gasket surfaces, or allow material to fall into lower intake manifold.
2. Position new gasket onto lower intake manifold.
3. Position upper intake manifold and feed vacuum hoses into position and connect.
4. Reach behind upper intake and install PCV valve into lower intake manifold.
5. Connect vacuum hose to brake booster.
6. Making sure gasket is in correct position, install upper intake manifold mounting bolts and tighten to 17-24 N·m (12-18 ft·lb) in sequence shown.

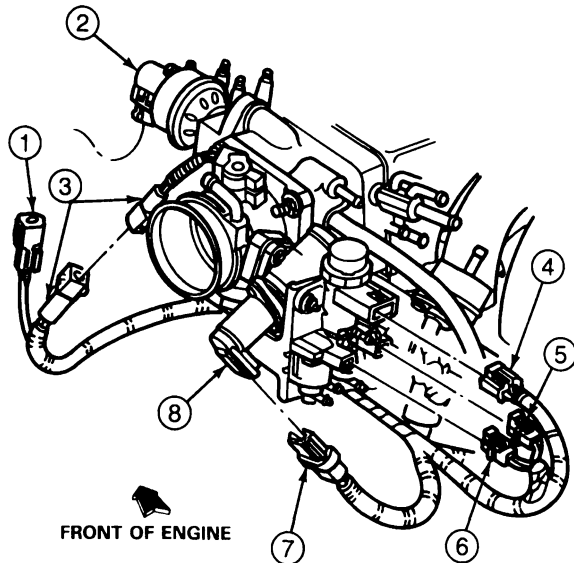


A17868-A

7. Connect throttle cable.
8. Connect coolant hoses to EGR spacer plate. Refill cooling system as required.
9. Install PCV fresh air hose to oil fill tube and throttle body.
10. Connect vacuum lines to:
 - a. Vacuum tree
 - b. AIRB / AIRD solenoids
 - c. Emission Vacuum Control Regulator
 - d. EVP sensor
11. Connect electrical connectors to:
 - a. AIRB / AIRD solenoids
 - b. Emission vacuum control regulator
 - c. EGR external pressure valve
 - d. Idle air control valve
 - e. Throttle position sensor
12. Install snow / ice shield onto throttle body.
13. Install air intake tube and connect battery negative cable.

REMOVAL AND INSTALLATION (Continued)

14. Start engine and check for proper operation.



A17865-A

Item	Description
1	EGR Valve Position Sensor Connector
2	EGR Valve
3	TP Sensor Connector
4	EVR Connector
5	AIRB Connector
6	AIRD Connector
7	Idle Air Control Valve Connector
8	Idle Air Control Valve

TA17865A

Lower Intake Manifold

Removal

1. Perform all pre-service procedures as described in this section.
2. Remove upper intake manifold and throttle body as outlined.
3. Drain cooling system. Refer to Section 03-03.
4. Remove distributor assembly, cap and wires. Mark position of distributor and rotor during removal so they can be reinstalled in their original positions.
5. Disconnect electrical connectors from engine coolant temperature sensor (12A648), water temperature sending unit and intake air temperature sensor (12A697).
6. Disconnect injector wiring harness from main harness connector.

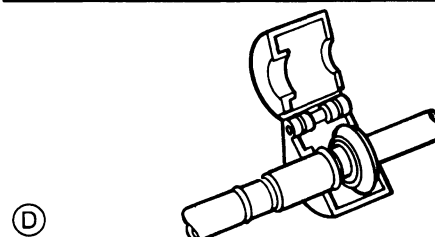
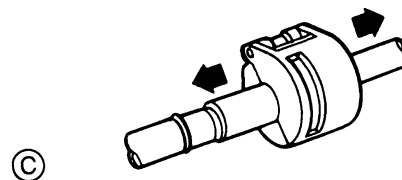
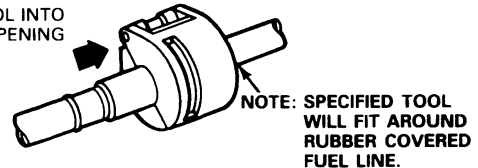
7. Remove fuel supply and return line retaining clips. Disconnect fuel supply and return lines from fuel supply manifold, using Disconnect Tool D87L-9280-A and D87L-9287-B or equivalents as follows:
 - a. Fit tool to coupling so that tool can enter cage opening to release the garter spring.
 - b. Push tool into the cage opening to release the female fitting from the garter spring.
 - c. Pull the coupling male and female fitting apart.
 - d. Remove the tool from the disconnected spring lock coupling.
8. Remove upper radiator hose and water bypass hose from thermostat housing.
9. Remove lower intake manifold retaining bolts and studs, noting their location.
10. Remove lower intake manifold assembly.

USE SPECIFIED
TOOL OR
EQUIVALENT

TOOL SPRING LOCK
CONNECTOR TOOL
D87L-9280-A — 3/8 INCH
D87L-9280-B — 1/2 INCH



PUSH TOOL INTO
CAGE OPENING



V9059-A

Installation

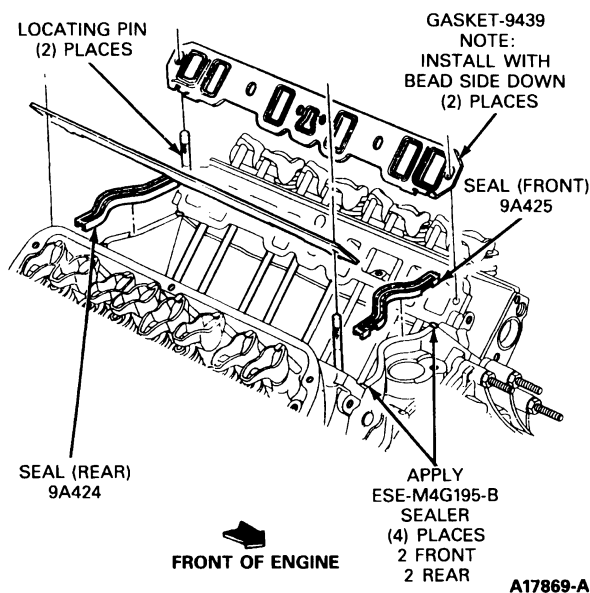
1. Clean and inspect mounting surfaces of lower intake manifold, cylinder head and engine block. Refer to Section 03-00.

REMOVAL AND INSTALLATION (Continued)

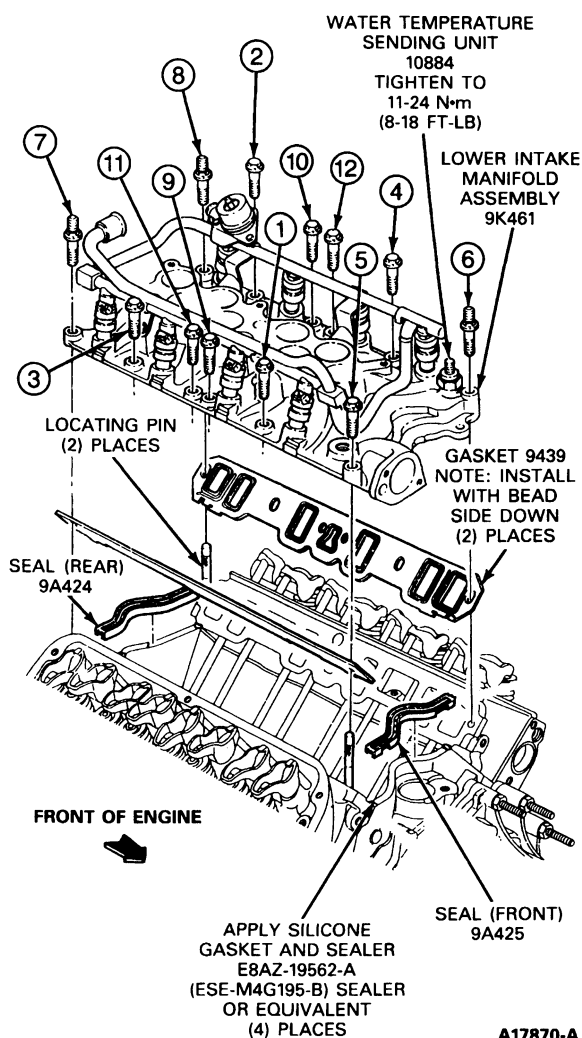
2. Apply 1.6mm (1/16 inch) bead of silicone Gasket and Sealer E8AZ-19562-A (ESE-M4G195-B) or equivalent in four places as shown in the following illustration.

3. Install end seals on the engine block and new gaskets on the cylinder head.

NOTE: The gaskets must be interlocked with seal tabs.



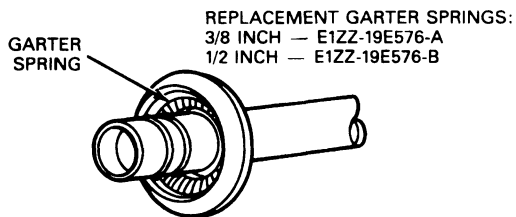
4. Install two locator pins, if available, into opposite corners.
5. Carefully position lower intake manifold over locator pins.
6. Remove locator pins, if used, and install bolts and studs. Tighten all in sequence shown to 31-33 N·m (23-25 ft·lb).



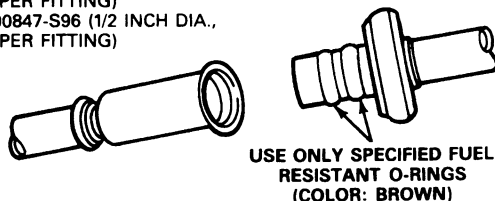
7. Install upper radiator hose and water bypass hose.
8. Connect fuel supply and return lines to fuel supply manifold as follows:
 - a. Check for missing or damaged garter spring. Remove damaged spring with small hooked tool and install new spring.
 - b. Clean fittings with solvent. Check for missing or damaged O-rings. Replace missing O-rings. If either O-ring is damaged, replace both O-rings.
 - c. Assemble fitting by pushing with a slight twisting motion.

REMOVAL AND INSTALLATION (Continued)

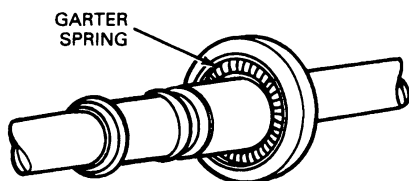
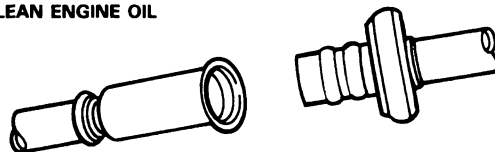
- d. To make sure of coupling engagement, pull on fitting and visually check to be sure garter spring is over flared end of female fitting.



REPLACEMENT O-RINGS
390846-S96 (3/8 INCH DIA.,
2 PER FITTING)
390847-S96 (1/2 INCH DIA.,
2 PER FITTING)



LUBRICATE O-RINGS WITH
CLEAN ENGINE OIL



V9058-A

9. Connect injector wiring harness to main harness connector.
10. Connect electrical connectors to engine coolant temperature sensor, water temperature sending unit and intake air temperature sensor.
11. Install distributor assembly in the proper position as noted during removal. Install distributor cap and wires.
12. Fill and bleed cooling system. Refer to Section 03-03.
13. Perform all post-service procedures as described in this section.

Air Intake Throttle Body

Removal

1. Open hood, disconnect battery negative cable and remove snow / ice shield.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
2. Remove air intake tube.
3. Remove PCV fresh air hose from throttle body and oil fill tube.
4. Disconnect electrical connectors from throttle position sensor and idle air control valve.
5. Loosen radiator cap to relieve cooling system pressure (allow engine to cool first). Remove and plug cooling hoses from EGR spacer.
NOTE: Some coolant will be lost from EGR spacer when throttle body is removed.
6. Remove AIRB / AIRD bracket attaching nuts, remove bracket from EGR spacer and place out of way.
7. Remove throttle body attaching nuts and throttle cable bracket.
8. Separate throttle body from EGR spacer.
9. Disconnect throttle cable at throttle ball stud, then remove throttle body from vehicle.

CAUTION: When disconnecting throttle cable from ball stud, use a screwdriver or similar tool close to the stud and pry slowly. Pulling by hand may damage cable.

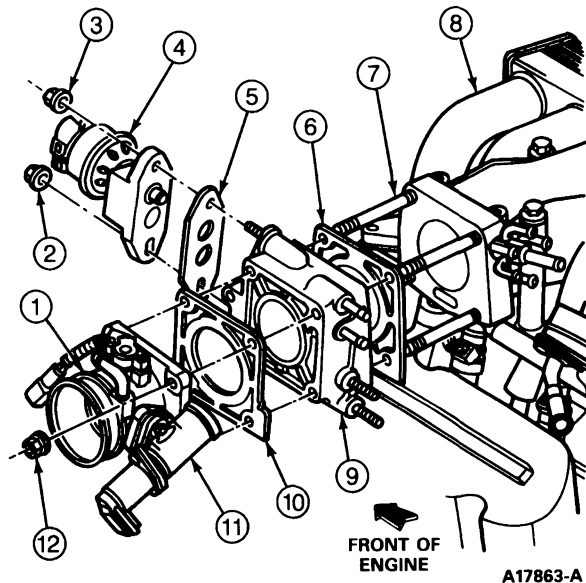
10. Remove EGR spacer from upper intake manifold.

Installation

1. Clean and inspect all gasket surfaces.
NOTE: If scraping is necessary, be careful not to damage gasket surfaces, or allow material to fall into upper intake manifold.
NOTE: The EGR spacer-to-intake manifold gasket and the throttle body-to-EGR spacer gasket are very similar to each other but are NOT to be interchanged.
2. Position new EGR spacer gasket onto studs and install EGR spacer.
3. Connect throttle cable to throttle body.
4. Position new throttle body gasket onto studs and install throttle body. Install mounting nuts and tighten to 17-24 N·m (12-18 ft·lb).
5. Connect throttle cable bracket.
6. Connect cooling hoses to EGR spacer and secure with clamps.
7. Position AIRB / AIRD bracket to EGR spacer and install attaching nuts.
8. Connect electrical connectors at throttle position sensor and idle air control valve.

REMOVAL AND INSTALLATION (Continued)

9. Connect PCV fresh air hose to throttle body and to oil fill tube.
10. Check and fill cooling system as required.
11. Install snow / ice shield and air intake tube.
12. Connect battery negative cable. Start engine and check for proper operation.



Item	Part Number	Description
1	9E926	Throttle Body Assembly
2	—	Nut and Washer Assembly 3/8-16 17-24 N·m (12-18 Ft-Lb) Lower EGR-To-EGR Spacer
3	—	Nut and Washer Assembly 5/16-18 17-24 N·m (12-18 Ft-Lb) Upper EGR-To-EGR Spacer
4	9F483	EGR Valve Assembly
5	9D476	Gasket, EGR-To-EGR Spacer Plate
6	9E464	Gasket, EGR Spacer Plate-To-Upper Intake
7	—	Stud, 5/16-18-18 x 4.12 (4 Req.) Throttle Body and EGR Spacer Plate Mount 17-24 N·m (12-18 Ft-Lb)
8	9425	Manifold, Upper Intake
9	9H474	EGR Spacer Plate
10	9E933	Gasket, Throttle Body-To-EGR Spacer Plate
11	9F115	Idle Air Control Valve
12	45357	Nut, 5/16-18 17-24 N·m (12-18 Ft-Lb) (4 Req.) Throttle Body-To-EGR Spacer

TA17863A

Throttle Position (TP) Sensor

Removal

1. Disconnect throttle position sensor from wiring harness.
2. Scribe a reference line across the edge of the sensor and the throttle body to make sure correct positioning is achieved during installation, if the same sensor is to be used.
3. Remove retaining screws and remove sensor from throttle body.

Installation

1. Position throttle position sensor to throttle body aligning scribe marks made during removal.
2. Install remaining screws and tighten to 2 N·m (18 in-lb).
3. Connect throttle position sensor to wiring harness.
4. Adjust throttle position sensor. Refer to the Powertrain Control / Emissions Diagnosis Manual.²
5. Start engine and check for proper operation.

Idle Air Control Valve

Removal

1. Disconnect vacuum and electrical connectors from EVR, AIRB / AIRD solenoids and idle air control valve.
2. Remove AIRB / AIRD solenoid bracket retaining nuts and position bracket out of the way.
3. Remove idle air control valve retaining screws.
4. Remove idle air control valve and gasket from throttle body.

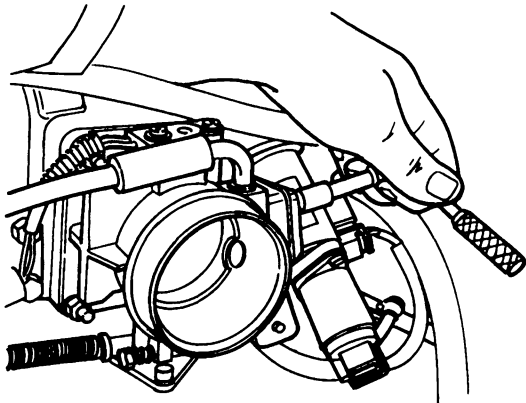
Installation

1. Clean and inspect mounting surfaces.
NOTE: If scraping is necessary, be careful not to damage gasket surfaces, or allow material to fall into throttle body.
2. Position gasket and idle air control valve onto throttle body and install retaining screws. Tighten screws to 8-11 N·m (71-97 in-lb).
3. Position AIRB / AIRD solenoid bracket to EGR spacer plate and install retaining nuts. Tighten nuts to 17-24 N·m (12-18 ft-lb).
4. Connect electrical and vacuum connectors to idle air control valve, AIRB / AIRD solenoids and emission vacuum control regulator.

² Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

5. Start engine and check for proper operation.



A19018-A

Fuel Supply Manifold Assembly**Removal**

1. Perform all pre-service procedures as described in this section.
2. Remove upper intake manifold as described in this section.
3. Remove fuel supply and return line retaining clips. Disconnect fuel supply and return lines from fuel supply manifold, using Disconnect Tools D87L-9280-A and D87L-9287-B or equivalents as follows:
 - a. Fit tool to coupling so that tool can enter cage opening to release the garter spring.
 - b. Push tool into the cage opening to release the female fitting from the garter spring.
 - c. Pull the coupling male and female fitting apart.
 - d. Remove the tool from the disconnected spring lock coupling.

USE SPECIFIED TOOL OR EQUIVALENT

TOOL SPRING LOCK CONNECTOR TOOL
D87L-9280-A — 3/8 INCH
D87L-9280-B — 1/2 INCH

CAGE OPENING

(A)

PUSH TOOL INTO CAGE OPENING

(B)

NOTE: SPECIFIED TOOL WILL FIT AROUND RUBBER COVERED FUEL LINE.

(C)

(D)

V9059-A

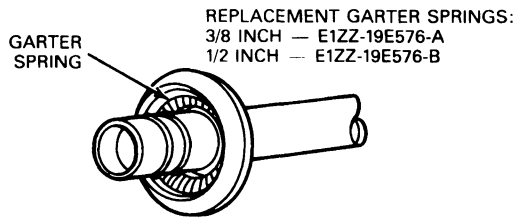
4. Remove four (two per group) fuel supply manifold retaining bolts.
5. Carefully disengage manifold from fuel injectors and remove manifold.

Installation

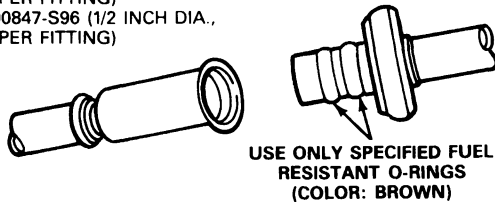
1. Make sure injector caps are clean and free of contamination.
2. Place the fuel supply manifold over each of the injectors, making sure the injectors are fully seated in both the supply manifold and lower intake manifold.
3. Install four retaining bolts and tighten to 8-17 N·m (70-150 in·lb).
4. Connect fuel supply and return lines to fuel supply manifold as follows:
 - a. Check for missing or damaged garter spring. Remove damaged spring with small hooked tool and install new spring.
 - b. Clean fittings with solvent. Check for missing or damaged O-rings. Replace missing O-rings. If either O-ring is damaged, replace both O-rings.
 - c. Assemble fitting by pushing with a slight twisting motion.

REMOVAL AND INSTALLATION (Continued)

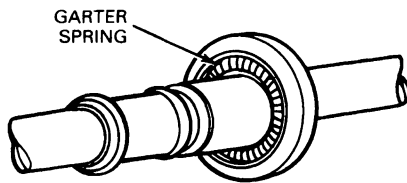
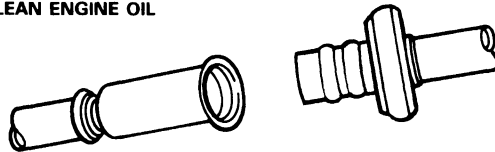
- d. To make sure of coupling engagement, pull on fitting and visually check to be sure garter spring is over flared end of female fitting.



REPLACEMENT O-RINGS
390846-S96 (3/8 INCH DIA.,
2 PER FITTING)
390847-S96 (1/2 INCH DIA.,
2 PER FITTING)



LUBRICATE O-RINGS WITH
CLEAN ENGINE OIL



V9058-A

5. Install fuel supply and return line retaining clips.
6. Install upper intake manifold as described in this section.
7. Perform all post-service procedures as described in this section.
8. Start engine and check for proper operation.

Fuel Pressure Regulator

Removal

1. Perform all pre-service procedures as described in this section.
2. Remove fuel supply manifold as outlined.

3. Remove three Allen screws and remove fuel pressure regulator from regulator housing.
4. Remove O-ring and gasket. Discard gasket and inspect O-ring for signs of deterioration.

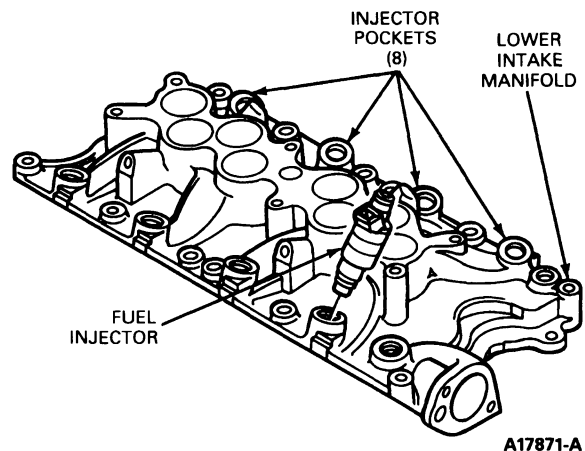
Installation

1. Clean and inspect pressure regulator and regulator housing mating surfaces.
NOTE: If scraping is necessary, be careful not to damage mating surfaces.
2. Lubricate fuel pressure regulator O-ring with 10W-30 oil (WSE-M2C903-A2) or equivalent.
CAUTION: Never use silicone grease to lubricate O-ring.
3. Install O-ring and new gasket on pressure regulator.
4. Position fuel pressure regulator and install Allen screws. Tighten screws to 3-4 N·m (27-35 in-lb).
5. Install fuel supply manifold as outlined.
6. Perform all post-service procedures as described in this section.
7. Start engine and check for proper operation.

Fuel Injector

Removal

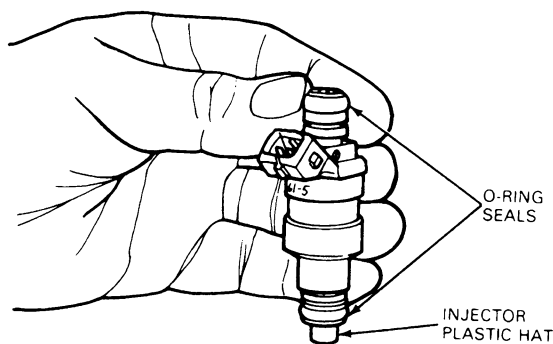
1. Perform all pre-service procedures as described in this section.
2. Remove upper intake manifold and fuel supply manifold as outlined.
3. Carefully disconnect electrical connectors from injectors.
4. Grasping injector body, pull up while gently rock injector from side to side.



A17871-A

REMOVAL AND INSTALLATION (Continued)

5. Inspect injector O-rings (two per injector) for signs of deterioration. Replace as required.
CAUTION: Do not attempt to clean the injector metering orifice with tools or brushes. Use Rotunda Injector Cleaner / Tester 113-00001 or equivalent.



V5040-1A

Installation

1. Lubricate new O-rings with 10W-30 oil (WSE-M2C903-A2) or equivalent and install two on each injector.
CAUTION: Never use silicone grease. It will clog the injectors.
2. Install injectors using light, twisting, pushing motion.
3. Connect electrical connectors to injectors.
4. Install fuel supply manifold as outlined.
5. Install upper intake manifold as outlined.
6. Perform all post-service procedures as described in this section.

5. Start the actuator and then start the engine.
6. Spray Carburetor Tune-Up Cleaner D9AZ-19579-AA or equivalent or about five seconds into the idle air control valve inlet passage while the actuator is operating.
CAUTION: Avoid direct spraying on throttle plate / bore area.
7. Stop the engine and actuator. Let everything soak for 15 minutes.
8. Start the actuator and then start the engine.
9. Spray the Carburetor Tune-up Cleaner into the idle air control valve passage leading to the inlet of the valve for up to one minute.
10. Stop the actuator and stop the engine.
11. Reinstall the air duct.
12. Start and run the engine for about one minute to dry out the solvent residue.
13. Operate the actuator to make sure the solvent is purged from the idle air control valve.
14. Disconnect the actuator from the idle air control valve.
15. Reattach the control signal lead to the idle air control valve.
16. Check the engine for normal operation.

Alternate Cleaning Procedure

NOTE: To be used only when tools for the preferred method are not available.

Remove the idle air control valve from the throttle body. Remove the electrical solenoid assembly from the mechanical portion of the idle air control valve by removing the two screws, then sliding the mechanical portion away from the solenoid.

Soak the mechanical portion in Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A) or equivalent for two to three minutes maximum.

CAUTION: Do not exceed three minutes soak time, and do not use choke cleaner as an internal O-ring may begin to deteriorate.

With the mechanical portion completely submerged, shake in all directions: up, down, right and left. Then push in on the rod that mates with the solenoid assembly, and again shake in all directions with the unit submerged and the rod held in as far as possible.

Remove the unit from the cleaning fluid and dry out thoroughly with compressed air.

CLEANING AND INSPECTION

Idle Air Control Valve Cleaning

CAUTION: This cleaning procedure may be used with sludge tolerant bodies which are identified with a yellow / black "attention" label. No attempt should be made to clean the throttle body bore / plate area by directly spraying or scrubbing.

1. Plug the actuator into the connector in Rotunda Cleaner / Tester 113-00009 or equivalent.
2. Remove the air duct to the throttle body inlet.
3. Disconnect the idle air control valve signal lead.
4. Attach the actuator harness plug to the idle air control valve.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

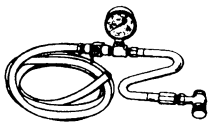
Description	N-m	Lb-Ft
Nut and Washer Assembly, EGR Retaining, Both	17-24	12-18
Stud, Throttle Body and EGR Spacer Plate Mounting, 5/16-18-18 x 4.12	17-24	12-18
Nut, Throttle Body-to-EGR Spacer Plate Retaining (4 Required)	17-24	12-18
Bolts, Upper Intake Manifold Retaining	17-24	12-18
Bolts and Studs, Lower Intake Manifold Retaining	31-33	23-25
Screws, TP Sensor Retaining	2	18
Screws, Idle Air Control Valve Retaining	8-11	71-97 In-Lb
Screws, AIRB / AIRD Solenoid Bracket Retaining	16-24	12-18
Bolts, Fuel Supply Manifold	8-17	70-150 In-Lb
Screws, Fuel Pressure Regulator	3-4	27-35 In-Lb

ROTUNDA EQUIPMENT

Tool Number	Description
113-00001	Injector Cleaner / Tester
113-00009	Air Bypass Actuator

Tool Number	Description
D87L-9280-B	Spring Lock Coupling Disconnect Tool 1/2 inch
D87L-9280-A	Spring Lock Coupling Disconnect Tool 3/8 inch

SPECIAL SERVICE TOOLS / EQUIPMENT

Tool Number / Description	Illustration
T80L-9974-B MFI Fuel Pressure Test Gauge	 <p>T80L-9974-B</p>

SECTION 03-05 Accessory Drive

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		DIAGNOSIS AND TESTING (Cont'd.)	
Belt Tension, Automatically Tensioned Belts	03-05-12	Engine Cooling Fan Clutch	03-05-4
Belt Tension, Manually Tensioned Belts, 7.5L Gasoline Engine	03-05-11	REMOVAL AND INSTALLATION	
Power Steering Pulley Alignment	03-05-12	Accessory Drive Belts	03-05-7
DESCRIPTION AND OPERATION		Automatically Tensioned Belts	03-05-7
Accessory Drive Belts	03-05-1	Fan and Viscous Clutch, 4.9L MFI	03-05-9
Fan and Clutch, Engine Operated	03-05-1	Fan and Viscous Clutch, 5.0L, 5.8L and 7.5L Engines	03-05-10
DIAGNOSIS AND TESTING		Fan and Viscous Clutch, 7.3L Diesel	03-05-10
Belt Tension, Automatically Tensioned Belts	03-05-6	Manually Tensioned Belts	03-05-8
Belt Tension, Manually Tensioned Belts	03-05-5	SPECIAL SERVICE TOOLS/EQUIPMENT	03-05-13
Diagnosis Guide	03-05-3	SPECIFICATIONS	03-05-12
		VEHICLE APPLICATION	03-05-1

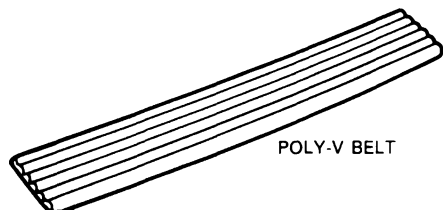
VEHICLE APPLICATION

All Light Truck Vehicles

DESCRIPTION AND OPERATION

Accessory Drive Belts

Ford vehicles are equipped with poly-V drive belts. To ensure maximum belt life, replacement belts should be of the same type and specification as originally installed.



Q4052-A

These belts must be properly tensioned at all times. Loose belt(s) will result in slippage which may cause a noise complaint or improper accessory operation (alternator will not charge, etc.). Overly tight belts will place severe loads on accessory bearings and result in premature belt or accessory failure. Refer to the illustrations in this section for the belt routing of each particular engine.

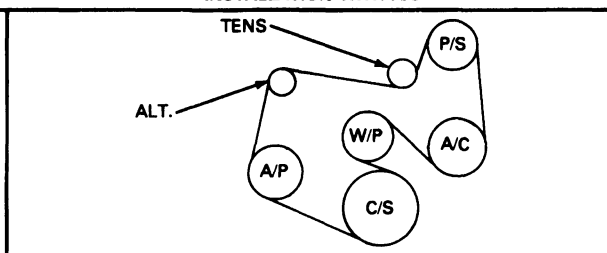
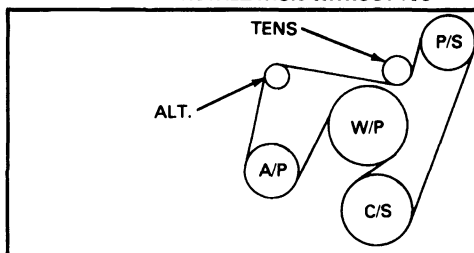
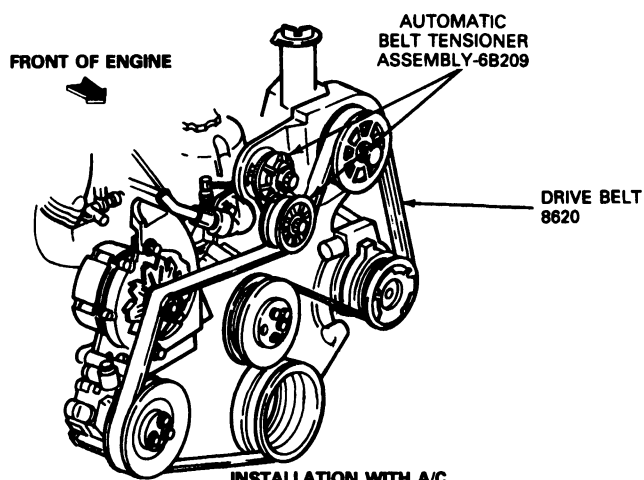
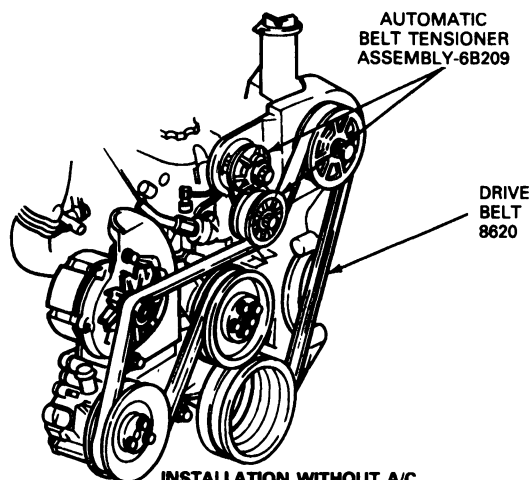
Fan and Clutch, Engine Operated

The fan and viscous clutch assembly is used to cool the engine. The fan is driven by the engine through the use of a drive belt(s).

If the fan drive belt(s) is noisy, refer to the Accessory Drive Diagnosis Guide in this section.

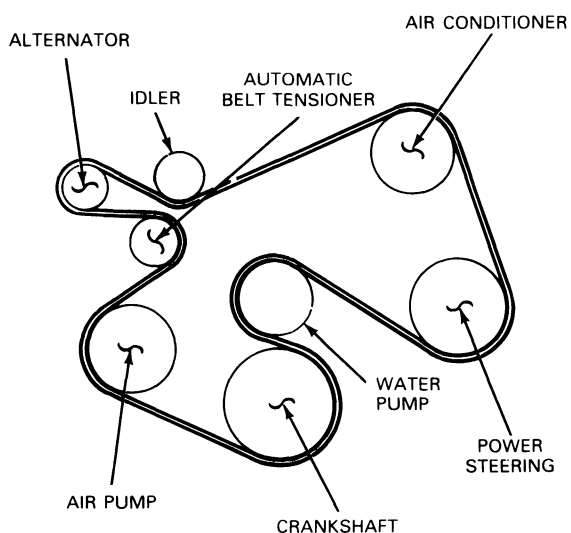
DESCRIPTION AND OPERATION (Continued)

4.9L MFI Engine Accessory Drive Belt



Q2475-F

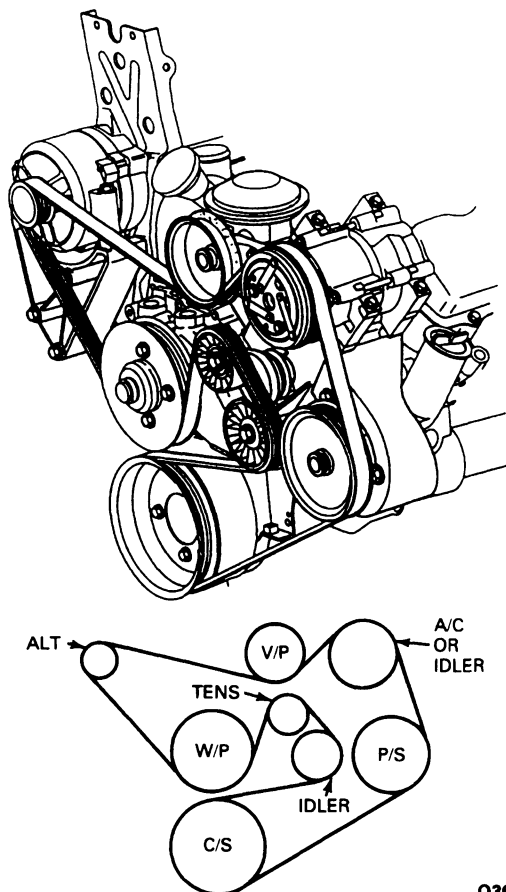
5.0L and 5.8L MFI Engines, Accessory Drive Belt



Q2601-E

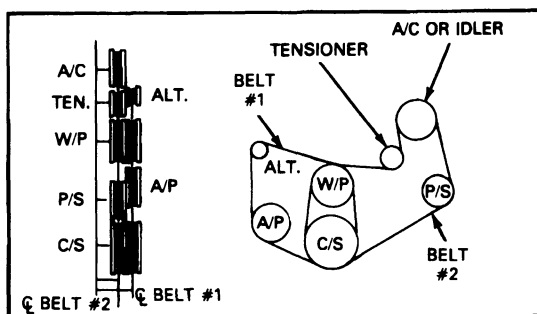
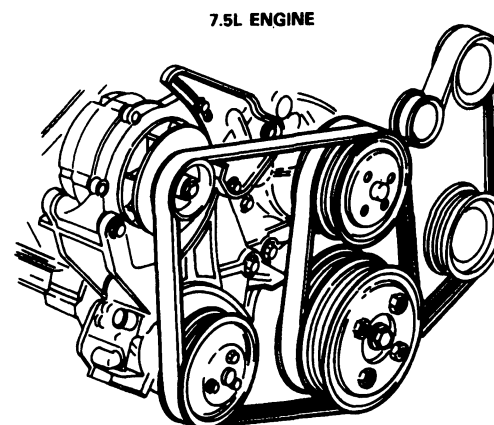
DESCRIPTION AND OPERATION (Continued)

7.3L Diesel Engine Accessory Drive Belt



Q3671-A

7.5L MFI Engine Accessory Drive Belt



Q2738-E

DIAGNOSIS AND TESTING

Diagnosis Guide

ACCESSORY DRIVE DIAGNOSIS GUIDE

CONDITION	POSSIBLE SOURCE	ACTION
Excessive noise Belt squeal.	<ul style="list-style-type: none"> Seized accessory. Loose belt. 	<ul style="list-style-type: none"> Check all accessories for free rotation and replace accessory if necessary. Replace belt. Check condition and tension of all belts. Replace belts or adjust tension of manually tensioned belts as necessary. Check that automatic tensioner is within the indicator marks. Check for correct belt length if tensioner is out of operating range.
Rattle.	<ul style="list-style-type: none"> Loose pulley or accessory. 	<ul style="list-style-type: none"> Check for looseness and tighten.
Noisy tensioner pulley bearing.	<ul style="list-style-type: none"> Worn bearing. 	<ul style="list-style-type: none"> Replace pulley per automatic belt tensioner pulley replacement procedure.
Belt chirp.	<ul style="list-style-type: none"> Misaligned power steering pulley. 	<ul style="list-style-type: none"> Align power steering per power steering pulley alignment procedure.

DIAGNOSIS AND TESTING (Continued)**ACCESSORY DRIVE DIAGNOSIS GUIDE (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
Severe belt flutter.	<ul style="list-style-type: none"> Loose belt. Binding tensioner arm. 	<ul style="list-style-type: none"> Check belt tension and adjust (manually tensioned belts only) if necessary. Check condition of belt and replace if necessary. Remove belt from automatic tensioner and verify that tensioner arm is not frozen in position or that arm does not bind when manually moved throughout its operating range.
Frayed belt.	<ul style="list-style-type: none"> Belt not seated correctly (poly-V belt). Severely misaligned pulley. Belt too tight. Belt worn out. 	<ul style="list-style-type: none"> Replace belt and verify correct belt seating. Use a straightedge to check for severe angular misalignment between adjacent pulleys. Correct as necessary. Replace belt. Replace belt.
Severely glazed belt.	<ul style="list-style-type: none"> Seized accessory. Loose belt. 	<ul style="list-style-type: none"> Check all accessories for free rotation and replace if necessary. Replace belt. Replace belt.
Improper accessory operation (power steering or air conditioning doesn't work, engine overheats or battery doesn't charge).	<ul style="list-style-type: none"> Loose belt. 	<ul style="list-style-type: none"> Check belt for looseness or glazing and replace or adjust tension of manually tensioned belts if necessary.
Belt jumps off pulley.	<ul style="list-style-type: none"> Greatly misaligned pulleys. Belt not seated correctly (poly-V belt). Pulley wobble. Excessive crankshaft end play. 	<ul style="list-style-type: none"> Check for misalignment between adjacent pulleys. Replace belt and verify correct seating. Verify that no pulley wobbles during engine operation. Conditions causing wobble are: bent pulley, bent accessory shaft, rear face of pulley not seated flat against mating surface. Engine rebuild.
Excessive wear on tensioner pulley.	<ul style="list-style-type: none"> Extended off-road operation. 	<ul style="list-style-type: none"> Replace pulley per automatic belt tensioner pulley replacement procedure.

TCQ2761C

Engine Cooling Fan Clutch

The purpose of this procedure is to determine whether the fan clutch is functioning properly, or to determine if clutch is not engaging, not disengaging, or causing vibration. Worn or damaged cooling fan clutches should be replaced with the proper service part. Do not attempt to modify the bi-metallic coil on the face of the face clutch. Locate a piece of cardboard large enough to cover the front of the radiator and an engine tachometer before proceeding with this diagnostic test, and proceed only after completing the engine cooling diagnosis procedure in Section 03-03 of the service manual.

1. Turn off air conditioner, heater-A/C fan, radio, and any other accessories.
2. Before starting the engine, rotate the fan and clutch assembly by hand. It should have some viscous drag, but it should turn smoothly during the full 360 degrees of rotation. The fan clutch should be replaced if it does not turn smoothly, or does not turn at all. If the fan clutch spins with no viscous drag when it is cold, and has not been run for an hour or more, it should be replaced.

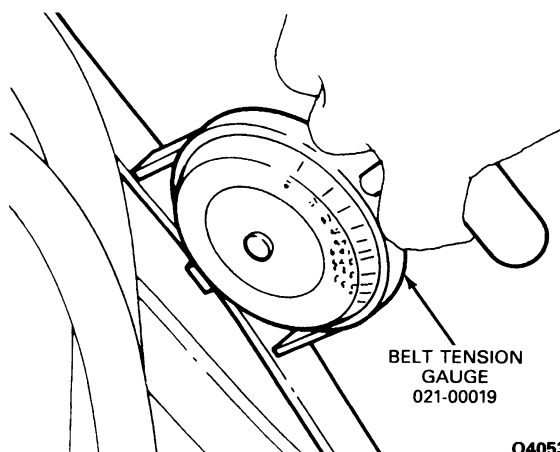
DIAGNOSIS AND TESTING (Continued)

3. To check for excessive fan clutch bearing clearance (cold fan clutch), hold the tip of the fan blade between the thumb and forefinger and lightly pull toward the radiator, then push toward the engine, repeating the motion several times. The total rocking movement at the end of the fan blade should be 5mm (2 / 10 inch) or less when no more than eight ounces of force is applied. A force greater than eight ounces may deflect the fan blade with erroneous results. Replace the fan clutch if more than 5mm (2 / 10 inch) of movement is observed.
4. Install a temporary engine tachometer if the vehicle is not equipped with a tachometer.
5. During the following tests, be sure to monitor the engine coolant temperature (temperature gauge in the instrument cluster) and shut off the engine if the temperature rises above the maximum recommended limit for the engine, or if coolant is discharged outside the system. The tests can be resumed using the following procedures after the coolant temperature drops off to a normal operating level.
6. If the hood is left open, the fan noise may be easier to hear.
7. Start the engine. The fan clutch may be engaged when the engine is first started. This will be apparent from the noise level of the fan which has a distinctive roar. The fan clutch engagement is due to the viscous silicone fluid draining back and filling the gap between input and output components. Running the engine at a constant speed of about 2000 rpm should pump the fluid back to its reservoir, disengaging the fan clutch after no more than five minutes. As the fan speed declines, the noise will drop off to level inaudible to most observers. If the fan does not disengage after five minutes at 2000 rpm, the fan clutch should be replaced. Repeat the test procedure after fan clutch replacement to verify the fix and to assure customer satisfaction.
8. Stop the engine. Cut and install a piece of cardboard large enough to cover the front of the radiator with a six inch diameter hole in line with the fan clutch. If it is not possible to install the cardboard directly against the radiator, attach it to the A/C condenser.
9. Start the engine. With the gas engine at 2700 to 3000 rpm (diesel at 2100 to 2300 rpm), the vehicle coolant temperature gauge will rise steadily as the engine warms, and then appear to level off for a short time when the thermostat opens. Make a note of the temperature gauge position when the thermostat opens. The engine coolant temperature will continue to rise until the fan clutch engages.

10. Continue to observe the coolant temperature gauge. As the fan clutch engages the fan noise will continue to increase and then level off at full engagement. The fan clutch may cycle off-and-on a few times during the initial engagement. If the fan clutch does not engage before the maximum safe operating engine coolant temperature is reached, it should be replaced (refer to Fan and Viscous Clutch removal in this section). Repeat the test procedure after fan clutch replacement to verify the fix and to assure customer satisfaction. The rate of rise of the coolant temperature will slow down after clutch engagement but it will continue to rise as long as the radiator remains covered.
11. After completion of the above tests, shut off engine. Remove the cardboard cover from the front of the radiator. Restart and return the gas engine to 2700 to 3000 rpm (diesel at 2100 to 2300 rpm), continuing to watch the coolant temperature which will begin to decrease. The fan rpm will drop to a reduced noise level where it was before the cycle began which indicates that the fan clutch has disengaged. If the fan clutch remains engaged and the coolant temperature has dropped below the thermostat opening temperature (as noted in Step 9) for at least five minutes, the fan clutch replaced. Repeat the test procedure after fan clutch replacement to verify the fix and to assure customer satisfaction.

Belt Tension, Manually Tensioned Belts

Use a standard poly-V belt tension gauge, such as Rotunda 021-00019 or equivalent. Tension measurements should be taken at midspan. Refer to Specifications chart for the correct belt tensions.



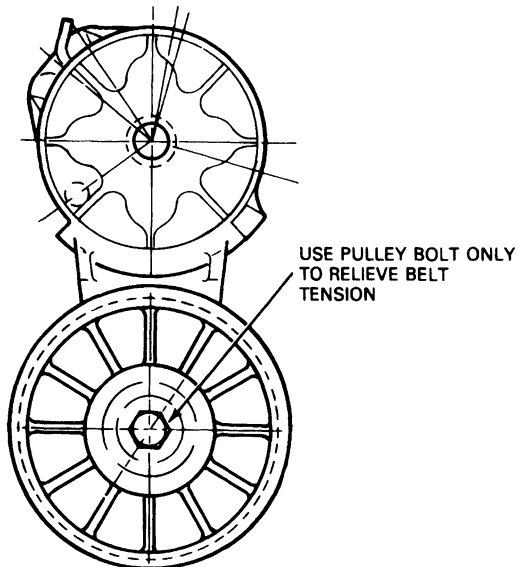
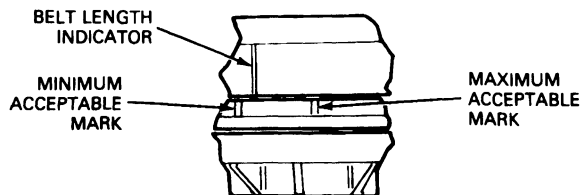
DIAGNOSIS AND TESTING (Continued)

Belt Tension, Automatically Tensioned Belts

The automatic belt tensioner will maintain correct belt tension if the correct length belt is on the engine. To verify that the tensioner is working properly on the 4.9L and 7.5L, check to see that the belt length indicator mark on the tensioner is between the maximum and minimum marks. The 5.0/5.8/7.3 tensioners do not have belt length indicator marks.

4.9L MFI, Belt Length Indicator

INDICATOR SHOULD BE BETWEEN MARKS

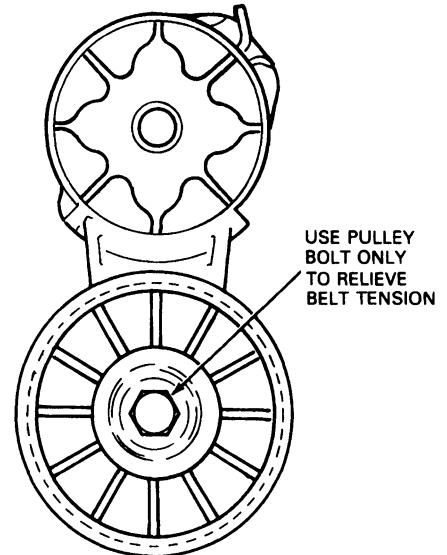
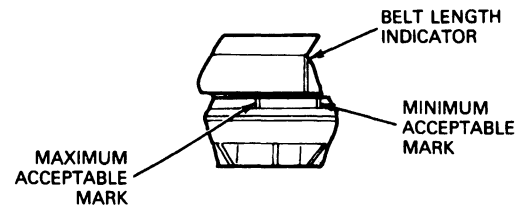


4.9L MFI TENSIONER

Q2739-C

7.5L MFI Belt Length Indicator

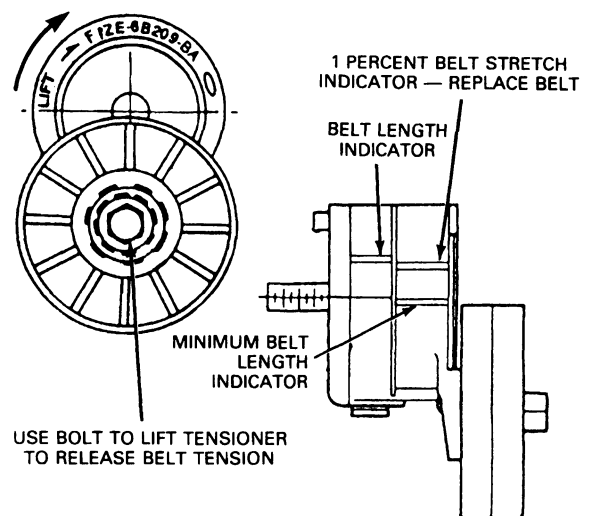
INDICATOR SHOULD BE BETWEEN MARKS



7.5L MFI TENSIONER

Q2741-B

7.5L MFI Belt Length Indicator, F-Super Duty Motorhome Chassis



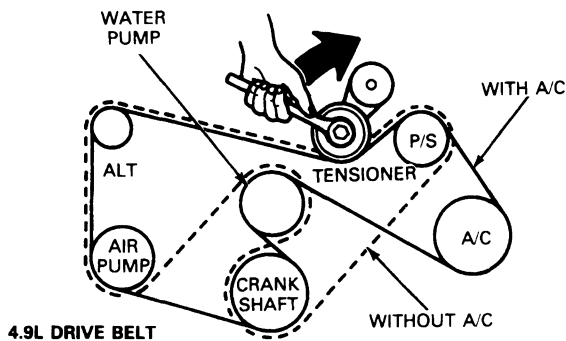
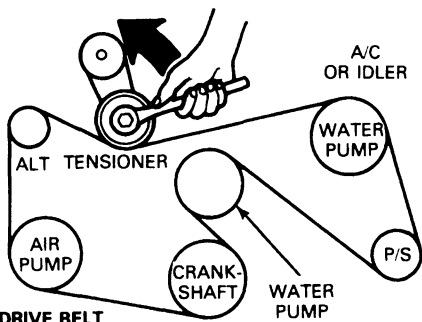
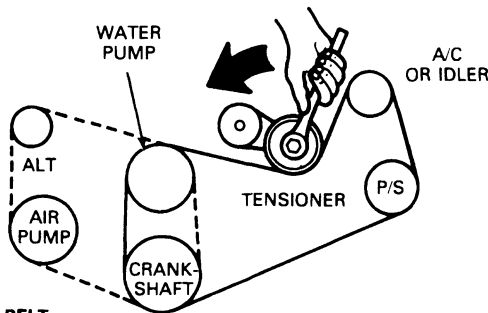
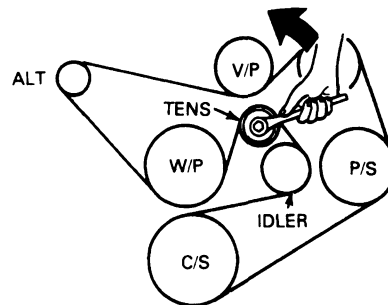
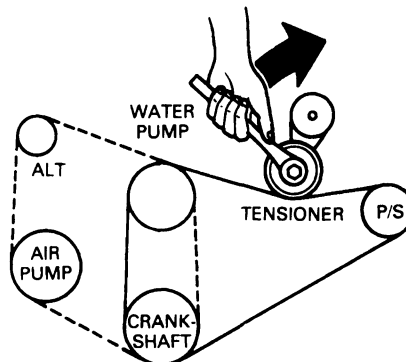
Q3672-A

The belt tension can be checked as follows:

DIAGNOSIS AND TESTING (Continued)

1. Install a 16mm or 5/8-inch wrench on the tensioner pulley bolt and rotate the tensioner arm to relieve all tension from the belt. Slowly return arm to rest against the belt and measure belt tension.

2. Rotate arm against belt causing the pulley to deflect approximately 1/2 inch from its rest position. Slowly release tension from arm and measure belt tension.
3. Average the two tensions and verify that result is above the minimum tension shown in Specifications chart.

Checking Belt Tension**4.9L DRIVE BELT****5.0L & 5.8L DRIVE BELT****7.5L DRIVE BELT****7.3L DIESEL DRIVE BELT****7.5L F-SUPER DUTY
MOTORHOME CHASSIS
DRIVE BELT**

Q2763-D

REMOVAL AND INSTALLATION**Accessory Drive Belts**

Conditions requiring belt replacement are excessive wear, severe glazing, frayed cords, etc. Replace any belt exhibiting any of these conditions.

NOTE: Minor cracks in the ribbed side of the belt are considered acceptable.

Proper removal and installation steps are as follows:

Automatically Tensioned Belts

1. Install a 16mm or 5/8-inch closed end wrench for 4.9L and 7.5L and a 15mm closed end wrench for the 5.0L, 5.8L and 7.3L on the tensioner pulley bolt and lift the tensioner arm away from the belt.

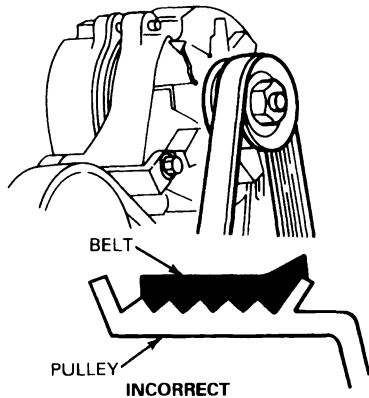
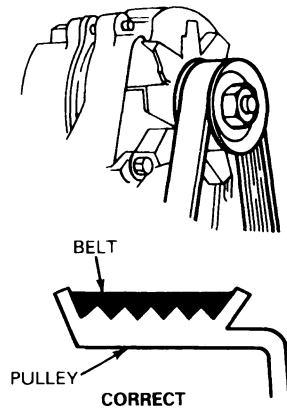
REMOVAL AND INSTALLATION (Continued)

2. Remove old belt. Release tensioner slowly. Do not allow tensioner to snap back after the belt is removed because this may damage the tensioner.

CAUTION: Make sure the belt is properly seated on all pulleys. One revolution of the engine with an incorrectly seated belt may snap tensile members in the belt.

3. Install new belt over pulleys making sure that all belt ribs are correctly seated in the pulley grooves.

Poly-V Belt Alignment



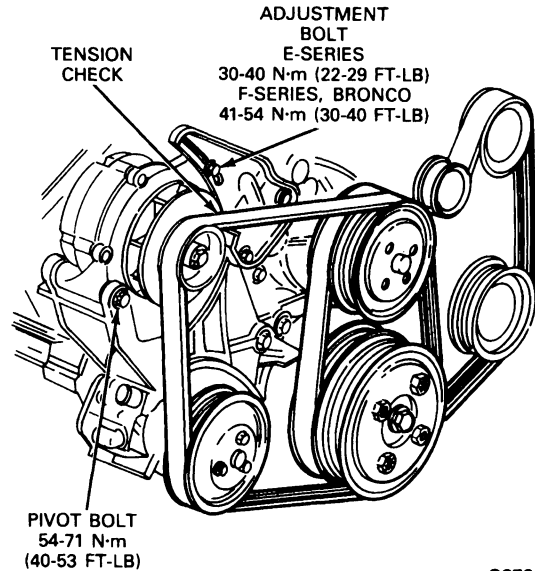
Q1696-F

Manually Tensioned Belts

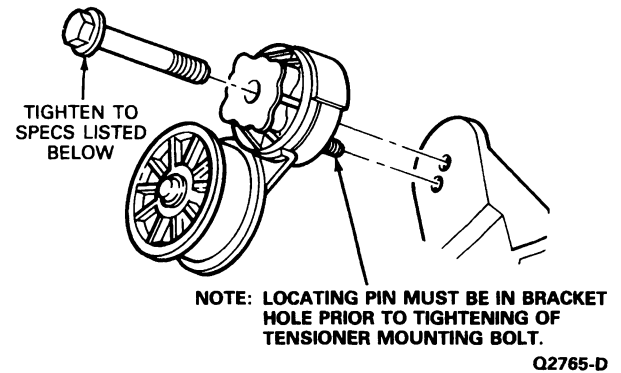
1. Loosen generator (alternator) adjustment bolts and pivot bolt as shown in the following illustration.

2. Remove old belt.
3. Install new belt and tension as described in this section.

7.5L MFI Engine Accessory Drive Belts



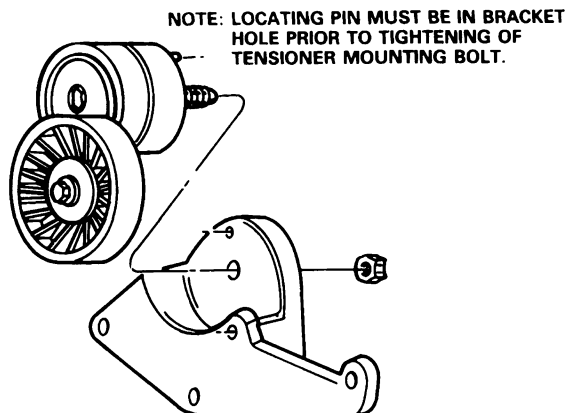
Automatic Tensioner



Engine	N·m	Ft-Lb
4.9L, 7.5L	68-92	50-68
5.0L, 5.8L, 7.3L	47-63	35-46
7.5L	24-32	18-24

REMOVAL AND INSTALLATION (Continued)

7.5L F-Super Duty Motorhome Chassis, Belt Tensioner



Q3673-A

Belt Tensioner Pulley Replacement

Engine	Tensioner	Replacement Pulley
4.9L / 7.5L	E7TA-6B209-HB E7TA-6B209-CB E7TA-6B209-FC	E9TA-19A216-BA

Conditions requiring pulley replacement are excessive pulley wear or pulley bearing noise usually resulting from extended operation in abrasive off-road conditions.

Using a 16mm closed end wrench, remove the drive belt per the Automatically Tensioned Belt removal procedure in this section.

- Using the same wrench, loosen the idler pulley retention bolt or nut.

NOTE: 7.5L (not F-Super Duty Motorhome Chassis) bolts have a left-hand thread, requiring clockwise motion to loosen. 4.9L and 7.5L F-Super Duty Motorhome Chassis idler pulley bolts have a conventional right-hand thread which loosens counterclockwise.

NOTE: Excessive rearward force on the bolt during removal may over-stress and crack the tensioner arm.

- Remove bolt or nut and dust shield and remove the pulley from the tensioner arm locating boss.

NOTE: Pulleys being replaced for suspected bearing wear should be evaluated for rough bearings. Bearing noise which continues or rapidly returns after a replacement pulley is installed is usually belt chirp rather than worn bearings. Bearings should rotate smoothly with a slight resistance due to the permanent lubrication.

- Replace the pulley and reverse the removal instructions observing the correct rotation of the retention bolt. Tighten bolt or nut to specifications.

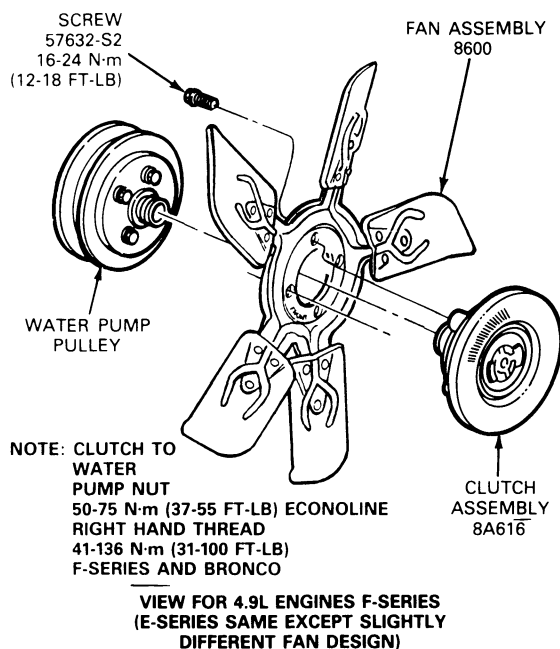
Fan and Viscous Clutch, 4.9L MFI

Removal

- Remove the fan shroud. Refer to Section 03-03.
- Remove the clutch assembly from the water pump by turning the large nut, which is part of the clutch, using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D.

CAUTION: This nut has a right-hand thread and must be rotated counterclockwise to remove it.

- Remove the fan and clutch assembly.
- If the fan and clutch have to be separated, remove the remaining bolts attaching the fan to the clutch.



Q1519-L

Installation

- Install all of the bolts attaching the fan to the clutch. Tighten all bolts to 16-24 N·m (12-18 ft-lb).
- Install the fan / clutch assembly on the water pump hub by turning the large nut, which is part of the clutch, using Fan Clutch Holding Tool T84T-6312-C and Fan Clutch Nut Wrench T84T-6312-D.

CAUTION: This nut has a right-hand thread and must be rotated clockwise to tighten it.

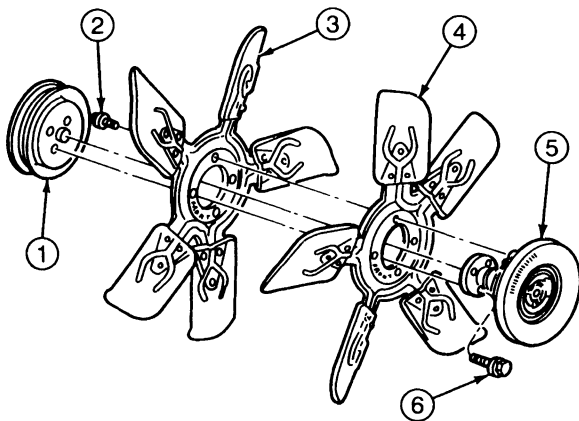
- Install the fan shroud. Refer to Section 03-03.

REMOVAL AND INSTALLATION (Continued)**Fan and Viscous Clutch, 5.0L, 5.8L and 7.5L Engines****Removal**

1. Remove shroud and radiator if necessary. Refer to Section 03-03.
2. Remove four screws retaining clutch on water pump hub.
3. Pull clutch and fan assembly off water pump pilot and remove assembly from vehicle.
4. Remove four screws and separate clutch from fan.

Installation

1. Position fan to clutch assembly and attach with four screws. Tighten screws to 16-24 N·m (12-17 ft-lb).
2. Position fan and clutch assembly to water pump pulley and attach with four screws. Tighten screws to 16-24 N·m (12-18 ft-lb).
3. Install the fan shroud. Refer to Section 03-03.



Q3565-C

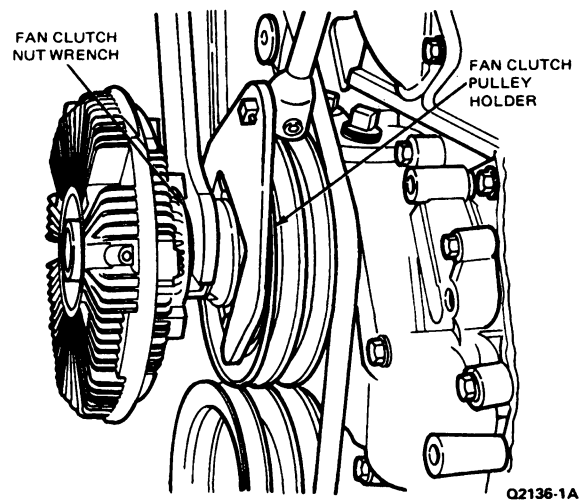
Item	Part Number	Description
1	8509	Water Pump Pulley
2	57632-S	Screw and Washer Assembly 5 / 16-18 x .62 Hex 16-24 N·m (12-18 Ft-Lb)
3	8600	Fan Assembly (5.0 and 5.8L)
4	8600	Fan Assembly (7.5L)
5	8A616	Fan Clutch Assembly
6	380288-S2	Screw and Washer Assembly 5 / 16-24 x .88 Hex 16-24 N·m (12-18 Ft-Lb)

Fan and Viscous Clutch, 7.3L Diesel**Removal**

1. Remove the fan shroud. Refer to Section 03-03.
2. Remove the clutch assembly from the water pump shaft by turning the nut, which is part of the clutch, using Fan Clutch Pulley Holder T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.

CAUTION: This nut has a left-hand thread and must be rotated clockwise for removal.

3. Remove the fan and clutch as an assembly.
4. Remove the bolts attaching the fan to the clutch, if necessary.



Q2136-1A

Installation

1. Install the bolts attaching the fan to the clutch. Tighten to 16-24 N·m (12-18 ft-lb).
2. Install the clutch / fan assembly on the water pump by turning the large nut which is part of the clutch.

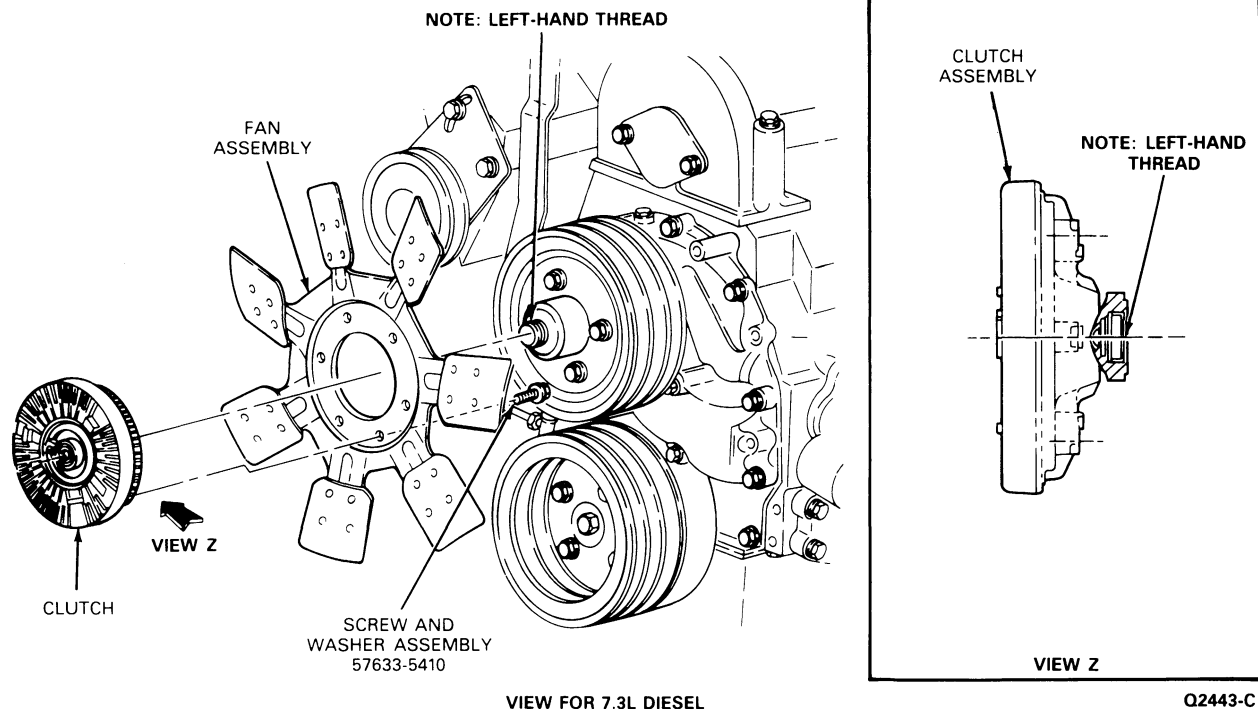
CAUTION: This nut has a left-hand thread and must be rotated counterclockwise for tightening.

Tighten to 113-153 N·m (83-113 ft-lb) using Fan Clutch Holding Tool T83T-6312-A and Fan Clutch Nut Wrench T83T-6312-B.

3. Install the fan shroud. Refer to Section 03-03.

REMOVAL AND INSTALLATION (Continued)

Fan and Clutch Assembly

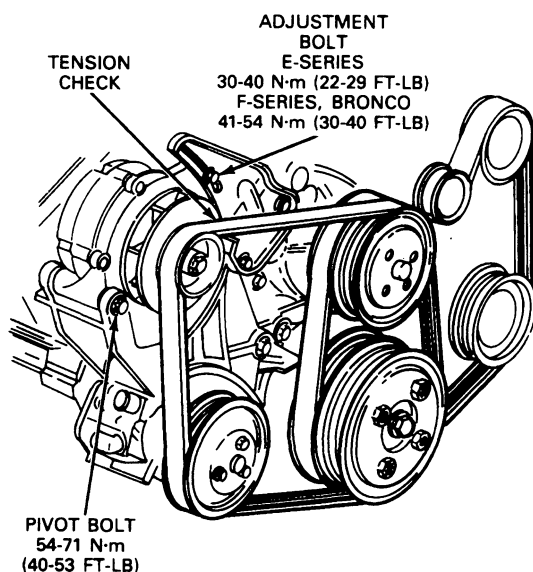


ADJUSTMENTS

Belt Tension, Manually Tensioned Belts, 7.5L Gasoline Engine

1. Use Rotunda Belt Tension Gauge 02 1-000 19 or equivalent for checking tension.
2. Loosen generator (alternator) adjustment bolts.

7.5L MFI Engine Accessory Drive Belts



3. Tighten pivot bolt enough to remove all free play from pivot area but not enough to prevent the generator (alternator) from rotating to allow belt tensioning.
4. Place an adjustable wrench on the top lug of the alternator and rotate generator (alternator) until the belt is tightened to the proper tension.

Be sure to use the new belt tension for new belts and the used belt tension for used belts. A used belt is a belt with more than 5 minutes of engine operation. See Accessory Drive Belt Tension chart in the Specifications portion of this section.

5. Tighten adjustment bolt to specification while maintaining belt tension. Refer to previous illustration for torque specification.
6. Tighten pivot bolt to specification. Refer to previous illustration for torque specification.
7. Check and readjust belt tension if necessary.
8. Start engine and idle for 5 minutes.
9. Recheck belt tension.
10. If tension is less than the minimum tension after 5 minutes operation from the table, then reset belt tension to within used belt tension limits. Start engine and idle for 5 minutes. Recheck belt tension.
11. If belt will not hold tension, then replace belt.

ADJUSTMENTS (Continued)

Power Steering Pulley Alignment

A chirping noise from the accessory drive belt that is more noticeable at idle than at higher speeds may be caused by a power steering pump pulley that is out of alignment.

The misaligned power steering pulley causes the accessory drive belt to chirp as the belt enters it on an angle on 4.9L engines, or after it leaves the power steering pulley, travels over the water pump pulley and enters into the crankshaft pulley on an angle on 5.0L and 5.8L engines. Verify that the chirping noise is coming from the entrance to one of these two pulleys by listening through a length of rubber hose or other type of stethoscope-like device.

If the chirp has been isolated to one of these pulleys then to correct this condition align the power steering pump pulley using the following service procedure.

CAUTION: Do not sand the edges of the drive belt or apply lubricants or dressings. These are only temporary fixes and may damage belt.

1. Clean the accessory drive belt with mild soap and water to wash away oil or other contaminants.
2. On some models, it may be necessary to remove the fan shroud to allow for proper installation and operation of the power steering pulley puller and installer tools.

CAUTION: Damaged accessory drive belts should be replaced before proceeding to Step 4. Only use a 16mm closed end wrench to lift the belt tensioner to avoid possible damage. A wedged screwdriver will crack the pulley or crack the housing.

3. Using Special Service tools T69L-10300-B (puller) and T65P-3A733-C (installer), set the power steering pump pulley hub to within $\pm .010$ inch of being flush with the end of the power steering pump shaft.
4. Operate the engine at idle for five (5) minutes to see if chirping noise has been corrected. If not, proceed to Step 5.
5. Select a direction and move the power steering pump pulley at .020 inch increments in that direction. After each move (increment), remove the tool and operate the engine for five (5) minutes. If chirp fades, alignment is being achieved; if chirp increases reverse the alignment direction. Continue moving the pulley until the noise is eliminated.
6. Reinstall the fan shroud.

NOTE: Accessory drive belt chirp not corrected by this procedure may be caused by a damaged pulley or bent accessory shafts. Steady pulsation of the belt tensioner pulley indicates this condition. Observe each pulley in the system for runout.

Belt Tension, Automatically Tensioned Belts

The automatic belt tensioner has no provision for adjustment and will be damaged if forced to travel beyond its operating range.

SPECIFICATIONS

Refer to the following charts for belt tension specifications.

ACCESSORY DRIVE BELT TENSION

Engine	Tensioning Method	Belt Type	New Belt Tension (0 Min. Operation)	Used Belt Tension (Greater Than 5 Min. Operation)	Min. Tension After 5 Min. Operation
4.9L	Automatic	6K "poly V" belt	Tension OK if tensioner within indicator marks. 60A / 75A 400 N (90 Lb) min. 100A 520 N (117 Lb) min.	Same as new	Same as new
5.0L 5.8L	Automatic	6K "poly V" belt	Tension OK is tensioner within indicator marks. 227 N (51 Lb) min.	Same as new	Same as new

(Continued)



SPECIFICATIONS (Continued)**ACCESSORY DRIVE BELT TENSION (Cont'd)**

Engine	Tensioning Method	Belt Type	New Belt Tension (0 Min. Operation)	Used Belt Tension (Greater Than 5 Min. Operation)	Min. Tension After 5 Min. Operation
7.5L	(A/C & P/S belt) Automatic	6K "poly V" belt	Tension OK if tensioner within indicator marks. 418 N (94 Lb) min.	Same as new	Same as new
7.5L	(Alt & Air Pump belt) Manual	6K "poly V" belt	711-889 N (160-200 Lb)	489-578 N (110-130 Lb)	467 N (105 Lb)
7.3L	Automatic	6K "poly V" belt	310 N (70 Lb) min.	Same as new	Same as new

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
Pivot Bolt, Alternator, 7.5L, All	54-71	40-53
Adjuster Bolt, Alternator, 7.5L, E-Series	30-40	40-53
Adjuster Bolt, Alternator, 7.5L F-Series	41-54	30-40
Bolt, Automatic Tensioner-to-Bracket, 4.9L, 7.5L	68-92	50-68
Bolt, Automatic Tensioner-to-Bracket, 5.0L, 5.8L, 7.3L Diesel	47-63	35-46
Screw, Fan-to-Clutch, 4.9L, 5.0L, 5.8L, 7.5L	16-24	12-18
Clutch-to-Water Pump, 4.9L	41-136	30-100
Screw, Clutch-to-Water Pump, 5.0L, 5.8L, 7.5L	16-24	12-18
Screw, Clutch-to-Water Pump, 7.3L	113-153	84-112

SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number / Description	Illustration
T63L-8620-A Belt Tension Gauge	 T63L-8620-A
T83T-6312-A Fan Clutch Pulley Holder	 T83T-6312-A

(Continued)

Tool Number / Description**Illustration**T69L-10300-B
Steering Pump Pulley Remover

T69L-10300-B

T65P-3A733-C
Steering Pump Pulley Replacer

T65P-3A733-C

T84T-6312-C
Fan Clutch Holding Tool

T84T-6312-C

T83-6312-B
Fan Clutch Nut Wrench

T83T-6312-B

ROTUNDA EQUIPMENT

Tool Number	Description
021-00019	Poly-V Ribbed Belt Tension Gauge

SECTION 03-06A Starter, Permanent Magnet

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION AND OPERATION		DISASSEMBLY AND ASSEMBLY (Cont'd.)	
Jump Starting.....	03-06A-4	Cleaning and Inspection.....	03-06A-11
Road Service.....	03-06A-4	Starter Drive Replacement.....	03-06A-12
Sequence of Operation.....	03-06A-1	Starter Motor Brushes Replacement.....	03-06A-12
DIAGNOSIS AND TESTING		REMOVAL AND INSTALLATION	
Bench Tests.....	03-06A-8	Starter Motor.....	03-06A-9
System Inspection.....	03-06A-5	SPECIAL SERVICE TOOLS/EQUIPMENT	03-06A-13
DISASSEMBLY AND ASSEMBLY		SPECIFICATIONS	03-06A-13
Armature Replacement.....	03-06A-13	VEHICLE APPLICATION	03-06A-1

VEHICLE APPLICATION

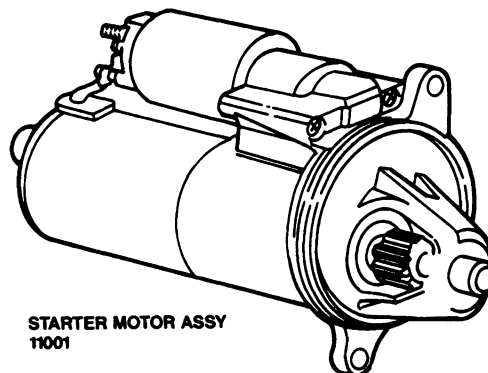
F-Series and Econoline Equipped with Gasoline Engines and Bronco

DESCRIPTION AND OPERATION

The function of the starting system is to crank the engine at a speed fast enough to permit the engine to start. Heavy cables, connectors, and switches are used in the starting system because of the large current required by the starter while it is cranking the engine. The amount of resistance in the starting circuit must be kept to an absolute minimum to provide maximum current for starter operation. A discharged or damaged battery, loose or corroded connections, or partially broken cables will result in slower than normal cranking speeds, and may even prevent the starter from cranking the engine.

In case of starting system trouble, the operator may have discharged the battery before calling for assistance. A road service procedure is presented to aid the service technician in such cases of starting trouble. Be sure to follow diagnosis procedures in the Powertrain Control/Emissions Diagnosis Manual¹, in order to locate the cause of the starting difficulty. Road service is not a part of the diagnosis procedures.

The starting system includes the permanent magnet gear-reduction starter motor with a solenoid-actuated drive, the battery, a remote-control starter switch (part of the ignition switch), the park/neutral position switch (automatic transmission), the clutch pedal position switch (manual transmission), the starter relay, and heavy circuit wiring.



Vehicles equipped with an automatic transmission have a park/neutral position switch in the starter control circuit, which prevents operation of the starter unless the selector lever is in the NEUTRAL or PARK position.

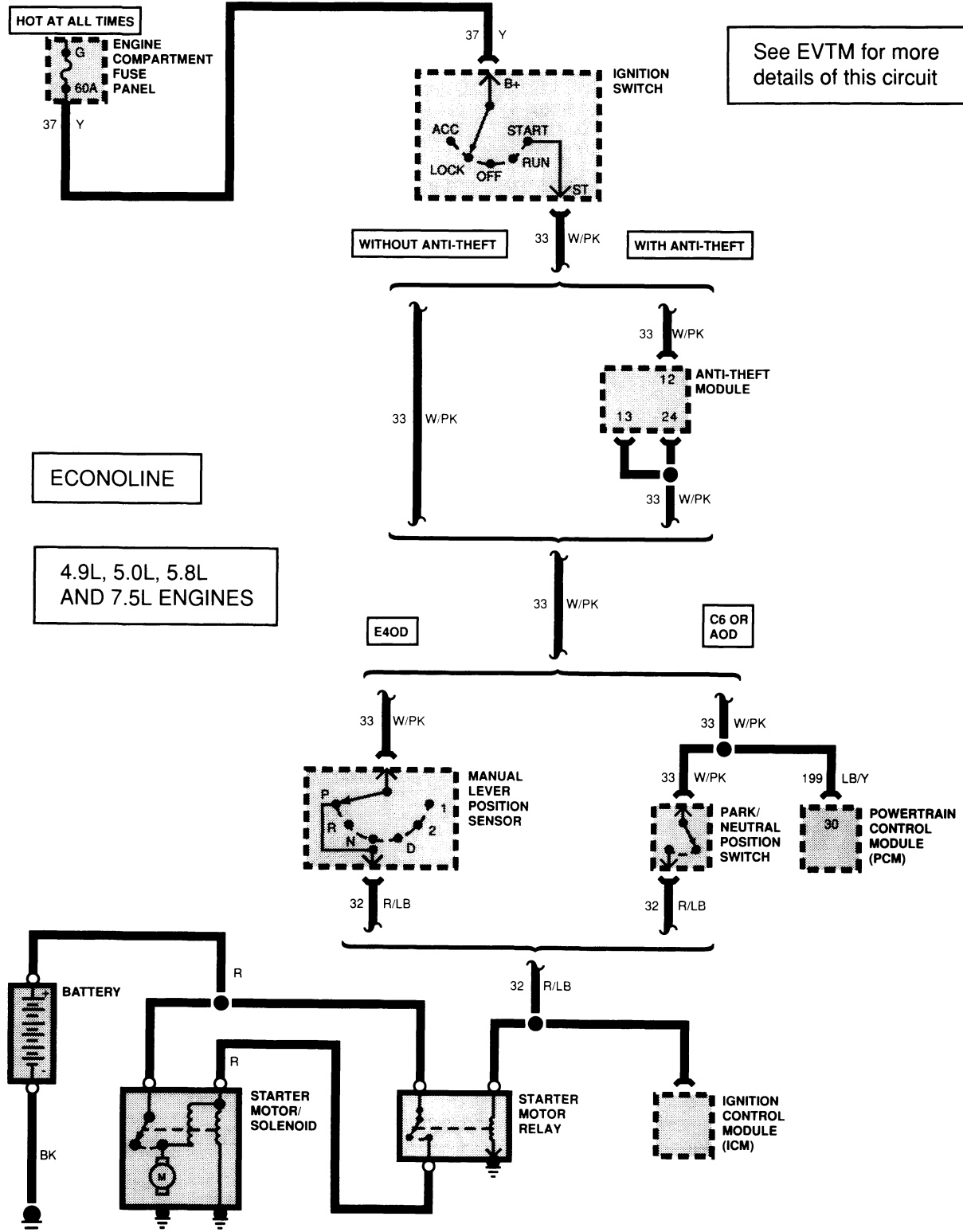
Vehicles equipped with a manual transmission have a clutch pedal position switch in the starter control circuit that prevents operation of the starter if the clutch pedal is not fully depressed.

Sequence of Operation

1. The ignition switch is turned to the START position.
2. A fender-mounted starter relay is energized, which provides voltage to the starter solenoid. The starter solenoid is energized, creating a magnetic field in the solenoid coil.
3. The iron plunger core is drawn into the solenoid coil.
4. A lever connected to the drive assembly engages the drive pinion gear to the flywheel ring gear.
5. When the iron plunger core is all the way into the coil, its contact disc closes the circuit between the battery and the motor terminals.

¹ Can be purchased as a separate item.

DESCRIPTION AND OPERATION (Continued)



ECONOLINE

4.9L, 5.0L, 5.8L AND 7.5L ENGINES

E4OD

**C6 OR
AOD**

J5357-A

DESCRIPTION AND OPERATION (Continued)

6. The current flows to the motor, and the drive pinion gear cranks the flywheel and the engine crankshaft.
7. As current flows to the motor, the solenoid pull-in coil is bypassed.
8. The hold-in coil keeps the drive pinion gear engaged with the flywheel.
9. The gear remains engaged until the ignition switch is released from the START position.

An overrunning clutch in the drive assembly protects the starter from excessive speeds during the brief period before the driver releases the ignition switch from the START position (as the engine starts).

Road Service

For cases of a starter that cranks the engine very slowly, connect a 12-volt booster battery to the system.

Jump Starting

To avoid damage to the vehicle and battery or the possibility of personal harm, follow these instructions and precautions:

WARNING: HYDROGEN AND OXYGEN GASES ARE PRODUCED DURING NORMAL BATTERY OPERATION. THIS GAS MIXTURE CAN EXPLODE IF FLAMES, SPARKS OR LIGHTED TOBACCO ARE BROUGHT NEAR THE BATTERY. WHEN CHARGING OR USING A BATTERY IN AN ENCLOSED SPACE, ALWAYS PROVIDE VENTILATION AND SHIELD YOUR EYES.

WARNING: KEEP OUT OF REACH OF CHILDREN. BATTERIES CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION. IN CASE OF ACID CONTACT WITH SKIN, EYES OR CLOTHING, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF FIFTEEN MINUTES. IF ACID IS SWALLOWED, DRINK LARGE QUANTITIES OF MILK OR WATER, FOLLOWED BY MILK OF MAGNESIA, A BEATEN EGG, OR VEGETABLE OIL. CALL A PHYSICIAN IMMEDIATELY.

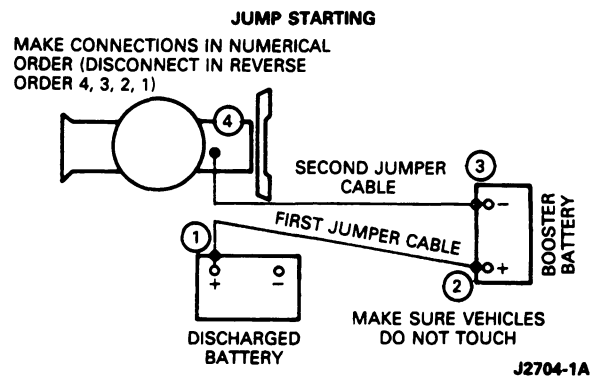
CAUTION: DO NOT DISCONNECT THE BATTERY OF THE VEHICLE TO BE STARTED. DISCONNECTING THE BATTERY COULD DAMAGE THE VEHICLE ELECTRONIC SYSTEM.

Negative Grounded Battery

WARNING: TO AVOID ANY POSSIBILITY OF INJURY, USE PARTICULAR CARE WHEN CONNECTING A BOOSTER BATTERY TO A DISCHARGED BATTERY.

1. Position vehicles so jumper cables will reach, being careful that vehicles do not touch.

2. Turn on heater blower motor of vehicle to be started (set control on DEFROST for vehicles equipped with automatic temperature control). Turn off other switches and lamps.
3. Make jumper cable connections.
 - Connect one end of first jumper cable to battery positive voltage (+) terminal of discharged battery and other end to battery positive voltage (+) terminal of booster battery.
 - Connect one end of second jumper cable to battery negative voltage (-) terminal of booster battery. Connect other end to an engine bolthead or good metallic contact spot on engine of vehicle to be started, NOT TO BATTERY NEGATIVE VOLTAGE (-) BATTERY TERMINAL.



WARNING: MAKING THE FINAL CABLE CONNECTION COULD CAUSE AN ELECTRICAL SPARK NEAR THE BATTERY AND COULD CAUSE AN EXPLOSION. REFER TO WARNINGS AT THE BEGINNING OF THE JUMP STARTING PROCEDURE.

CAUTION: When servicing starter or performing other underhood work in the vicinity of the starter, be aware that the heavy gauge battery input lead at the starter solenoid is "electrically hot" at all times.

A protective cap or boot is provided over this terminal that must be replaced after servicing. Be sure to disconnect battery negative cable before servicing starter.

- Make sure jumper cables are not in way of moving engine parts.
- Start engine of vehicle with good battery. Run engine at a moderate speed.
- Start engine of vehicle with discharged battery. Follow starting instructions in the Owner Guide.
- Leave all switches off except heater blower motor. Reduce engine speed to idle on both vehicles to prevent possible damage to vehicle electrical systems.

DESCRIPTION AND OPERATION (Continued)

4. Remove cables in exact REVERSE sequence.
Begin by removing cable from engine of vehicle that had discharged battery.

If the starter does not turn the engine over, even with the booster battery attached, refer to Symptom Chart in this section.

DIAGNOSIS AND TESTING**System Inspection**

WARNING: WHEN SERVICING STARTER OR PERFORMING OTHER UNDERHOOD WORK IN THE VICINITY OF THE STARTER, BE AWARE THAT THE HEAVY GAUGE BATTERY INPUT LEAD AT THE STARTER SOLENOID IS "ELECTRICALLY HOT" AT ALL TIMES.

A protective cap or boot is provided over this terminal and must be replaced after servicing. Be sure to disconnect battery negative cable before servicing starter.

CAUTION: When disconnecting the plastic hardshell connector at the solenoid "S" terminal, grasp the plastic connector and pull lead off. DO NOT pull separately on lead wire.

1. Inspect starting system for loose connections.
2. Note condition if system does not operate properly, and continue diagnosis using the symptom chart.

WARNING: WHEN WORKING IN AREA OF THE STARTER, BE CAREFUL TO AVOID TOUCHING HOT EXHAUST COMPONENTS.

Symptom Chart

CONDITION	POSSIBLE SOURCE	ACTION
Starter solenoid does not pull-in and starter does not crank (Audible click may or may not be heard).	<ul style="list-style-type: none"> ● Open fuse. ● Low battery. ● Open circuit or high resistance in external feed circuit to starter solenoid. ● Inoperative fender apron relay. ● Inoperative starter or solenoid. 	<ul style="list-style-type: none"> ● Check fuse continuity. ● Refer to appropriate battery section in this manual. ● Go to Pinpoint Test A. ● Go to Pinpoint Test B. ● Replace starter or solenoid. See removal and installation procedure.
Unusual starter noise during starter overrun.	<ul style="list-style-type: none"> ● Starter not mounted flush (cocked). ● Noise from other components. ● Ring gear tooth damage or excessive ring gear runout. ● Inoperative starter. 	<ul style="list-style-type: none"> ● Realign starter on transmission bell housing. ● Refer to Section 00-04. Investigate other powertrain accessory noise contributors. ● Inspect ring gear and service as required. ● Replace starter. See removal and installation procedure.
Starter cranks normally but engine does not start.	<ul style="list-style-type: none"> ● Problem in fuel system or electrical fuel system controls. ● Problem in ignition system. ● Engine related concern. 	<ul style="list-style-type: none"> ● Refer to appropriate fuel system section in this manual and the Powertrain Control/Emission Diagnosis manual.² ● Refer to appropriate ignition system section in this manual and the Powertrain Control/Emission Diagnosis manual.² ● Refer to appropriate engine section in this manual.

² May be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
Starter cranks slowly.	<ul style="list-style-type: none"> Low battery. High resistance or loose connections in starter solenoid battery feed or ground circuit. Ring gear runout excessive. Inoperative starter. 	<ul style="list-style-type: none"> Refer to appropriate battery section in this manual. Check that all connections are secure. Inspect ring gear and service as required. Perform start load test as described in this section.
Starter remains engaged and runs with engine.	<ul style="list-style-type: none"> Battery cable touching solenoid "S" terminal (worn or mispositioned cable). Inoperative starter. Starter relay remains engaged. 	<ul style="list-style-type: none"> Replace or relocate cable and replace starter. Replace starter. See removal and installation procedure. Refer to Pinpoint Test B.

TJ4971B

Pinpoint Test A

NOTE: Hoist vehicle (if necessary) to access starter solenoid terminals.

CAUTION: Remove plastic safety cap on starter solenoid and disconnect hardshell connector at solenoid "S" terminal as described under "Removal and Installation" in this section.

CHECK STARTER MOTOR — TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	CHECK FOR VOLTAGE TO STARTER		
	<ul style="list-style-type: none"> Key OFF. Transmission in PARK or NEUTRAL (automatic transmission), or clutch pedal fully depressed (manual transmission). Check for voltage between starter battery positive voltage (B+) terminal and starter drive housing. Is voltage OK? (12-12.45V) 	Yes No	GO to A2. CHECK wire connections between battery and starter solenoid and the ground circuit for open or short as outlined in this section.
A2	CHECK STARTER MOTOR		
	<ul style="list-style-type: none"> Key OFF. Transmission in PARK or NEUTRAL (automatic transmission), or clutch pedal fully depressed (manual transmission). Connect one end of a jumper wire to the starter battery positive voltage (B+) terminal and momentarily touch the other end to solenoid "S" terminal. Does starter crank? 	Yes No	CHECK connections from output of fender apron relay to "S" terminal for open or short. Defective starter. REPLACE starter. See Removal and Installation Procedure.

TJ4972B

Pinpoint Test B

CHECK FENDER APRON RELAY — TEST B

TEST STEP		RESULT	ACTION TO TAKE
B1	CHECK FENDER APRON RELAY		
	<ul style="list-style-type: none"> Key in START. Transmission in PARK or NEUTRAL (automatic transmission), or clutch pedal fully depressed (manual transmission). Is relay housing ground OK? 	Yes No	GO to B2. REPAIR ground. GO to B2.

DIAGNOSIS AND TESTING (Continued)**CHECK FENDER APRON RELAY — TEST B (Continued)**

TEST STEP		RESULT	ACTION TO TAKE
B2	CHECK VOLTAGE AT FENDER APRON RELAY START TERMINAL		
	<ul style="list-style-type: none"> ● Key in START. Transmission in PARK or NEUTRAL (automatic transmission), or clutch pedal fully depressed (manual transmission). ● Check for voltage between fender apron relay start terminal and relay housing ground. ● Is voltage OK? (12-12.45V) 	Yes No	GO to B3 . Open circuit or high resistance exists in external circuit wiring or components. CHECK the following: <ul style="list-style-type: none"> — All circuit connections including plastic hard-shell connector at solenoid "S" terminal to make sure it is not broken or distorted. — Ignition switch. — Park / neutral position switch or manual lever position sensor. — Anti-theft contact.
B3	CHECK OUTPUT TERMINAL VOLTAGE		
	<ul style="list-style-type: none"> ● Key in START. Transmission in PARK or NEUTRAL (automatic transmission), or clutch pedal fully depressed (manual transmission). ● Check for voltage at output terminal of fender relay. ● Is voltage OK? 	Yes No	REFER to Starter System Diagnosis in this section. Defective fender apron relay. REMOVE and REPLACE relay.

TJ4973B

Starter Load Test

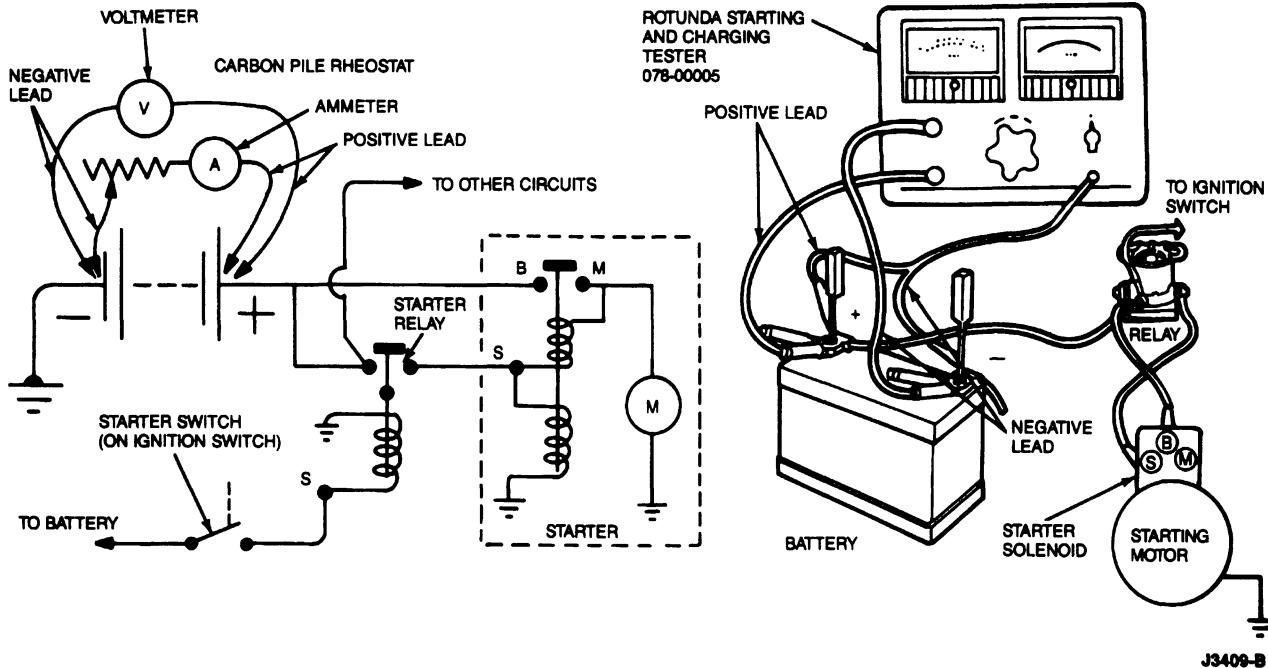
Conduct this test if the starter cranks slowly and it is desired to compare current to specifications.

1. Connect Rotunda Starting and Charging Tester 078-00005 or equivalent. Make sure that current is not flowing through ammeter and heavy-duty carbon pile rheostat portion of circuit (rheostat at maximum counterclockwise position).
2. Place transmission in NEUTRAL or PARK (automatic transmission), or fully depress clutch pedal (manual transmission). Crank engine with ignition off, and determine exact reading on voltmeter. This test is accomplished by disconnecting push-on connector S at starter relay and connecting a remote control starter switch from positive battery terminal to S terminal of starter relay.

3. Stop cranking engine, and reduce resistance of carbon pile until voltmeter indicates same reading as that obtained while starter cranked the engine. The ammeter will indicate starter current draw under load. Check this with value listed in Specifications.

DIAGNOSIS AND TESTING (Continued)

Starter Load Test



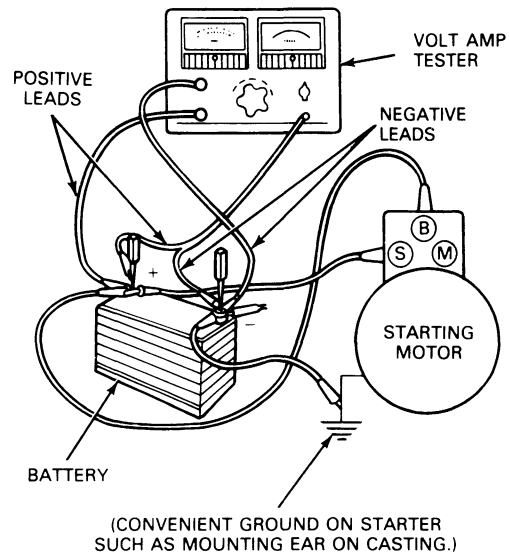
Bench Tests

Starter No-Load Test

The starter no-load test will uncover such conditions as open or shorted windings, or rubbing armature. The starter can be tested, at no-load, on the test bench only.

1. Make test connections with Rotunda Starting and Charging Tester 078-00005 or equivalent cables connected to starter, large enough to carry high current (the same as in the vehicle). The starter will run at no-load. Be sure that no current is flowing through ammeter (rheostat at maximum counterclockwise position). Determine exact reading on voltmeter.

CAUTION: Make sure that the starter is securely mounted in bench vise while energizing, as starter will move or jump.



2. Disconnect starter from battery. Then, reduce resistance of rheostat until voltmeter indicates same reading as that obtained while starter was running. The ammeter will indicate starter no-load current draw. Refer to Specifications at the end of this section for a comparative value.

DIAGNOSIS AND TESTING (Continued)

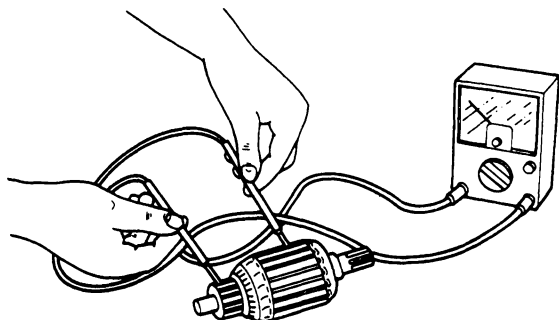
3. Check for rubbing armature, bent shaft, binding bearings, or shorts in armature, or brush assembly if current exceeds specification.

Armature Open Circuit Test

An open circuit armature may sometimes be detected by examining the commutator for evidence of burning. A burn spot on the commutator is caused by an arc formed every time the commutator segment, connected to the open circuit winding, passes under a brush.

Grounded Armature Test

This test will determine if the winding insulation has been damaged, permitting a conductor to touch the frame or armature core. To determine if the armature windings are grounded, check with a Digital Volt-Ohmmeter 007-0001 or equivalent, as shown. Infinite resistance indicates a normal condition.

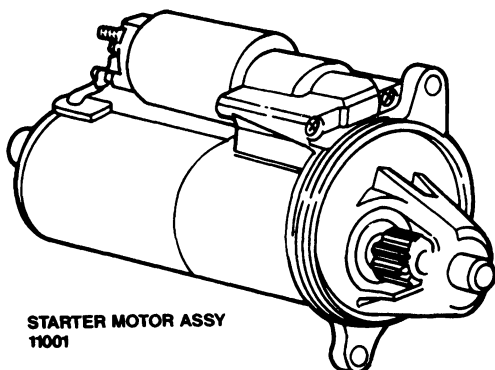


J3411-A

Starter Solenoid Test

Make sure that the solenoid is isolated electrically from the motor. Using a Digital Volt-Ohmmeter 007-0001 or equivalent, check for continuity between S terminal and M terminal, and between S terminal and ground (frame). If there is no continuity the following conditions may exist:

- open wire; replace solenoid.
- ice, dirt or other foreign material preventing contact.

STARTER MOTOR ASSY
11001

J3406-A

REMOVAL AND INSTALLATION**Starter Motor****Removal**

WARNING: WHEN SERVICING STARTER OR PERFORMING ANY MAINTENANCE IN THE AREA OF THE STARTER, NOTE THE HEAVY GAUGE INPUT LEAD CONNECTED TO THE STARTER SOLENOID IS HOT AT ALL TIMES. MAKE SURE THE PROTECTIVE CAP IS INSTALLED OVER THE TERMINAL AND IS REPLACED AFTER SERVICE.

1. Disconnect the battery negative cable.

NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

2. Raise the vehicle on a hoist. Refer to Section 00-02.
3. Disconnect starter cable and push-on connector from starter solenoid.

CAUTION: When disconnecting hardshell connector at S-terminal, grasp the plastic shell and pull off. Do not pull on wire. Be careful to pull straight off to prevent damage to the connector and S-terminal. If any part of the connection is damaged, replace the damaged components.

4. Remove upper bolt.
5. Remove lower bolt.

Installation

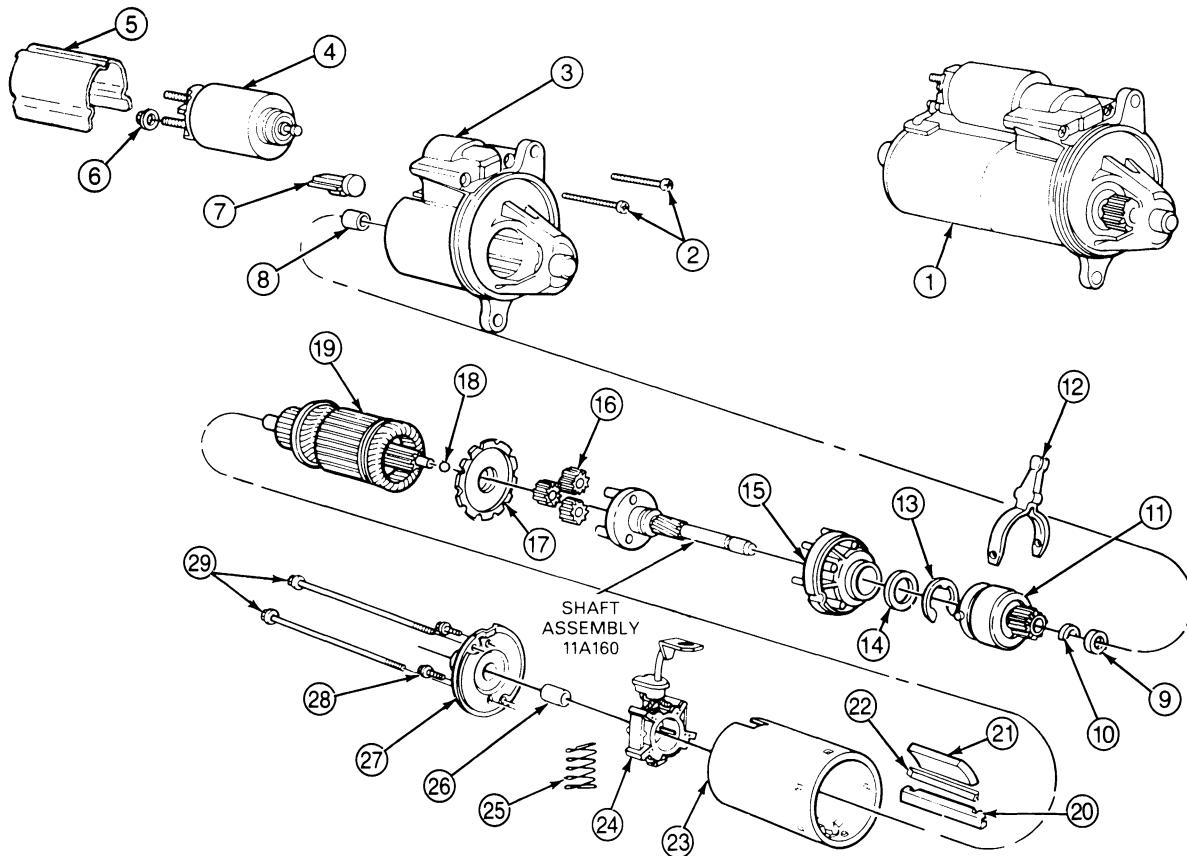
1. Position starter motor to engine and install upper and lower bolt finger-tight.
2. Tighten the upper bolt to 20-27 N·m (15-20 ft-lb).
3. Tighten the lower bolt to 20-27 N·m (15-20 ft-lb).
4. Be sure that solenoid heat shield is properly positioned over solenoid. Connect starter solenoid connector. Be careful to push straight on and make sure connector locks in position with a notable click or detent.
5. Install starter cable nut to starter terminal. Tighten to 9-14 N·m (80-124 in-lb).
6. Replace red solenoid safety cap.
7. Lower vehicle to floor.
8. Connect battery negative cable.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

DISASSEMBLY AND ASSEMBLY

NOTE: Although disassembly and service procedures are shown for the starter motor in this section, it is recommended that the starter motor be returned to Ford Return Parts Center for analysis and review.

Starter Motor, Exploded View



J5390-A

Item	Part Number	Description
1	11000	Starter Motor Assembly
2	N805405	Solenoid Screws
3	11130	Drive End Housing
4	11390	Starter Solenoid
5	11A059	Solenoid Heat Shield
6	N805403	Terminal Nut
7	11A171	Housing Seal Assembly
8	11135	Bushing
9	11223	Stop Ring Retainer
10	11222	Stop Ring
11	11350	Drive Assembly
12	11070	Drive Letter
13	N805404	Truarc E-Ring
14	11A075	Armature Thrust Washer

(Continued)

Item	Part Number	Description
15	11A165	Stationary Gear Assembly
16	11K190	Planet Gear
17	11A167	Gear Retainer
18	11A172	Armature Thrust Ball
19	11005	Armature Assembly
20	11A169	Magnet Retainer (6 Req.)
21	11A168	Magnet Pole Piece (6 Req.)
22	11A161	Pole Shunt (6 Req.)
23	11076	Starter Frame
24	11434	Brush Assembly
25	11059	Spring (4 Req.)
26	11135	Bushing
27	11050	Brush End Plate
28	N805406	Brush Plate Screw
29	N805428	Through Bolt

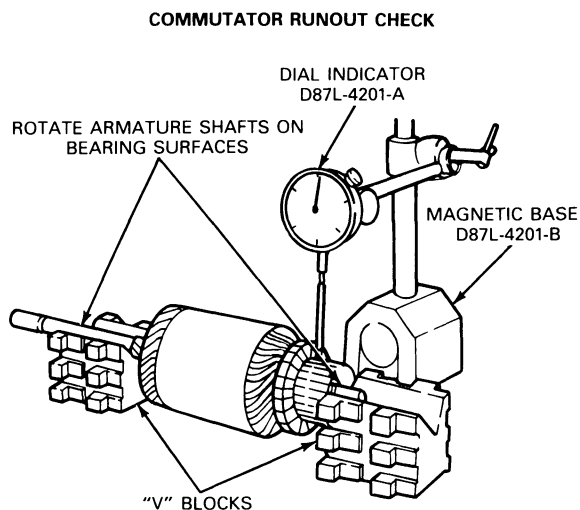
DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

1. Remove positive brush connector from solenoid motor (M) terminal.
2. Remove solenoid retaining screws and solenoid.
3. Remove through-bolts and separate drive end housing from starter frame. Remove housing seal assembly from drive. Remove drive and gear assembly from drive end housing.
4. Remove drive lever from drive assembly. Remove stop ring and retainer from driveshaft, then remove drive assembly from shaft. Push E-ring off driveshaft, and separate gear assembly from driveshaft.
5. Remove brush plate screws and brush end plate from starter frame. Remove brush assembly and push armature out of frame.

Cleaning and Inspection

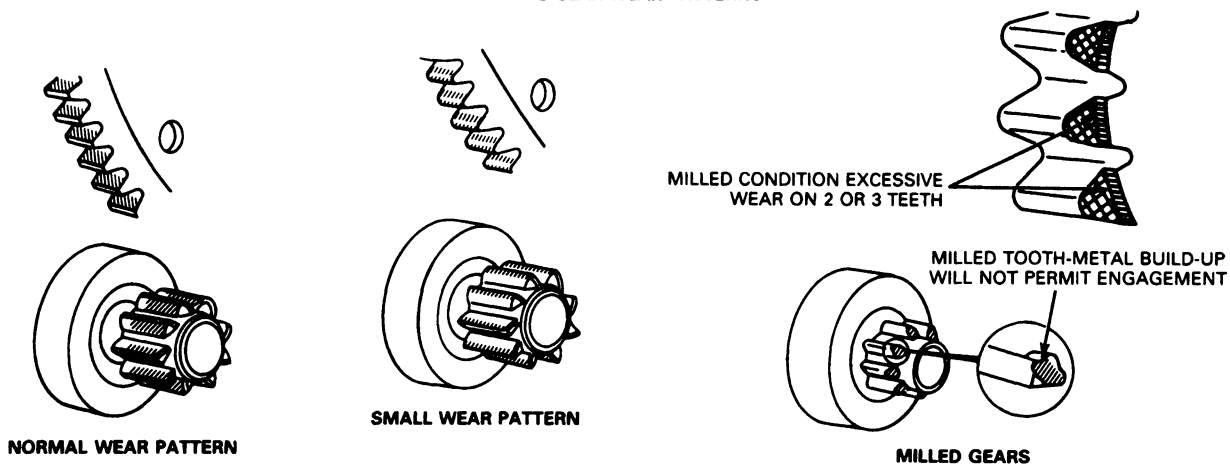
CAUTION: DO NOT WASH THE DRIVE BECAUSE THE SOLVENT WILL WASH OUT THE LUBRICANT CAUSING DRIVE TO SLIP. USE A BRUSH OR COMPRESSED AIR TO CLEAN THE DRIVE, ARMATURE, BRUSH, AND GEAR ASSEMBLIES, DRIVE END HOUSING, POLE PIECES AND PLANET GEARS. WASH ALL OTHER PARTS IN SOLVENT AND DRY.

1. Inspect armature windings for broken or burned insulation and unwelded or open connections.
2. Check armature for open circuits, shorts and grounds. Check for pole rub or rub on magnetic shunts.
3. Check commutator for runout. Inspect armature shaft and two bearings for scoring and excessive wear with Dial Indicator D87L-4201-A and Magnetic Base D87L-4201-B or equivalent. If commutator is rough, or more than 0.12mm (.005 inch) out of round, it must be replaced.



J2711-C

4. Examine gears, spline on driveshaft, and drive pinion for chipped, broken or worn conditions. Replace if required.

PINION AND RING GEAR WEAR PATTERNS

J2713-2A

DISASSEMBLY AND ASSEMBLY (Continued)**Assembly**

1. Install armature assembly in starter frame. Apply a thin coating of ESF-M1C2 18-A Grease or equivalent low temperature grease on both ends of armature shaft and spline. Install brush assembly making sure brushes fit over commutator. Apply grease to bearing bore in brush end plate. Push back grommet onto frame and attach brush end with brush plate screws. Tighten to 2-3 N·m (18-27 in-lb).
2. Apply grease to driveshaft spline and place stationary gear assembly over driveshaft. Install armature thrust washer and push E-ring onto driveshaft. Place drive assembly onto shaft and install stop ring and retainer. Attach drive lever to drive assembly.
3. Grease and install planet gears.
4. Apply grease into drive end housing bearing bore (approximately one-quarter full). Install drive gear assembly into housing, making sure to line up bolt holes in gear assembly and housing. Place gear retainer over gear assembly. Install housing seal assembly into drive end housing.
5. Position starter frame to housing and install through-bolts. Tighten to 5.0-10 N·m (45-89 in-lb).
6. Position solenoid to housing ensuring that solenoid plunger is attached through drive lever (bottom solenoid terminal (M) should have a metal strip attached to it). Tighten solenoid bolts to 5-10 N·m (45-89 in-lb).
7. Attach positive brush connector to solenoid (bottom terminal). Tighten nut to 9-14 N·m (80-124 in-lb).
8. Check that starter no-load current draw is within specification. Refer to Bench Tests.

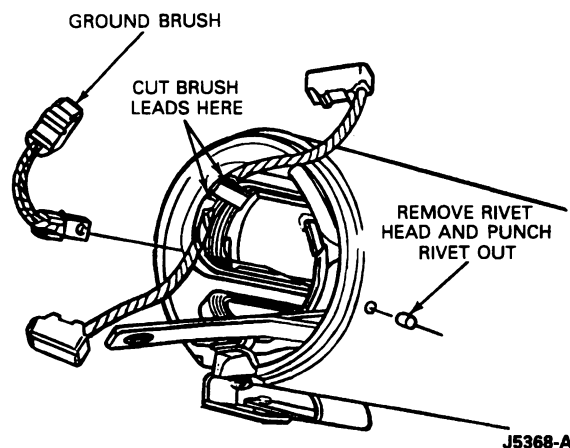
Starter Drive Replacement

1. Remove positive brush connector from solenoid motor (M) terminal. Remove solenoid retaining screws and remove solenoid.
2. Remove through-bolts and separate motor assembly drive end housing. Remove housing seal from drive end housing. Remove drive gear assembly from housing and detach drive lever.
3. Remove stop ring and retainer from driveshaft and then remove drive assembly.
4. Apply a thin coating of ESF-M1C2 18-A Grease or equivalent low temperature grease on driveshaft spline. Install new drive gear assembly on driveshaft. Install new stop ring and retainer. Attach drive lever.
5. Partially fill drive end housing bearing bore with grease (approximately one-quarter full). Install drive gear assembly in housing, making sure to line up bolt holes in gear assembly and housing.
6. Install lever support and housing seal in drive end housing.

7. Position starter frame to housing and install through-bolts. Tighten to 5-10 N·m (45-89 in-lb).
8. Install solenoid. Refer to Assembly.

Starter Motor Brushes Replacement

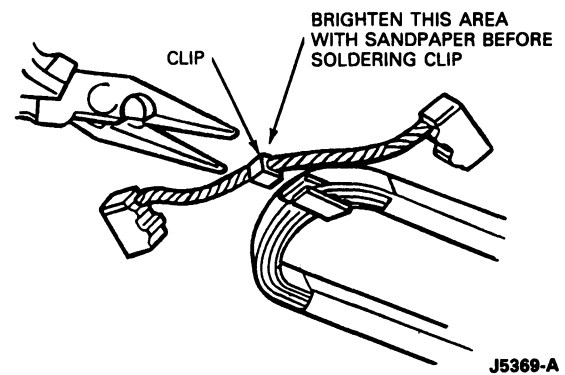
1. Remove starter drive plunger lever cover.
2. Remove the two through-bolts from the starter.
3. Remove the brush end plate.
4. Remove brush spring and pull brushes loose from brush holder.
5. Remove brush holder.
6. Remove the drive end housing and the plunger lever return spring.
7. Remove the starter drive plunger lever pivot pin and lever and remove the armature.
8. Remove ground brush rivet head with file or chisel and remove rivet with 1/8-inch punch.
9. Cut the brush leads from the field coils as close to the field connection point as possible.



10. Clean and inspect the starter motor.
11. Position the new field brush lead on the field coil connection. Position and crimp the clip provided with the brushes to hold the brush lead to the connection. Solder the lead clip and connection together using rosin core solder. Use a 300 watt iron.
12. Rivet the ground brush leads to the frame with rivets provided in the brush kit.
13. Clean the commutator with 00 or 000 sandpaper.
14. Install the armature in the starter frame.
15. Install the starter drive gear plunger lever to the frame and starter drive assembly and install the pivot pin.
16. Install brush holder and insert brushes in holder and install brush springs.
17. Install the brush end plate.
18. Install the two through bolts to the starter frame.

DISASSEMBLY AND ASSEMBLY (Continued)

19. Install starter drive plunger lever cover and tighten retainer screw.
20. Connect the starter to a battery to check operation.

**Armature Replacement**

1. Remove positive brush connector from solenoid motor (M) terminal.
2. Remove through-bolts and separate motor from gear assembly and drive end housing.
3. Remove brush end plate screws, brush end plate and brush assembly from starter frame. Remove armature from frame.
4. Install new armature in frame. Apply a thin coating of ESF-M1C218-A Grease or equivalent low temperature grease on both ends of armature shaft and pinion.
5. Install brush assembly. Using tool, make sure that brushes fit over commutator. Push black grommet onto frame. Apply grease to bearing bore in brush end plate and attach to starter frame.
6. Position starter frame to gear assembly and drive end housing and install through-bolts. Tighten to 5-10 N·m (45-89 in·lb).
7. Attach positive brush connector to solenoid (bottom terminal). Tighten nut to 9-14 N·m (80-124 in·lb).
8. Check that starter no-load current draw is within specification. Refer to Bench Testing.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N·m	In-Lb
Solenoid Bolt	5-10	45-89
M Terminal Nut	9.0-14	80-124
B Terminal Nut	9.0-13.5	80-124

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N·m	In-Lb
Through-Bolt	5-10	45-89
Mounting Bolt	20-27	15-20 (Lb-Ft)
Brush Plate Screw	2-3	18-27

Starter Motor				Load		Starter Brushes	
Motor Diameter	Current Draw Under Normal Load	Normal Engine Cranking Speed	Min. Stall Torque @ 5 Volts	Max. Load	No Load	Mfg. Length	Spring Tension
101.6mm (4 Inches)	130-220 Amps	140-220 RPM	14.7 N·m (11.0 Ft-Lb)	800 Amps	70 ± 10	16.8mm (0.66 Inch)	18 N (64 oz.)

Maximum commutator runout is 0.12mm (0.005 inch). Maximum starting circuit voltage drop (battery positive terminal to starter terminal) at normal engine temperature is 0.5 volt.

SPECIAL SERVICE TOOLS/EQUIPMENT

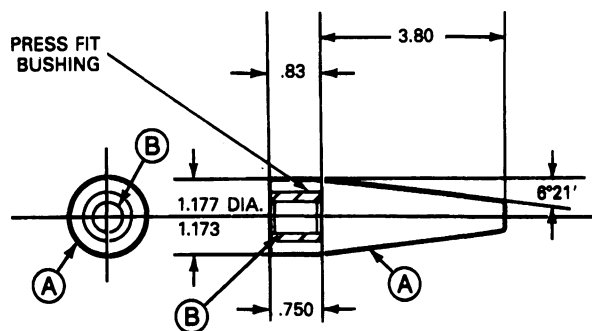
Tool Number	Description
D87L-4201-A	Dial Indicator
D87L-4201-B	Magnetic Base

SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

ROTUNDA EQUIPMENT

Tool Number	Description
078-00005	Starting and Charging Tester
007-00001	Digital Volt-Ohmmeter

TOOL TO ASSEMBLE BRUSH HOLDER TO ARMATURE



BRUSH HOLDER ASSEMBLY

- (A) MANDREL
MAT'L: MICAATA LL221
TAN-TYPE FBL

STK: 13/8 DIA. + ▲-LG
(1) REQ'D

- (B) BUSHING
UNIVERSAL HEADLESS TYPE
PRESS FIT BUSHING
CAT. NO. GS-93
.471/.472 I.D. .7518 O.D. .750 LG.
(1) REQ'D

J4974-A

SECTION 03-06B Starter, Gear Reduction

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		DESCRIPTION AND OPERATION	03-06B-1
Armature and Field Grounded Circuit Test	03-06B-10	DIAGNOSIS AND TESTING	
Armature Open Circuit Test.....	03-06B-10	Brush Holder	03-06B-5
Performance Test (No-Load Test).....	03-06B-9	Diagnosis Guide	03-06B-6
Pinion Gap.....	03-06B-9	Field Coils	03-06B-5
CLEANING AND INSPECTION		Jump Starting.....	03-06B-5
Armature Shaft and Commutator.....	03-06B-9	Starter Solenoid	03-06B-5
Bearings.....	03-06B-9	DISASSEMBLY AND ASSEMBLY	
Brush Holder and Brushes.....	03-06B-9	Starter Motor.....	03-06B-7
Gears	03-06B-9	REMOVAL AND INSTALLATION	
Overrunning Clutch	03-06B-9	Starter Motor.....	03-06B-6
Pole Shoes	03-06B-9	SPECIAL SERVICE TOOLS/EQUIPMENT	03-06B-10
		VEHICLE APPLICATION	03-06B-1

VEHICLE APPLICATION

All Vehicles Equipped with 7.3L Diesel Engines

DESCRIPTION AND OPERATION

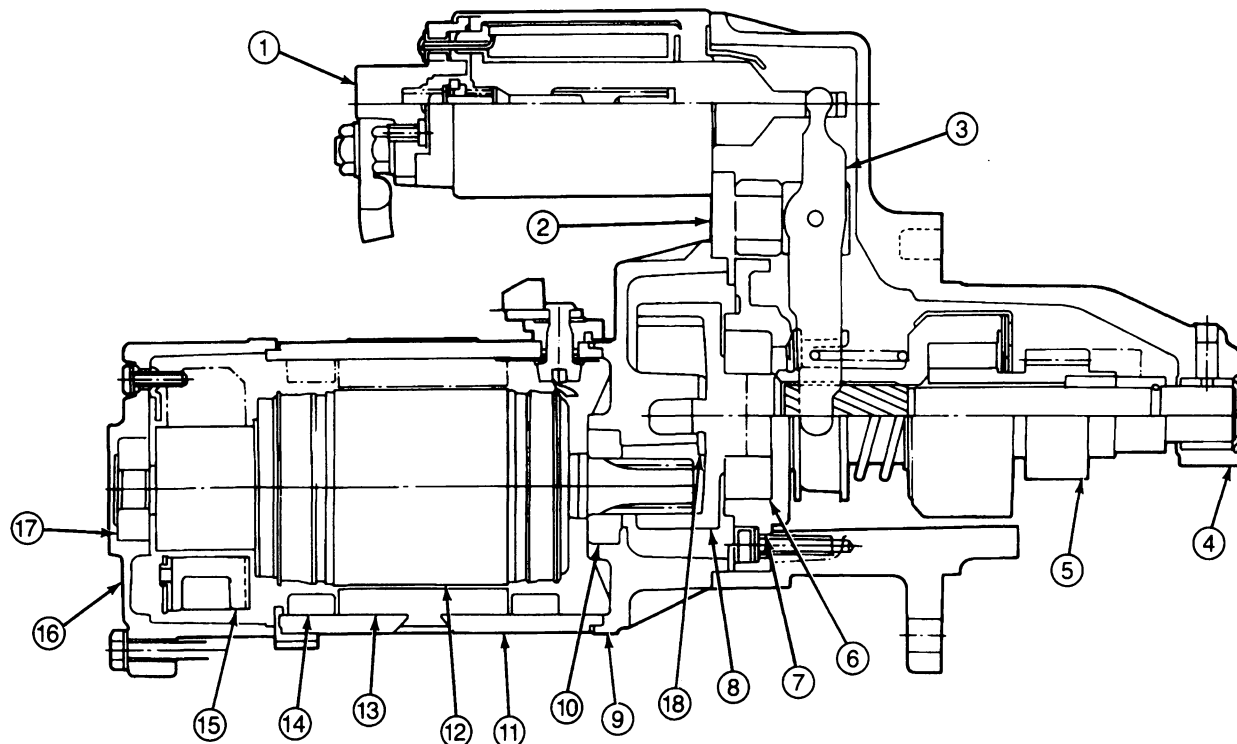
The Mitsubishi starter motor is a compact gear reduction type starter that utilizes an integral starter solenoid. With a gear reduction system, the starter motor can be relatively small and still provide the necessary torque to crank the engine.

When the ignition switch is closed, current flows to coils P and H. As current flows in the coils of the switch, the plunger is pulled in and this causes the drive pinion to be pushed out into engagement with the flywheel ring gear. At the same time, the main solenoid contact (P1) closes and allows battery voltage to pass to the starter motor. When the P1 contact is closed, no current flows in coil P and the solenoid plunger is held in by coil H.

When the ignition switch is opened (after engine start-up), contact P1 opens, and the starter motor disengages and stops. The drive pinion is pulled out of engagement with the flywheel by the return spring in the main solenoid.

DESCRIPTION AND OPERATION (Continued)

Starter



J4990-A

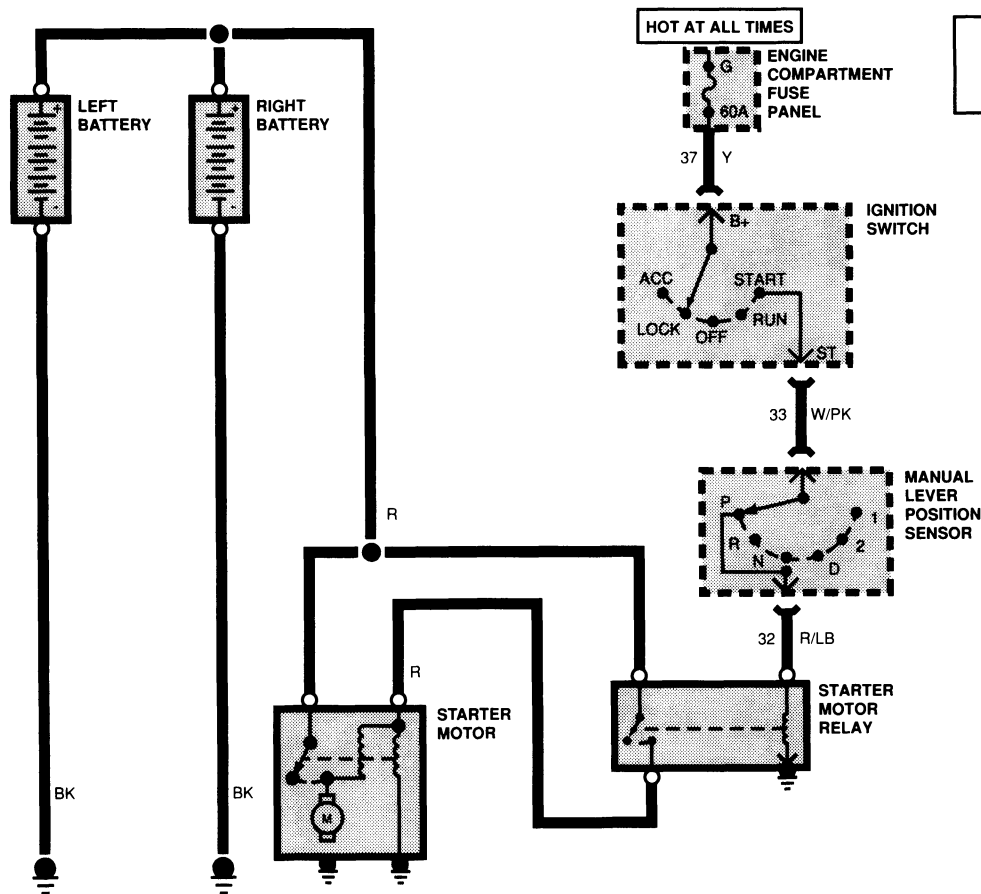
Item	Description
1	Solenoid
2	Seal
3	Lever
4	Drive End Housing
6	Shaft Bearing
7	Gear Housing (Inner)
8	Internal Gear Assembly
9	Gear Housing Outer

(Continued)

Item	Description
10	Bearing
11	Frame Assembly
12	Armature
13	Pole
14	Field Coil
15	Brush
16	Brush End Plate
17	Bearing
18	Shim

DESCRIPTION AND OPERATION (Continued)

Starter Circuit, Econoline



See EVTM for more details of this circuit

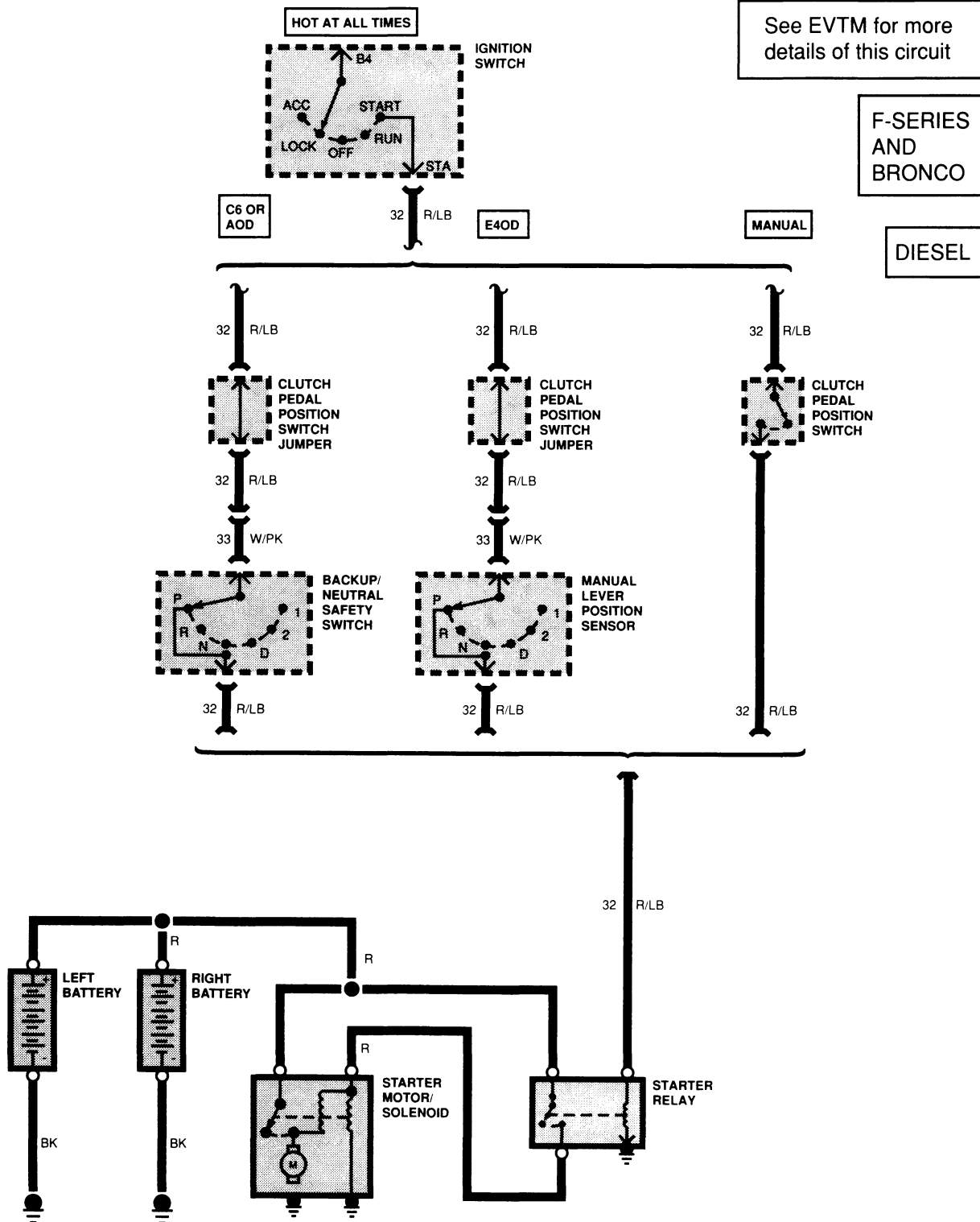
ECONOLINE

7.3L DIESEL ENGINE

J5360-A

DESCRIPTION AND OPERATION (Continued)

Starter Circuit, F-Series and Bronco



J5362-A

DIAGNOSIS AND TESTING

Jump Starting

The following instructions for starting the vehicle with jumper cables contain precautions that should be observed to avoid possible injury, or damage to the vehicle.

WARNING: KEEP BATTERIES OUT OF REACH OF CHILDREN. THEY CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION. IN CASE OF ACID CONTACT WITH SKIN, EYES, OR CLOTHING, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF 15 MINUTES. IF ACID IS SWALLOWED, DRINK LARGE QUANTITIES OF MILK OR WATER, FOLLOWED BY MILK OF MAGNESIA, A BEATEN EGG OR VEGETABLE OIL. CALL A PHYSICIAN IMMEDIATELY.

WARNING: HYDROGEN AND OXYGEN GASES ARE PRODUCED DURING NORMAL BATTERY OPERATION. THIS GAS MIXTURE CAN EXPLODE IF FLAMES, SPARKS OR LIGHTED TOBACCO ARE BROUGHT NEAR THE BATTERY. WHEN CHARGING OR USING A BATTERY IN AN ENCLOSED SPACE, ALWAYS PROVIDE VENTILATION AND SHIELD YOUR EYES.

CAUTION: Use only a 12-volt jumper system. A 12-volt starting motor and ignition system can be damaged beyond repair by connecting it to a 24-volt power supply (two 12-volt batteries in series, or a 24-volt motor generator set).

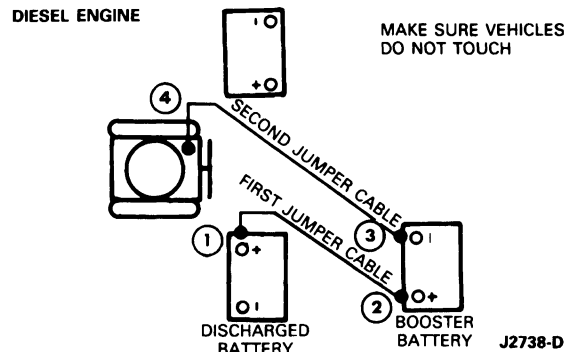
CAUTION: Follow procedure in exact sequence.

CAUTION: Filament failures of headlamps can occur when vehicle with a dead battery is jump started. Place the main light switch in OFF position.

CAUTION: Do not allow vehicles to touch.

1. Turn all lamps off before and during jump starting.
2. Turn on heater blower motor to remove transient voltage.
3. Shield eyes. Use safety goggles or similar eye protection.
4. Connect end of one cable to positive (+) terminal of discharged battery and the other end to the positive (+) terminal of the "good" battery.
NOTE: For optimum power and safety, connect booster cable to battery on passenger side of vehicle to be started.
5. Connect one end of the other cable to negative (-) terminal of "good" battery.
6. Connect other end of cable to engine bolthead or similar good contact spot on the vehicle being started (NOT to negative (-) terminal of battery).
7. To prevent damage to other electrical components on vehicle being started, make sure that engine is at idle speed before disconnecting jumper cables.

8. Remove cable from engine block first, then other end of negative cable. Disconnect cable from battery positive terminal of good battery before disconnecting positive cable from discharged battery. Lamps may now be turned on.



Field Coils

Test the field coils for an open circuit. There should be continuity through the coils.

Test the field coils for continuity to ground. There should be no continuity to ground between the field coil and the motor housing.

Brush Holder

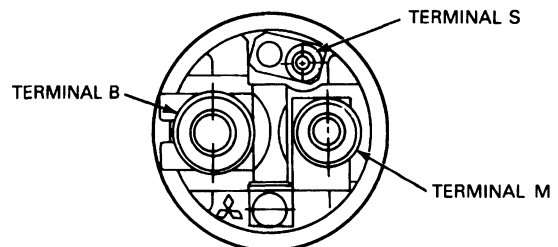
Check the insulated brush holder for continuity to the brush holder assembly. There should be no continuity.

Starter Solenoid

There should be continuity between the S and M terminals, and between S and ground.

There should be no continuity between the B and M terminals.

Inspect the main contact plate in the switch for excessive pitting.



J4992-A

DIAGNOSIS AND TESTING (Continued)

Diagnosis Guide

CONDITION	POSSIBLE SOURCE	ACTION
Engine will not crank.	<ul style="list-style-type: none"> Loose, corroded, or broken cables or connectors. Undercharged battery. Burned fusible link in main wire feed to ignition switch. Starter relay. Loose, corroded or open wiring — ignition switch, neutral switch, solenoid or auxiliary switch. Starting motor. Clutch or neutral start switches. 	<ul style="list-style-type: none"> Clean and tighten cable connections, check wire strands in eyelets. Replace if necessary. Check battery. Charge or replace. Check fusible link and replace if necessary. Check all connections and mounting screws. With transmission in park or neutral, connect a jumper from the small terminal of the starter relay to the battery. If this jumper activates starter, check wiring to relay, ignition switch, neutral switch or clutch interlock switch for open or loose connections. If relay is not activated by jumper, replace relay. Clean and tighten connections or replace wiring. Replace switches if necessary. Repair or replace as required. Repair or replace as required.
Engine will not crank, starter relay or auxiliary switch clicks.	<ul style="list-style-type: none"> Loose cable connections at relay, switch or starter. Undercharged battery. Starting motor. 	<ul style="list-style-type: none"> Clean and tighten cable connections, check wire strands in eyelets. Check battery. Charge or replace. Repair or replace as required.
Engine will not crank, starter spins.	<ul style="list-style-type: none"> Starting motor. Flywheel ring gear. 	<ul style="list-style-type: none"> Remove starter and inspect drive for worn clutch. Replace as required. Remove starter and inspect ring gear teeth (also starter drive pinions). Replace as required.
Engine cranks continuously with key off.	<ul style="list-style-type: none"> Starter relay or auxiliary switch. 	<ul style="list-style-type: none"> Replace starter relay or auxiliary switch.
Engine cranks slowly.	<ul style="list-style-type: none"> Loose connections or corroded battery cables. Undercharged battery. Starting motor. 	<ul style="list-style-type: none"> Clean and tighten cable connections. Check battery. Charge or replace. Repair or replace as required.

TJ4967B

REMOVAL AND INSTALLATION

Starter Motor

Removal

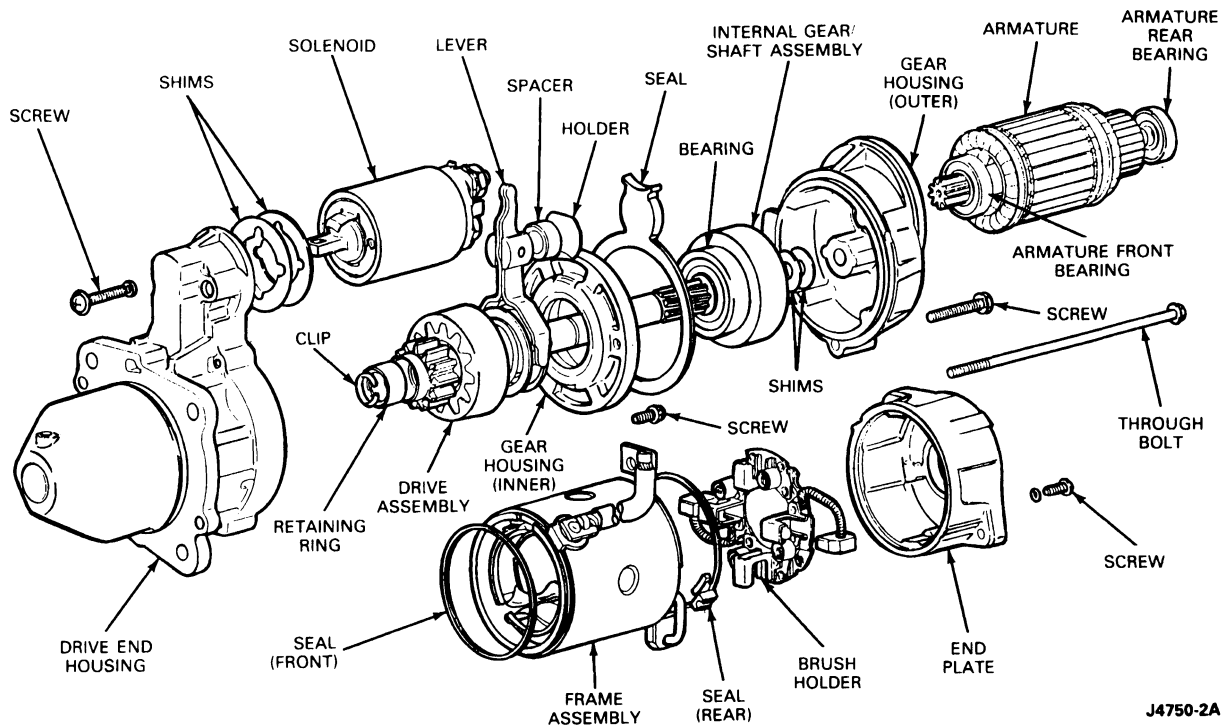
- Disconnect the negative battery cable.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
- Raise the vehicle on a hoist.
- Disconnect the wiring from the starter terminals.
- Remove the starter motor mounting bolts and remove the starter motor.

Installation

- Position the starter assembly to the flywheel housing and hand-start the mounting bolts.
- Snug all the bolts while holding the starter squarely against its mounting surface and fully inserted into the pilot hole.
- Tighten bolts.
- Connect the starter motor wiring.
- Lower the vehicle and connect the negative battery cable to the battery. Check operation of the starter motor.

REMOVAL AND INSTALLATION (Continued)

Starter Motor, Disassembled View



DISASSEMBLY AND ASSEMBLY

Starter Motor

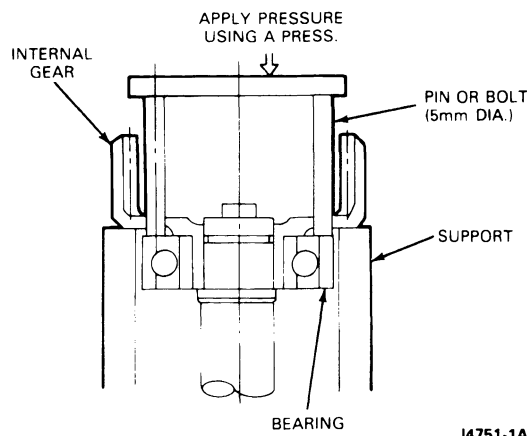
Disassembly

1. Loosen the M terminal on the solenoid and remove the connector. Remove the screws securing the main solenoid and remove the solenoid and adjusting shims.
2. Remove the through-bolts securing the motor unit to the gear assembly and remove the motor.
3. Remove the armature from the motor housing.
4. Remove the two screws from the brush holder and remove the end plate.
5. Lift up on the brush springs and disconnect the brushes. Remove the brush holder.
6. Remove the outer gear housing from the drive end housing and remove the adjusting shim.
NOTE: This shim is 0.2 or 1.0mm (.008 or .039 inch) thick.
7. Remove the seal, holder and spacer at the lever supporting point.

8. Remove the two screws securing the inner gear housing in the drive end housing and remove the internal gear / shaft assembly with the drive and lever.
9. To remove the drive assembly (overrunning clutch), place a small pipe over the end of the shaft and tap the pipe with a hammer to loosen the retaining ring and expose the retaining clip. Remove the clip and remove the ring and overrunning clutch assembly. Remove the inner gear housing.
NOTE: If the retaining ring is difficult to remove, lightly file the burrs in the groove on the shaft to ease removal.
10. Remove the armature bearings as required, using a suitable puller.
11. Remove the bearing from the gear shaft by inserting two bolts through the two 6mm holes in the internal gear and pressing on the bolts to remove the bearing.

DISASSEMBLY AND ASSEMBLY (Continued)

12. Perform cleaning and inspection procedures, if necessary, as described in this section.

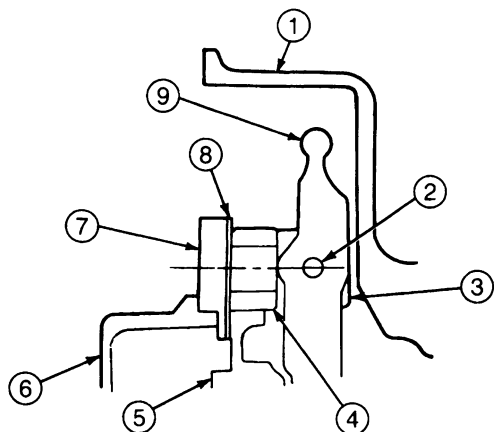


J4751-1A

Assembly

NOTE: During assembly, lubricate all sliding parts, pivot points and gear teeth with Multemp MS No. 2 or equivalent lubricant.

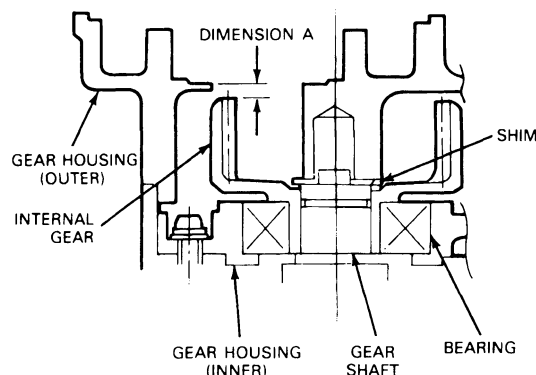
1. Install the overrunning clutch on the gear shaft and slide the retaining ring on the shaft. Install the clip in the groove in the shaft and pull the retaining ring over the clip to snap it in position.
2. Lubricate the lever pivot point with Multemp MS No. 2 or equivalent, and install the lever in the position shown. Apply a small amount of lubricant to the inside of the bushing in the drive end housing. Position the inner gear housing and shaft assembly in the drive end housing and install the two retaining screws.
3. Install the holder and spacer at the lever supporting point. Do **not** install the seal at this time.



J4996-A

Item	Description
1	Drive End Housing
2	Pin
3	Holder
4	Spacer
5	Gear Housing (Inner)
6	Gear Housing (Outer)
7	Seal
8	Holder
9	Lever

4. Install the outer gear housing to the drive end housing, with the adjusting shim in place. Install the retaining screw.
5. Check the shaft end play by moving the shaft up and down in the assembly and measuring Dimension A as shown. End play must be 0.025-0.5mm (.001-.020 inch).



J4753-1A

6. Remove the screw for the outer gear housing and reinstall the housing with the required shim and the seal.
7. Install the armature into the frame assembly and install a **new** rear seal on the frame assembly.
8. Position the brush holder onto the armature and set the brush springs. Install this assembly to the outer gear housing with a **new** front seal.
9. Install the end cover to the frame assembly and install the screws into the brush holder.
10. Install the through-bolts.
11. Install the solenoid and adjusting shims and secure with the screws.
12. Install the connector to the M terminal.
13. Check and adjust the pinion gap as described in this section under Adjustments, Pinion Gap.

CLEANING AND INSPECTION

Armature Shaft and Commutator

Using V-blocks and a dial indicator, check the armature shaft assembly for a bent shaft. If total shaft deflection indicated is more than 0.1mm (.004 inch), replace the armature.

With the same setup, move the dial indicator to rest on the commutator assembly. Maximum allowable total deflection is 0.1mm (.004 inch).

If the commutator surface is rough, it may be cleaned up using fine emery cloth or sand paper.

Gears

Replace components as required if gears are found to be worn or damaged.

Bearings

Replace bearings that do not turn smoothly, or if bearings produce abnormal sounds when turned.

Pole Shoes

Before assembling the starter motor, check the pole shoes for looseness.

Brush Holder and Brushes

Clean old brush material from the brush holder before installation.

Replace brushes that are worn down, or have worn unevenly.

Check that brushes move smoothly in the brush holder.

Overrunning Clutch

Replace the overrunning clutch if the pinion gear is worn or damaged.

The pinion gear should rotate in one direction and hold in the other direction.

CAUTION: Do not clean the clutch in solvent. The clutch is a pre-greased sealed unit.

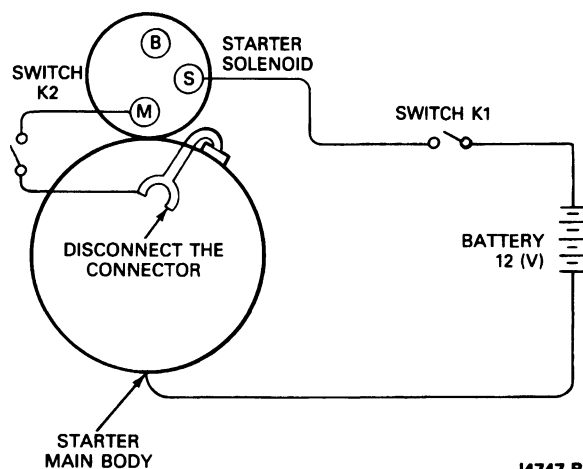
ADJUSTMENTS

Pinion Gap

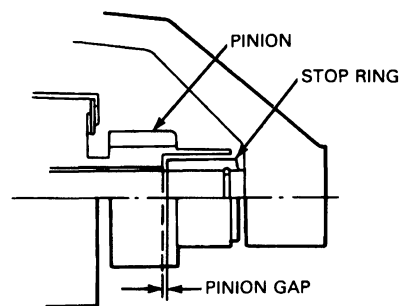
After the starter motor has been assembled, the pinion-to-drive end housing gap must be checked.

1. Mount the starter securely in a vise.

2. Using two switches and a battery, connect the starter as shown.



3. When switches K 1 and K 2 are closed, the starter drive will be forced outward and the motor will turn. By opening switch K 2, the starter will stop turning with the pinion in the full out position.
4. Gently push the pinion back by hand and measure the amount of pinion movement. The amount corresponds to the pinion gap of conventional starters. End gap should be 0.1-2.0mm (.004-.079 inch).
5. Adjust the end gap by changing the shims between the solenoid and the drive end housing. Increasing the shims will decrease the gap. Decreasing the shims will increase the gap.



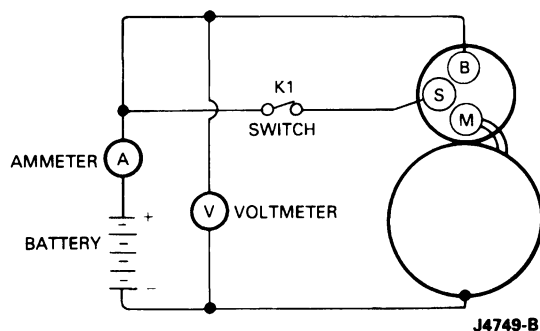
Performance Test (No-Load Test)

After setting the pinion gap adjustment, check the no-load operation of the starter.

1. Mount the starter securely in a vise.

ADJUSTMENTS (Continued)

2. Connect the starter as shown.



3. Close switch K 1 to rotate the starter.
4. The starter is operating properly if it rotates smoothly and at an acceptable speed. If the starter rotates slowly, there may be insufficient clearance between the armature and the housing (determined by the shim behind the bearing in the end cover). Refer to Disassembly and Assembly for shim replacement.

NOTE: Due to the characteristics of gear reduction starters, the starter has a higher rotary sound than conventional starters.

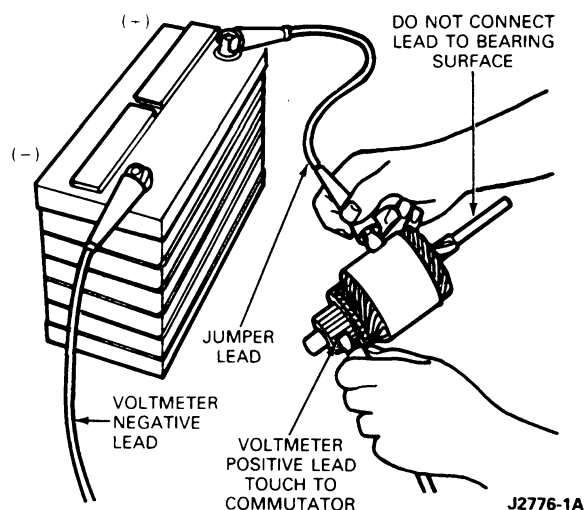
Armature Open Circuit Test

An open circuit may sometimes be detected by examining the commutator for evidence of burning. A spot burned on the commutator is caused by an arc formed every time the commutator segment, connected to the open circuit winding, passes under a brush.

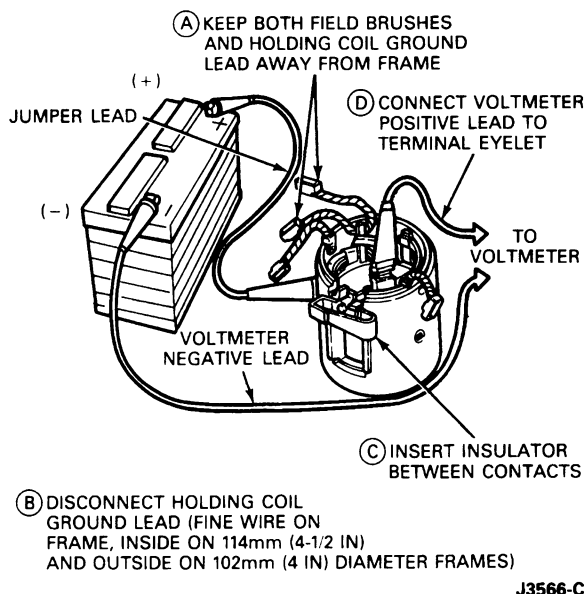
Armature and Field Grounded Circuit Test

This test will determine if the winding insulation has been damaged, permitting a conductor to touch the frame or armature core.

To determine if the armature windings are grounded, make the connections as shown. If the voltmeter indicates any voltage, the windings are grounded.



Grounded field windings can be detected by making the connections shown. If the voltmeter indicates any voltage, the field windings are grounded.



SPECIAL SERVICE TOOLS/EQUIPMENT

ROTUNDA EQUIPMENT

Tool Number	Description
078-00005	Starting and Charging Tester

SECTION 03-07 Engine Ignition General Service

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		REMOVAL AND INSTALLATION (Cont'd.)	
Ignition Coil	03-07-10	Distributor Rotor	03-07-3
Spark Plug Wires	03-07-10	Ignition Control Module (ICM)	03-07-7
Tachometer Connection	03-07-10	Spark Plug Wires	03-07-8
DESCRIPTION AND OPERATION		Spark Plugs	03-07-8
Ignition Systems Features	03-07-1	Stator Assembly	03-07-5
REMOVAL AND INSTALLATION		SPECIAL SERVICE TOOLS	03-07-11
Distributor Assembly	03-07-4	SPECIFICATIONS	03-07-11
Distributor Cap	03-07-3	VEHICLE APPLICATION	03-07-1

VEHICLE APPLICATION

All E-Series, F-Series and Bronco Vehicles

DESCRIPTION AND OPERATION

This section is designed to serve as a guide in understanding, testing and servicing the Distributor Ignition (DI) system.

Ignition Systems Features

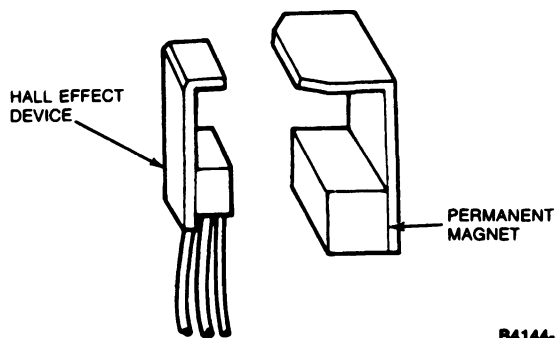
The DI system features a camshaft driven distributor which uses no centrifugal or vacuum advance. The distributor has a diecast base which incorporates a Hall effect stator assembly.

Initial timing adjustments are not required unless the distributor has been moved from its factory setting or removed from the engine. Ignition timing procedures and diagnostics are found in the Powertrain Control / Emissions Diagnosis Manual.¹

NOTE: Do not change timing by use of different octane rods without first having the proper authorization; federal emission requirements will be affected.

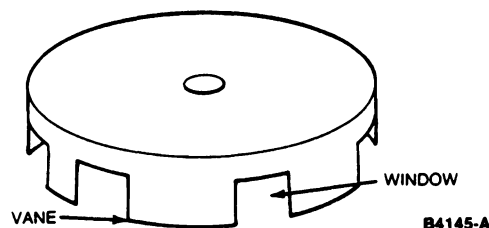
There are two DI type systems: "push start" and Computer Controlled Dwell. The first features a "push start" mode that will allow manual transmission vehicles to be push started. Do not attempt to push start automatic transmission vehicles. The second, Computer Controlled Dwell, features EEC-IV controlled ignition coil charge times.

The universal distributor operates by using a Hall effect vane switch assembly, causing the ignition coil to be switched off and on by the Powertrain Control Module (PCM)(12A650) and Ignition Control Module (ICM)(12A199). The vane switch is an encapsulated package consisting of a Hall sensor on one side and a permanent magnet on the other side.



B4144-A

A rotary vane cup, made of ferrous metal, is used to trigger the signal off and on.



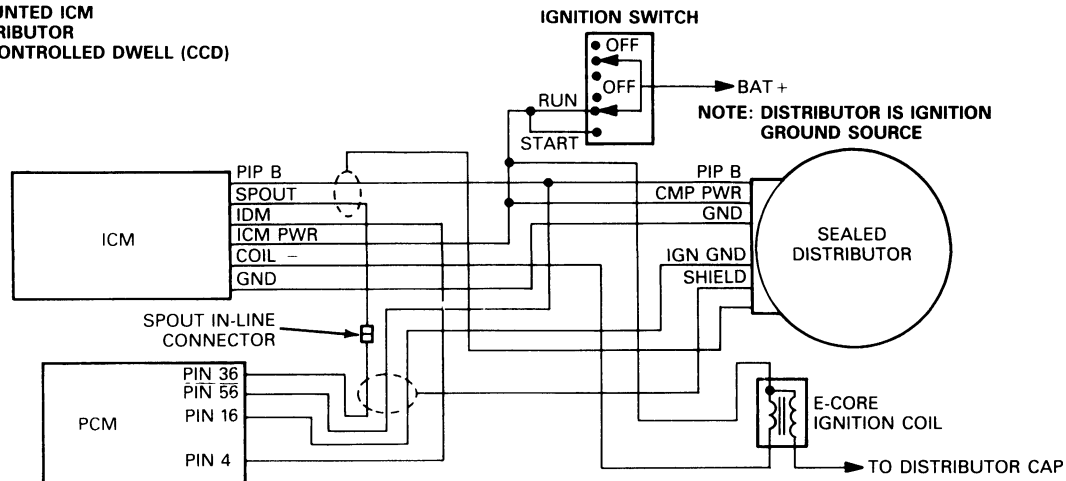
B4145-A

¹ Can be purchased as a separate item.

DESCRIPTION AND OPERATION (Continued)

Distributor Ignition (DI) System, Econoline (5.0L), 1993-1/2 Model Year

REMOTE MOUNTED ICM
SEALED DISTRIBUTOR
COMPUTER CONTROLLED DWELL (CCD)
(SYSTEM F)



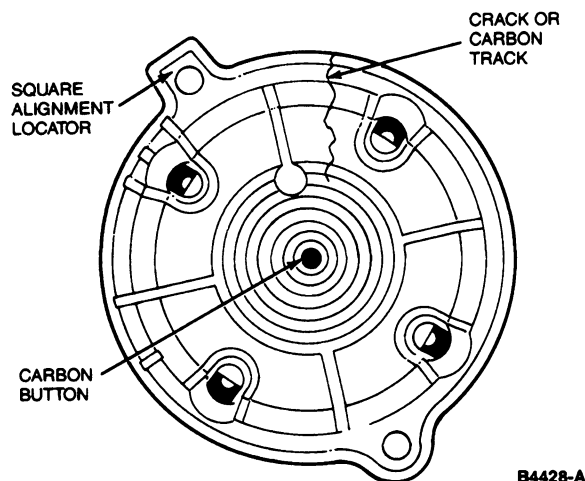
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REMOVAL AND INSTALLATION

Distributor Cap

Removal

1. Loosen distributor cap hold-down screws. Lift cap straight off distributor to prevent damage to rotor blade and spring.
2. Wash both inside and outside surfaces of the distributor cap with soap and water. Dry cap with compressed air.
3. Inspect cap for cracks, broken carbon button or carbon tracks. Inspect cap terminals for dirt and corrosion.
4. Replace the cap if it is damaged.



B4428-A

Installation

1. Position distributor cap on distributor base noting the square alignment locator. Tighten hold-down screws to 2.0-2.6 N·m (18-23 in-lb).
2. Reinstall any ignition wires that were removed, noting their correct locations on the distributor cap.

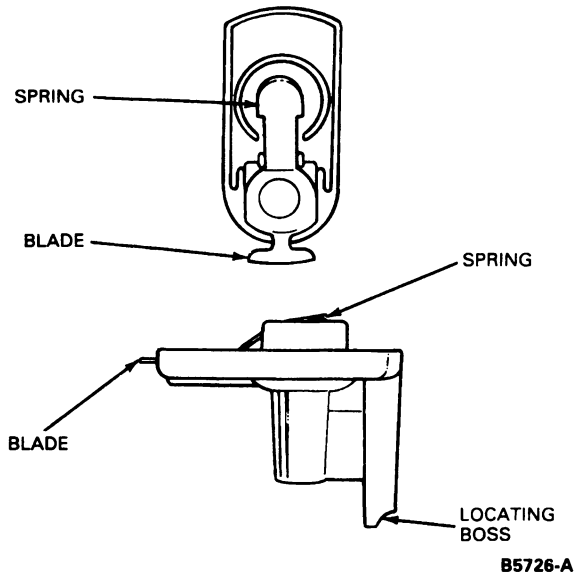
Distributor Rotor

Removal and Installation

1. With distributor cap removed, pull rotor upward to remove it from distributor shaft and armature.
2. Wash rotor with soap and water. Dry with compressed air.
3. Inspect and replace rotor if cracks, carbon tracks, burns or damage to blade or spring are observed.
4. Align locating boss on rotor with hole on armature.
5. Fully seat rotor on distributor shaft.

REMOVAL AND INSTALLATION (Continued)

6. Reinstall distributor cap.

**Distributor Assembly****Removal**

1. Disconnect distributor from wiring harness.
2. Mark position of No. 1 cylinder wire tower on distributor base for reference when installing distributor.
3. Loosen distributor cap hold-down screws. Lift cap straight off distributor to prevent damage to rotor blade and spring. Position cap and attached wires aside so as not to interfere with distributor removal.
4. Remove rotor by pulling upward to remove it from the distributor shaft and armature.
5. Remove distributor hold-down bolt and clamp. Remove distributor by pulling upward.
6. Cover distributor opening in the cylinder block or head with a clean shop towel to prevent the entry of foreign material or dirt into the engine.

Installation

1. Visually inspect distributor.

2. Inspect O-ring. It should fit tightly and be free of cuts.
3. The drive gear should be free of nicks, cracks and excessive wear.
4. Rotate distributor shaft. It should move freely, without binding.
5. Remove No. 1 cylinder spark plug and rotate engine clockwise until No. 1 piston is on the compression stroke.
6. With No. 1 piston on compression stroke, align timing pointer with TDC on the crankshaft damper.
NOTE: To install distributor correctly, No. 1 piston must be at Top Dead Center (TDC) of compression stroke.
7. Align locating boss on rotor with hole on armature. Fully seat rotor on distributor shaft.
8. Rotate distributor shaft so blade on rotor is pointing toward mark on distributor base that was previously made.
9. While installing distributor, continue rotating rotor slightly so leading edge of the vane is centered in vane switch stator assembly.

10. Rotate distributor in block to align leading edge of vane and vane switch stator assembly. Verify rotor is pointing at No. 1 mark on distributor base.

NOTE: If vane and vane switch stator cannot be aligned by rotating distributor in cylinder block, remove distributor enough to disengage distributor gear from camshaft gear. Rotate rotor enough to engage distributor gear on another tooth of camshaft gear. Repeat Step 1 if necessary.

11. Install distributor hold-down clamp and bolt. Tighten bolt, but leave it loose enough to rotate distributor.
12. Install distributor cap, No. 1 spark plug and ignition wires. Check that ignition wires are securely connected to the cap and spark plugs. Tighten distributor cap hold-down screws to 2.0-2.6 N·m (18-23 in-lb).
13. Reconnect distributor to wiring harness.

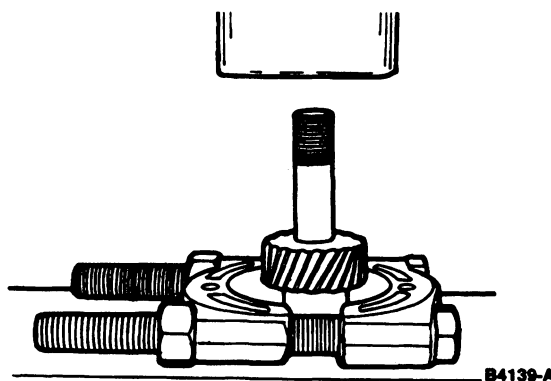
REMOVAL AND INSTALLATION (Continued)

14. Set initial timing according to procedures found in the Powertrain Control / Emissions Diagnosis Manual.²
15. After timing is set, tighten distributor hold-down bolt to 23-34 N·m (17-25 ft-lb).
16. Recheck initial timing. Adjust if necessary.

Stator Assembly**Removal**

CAUTION: Do not attempt to replace stator without an arbor press.

1. Using a screwdriver, remove distributor cap, position the cap and wires aside so as not to interfere with work area. Disconnect distributor from harness.
2. Remove distributor from block as described in this section.
3. Remove rotor.
4. Remove two armature retaining screws and remove armature.
NOTE: Hold gear to loosen armature screws; do not hold armature.
5. To ease assembly, mark armature collar (5.0L) and gear with a felt tip pen to note orientation.
6. Remove and discard pin in gear and collar (5.0L).
7. Invert distributor and place in Axle Bearing / Seal Plate T75L-1165-B, and press off gear using Bearing Removal Tool D84L-950-A or equivalent.

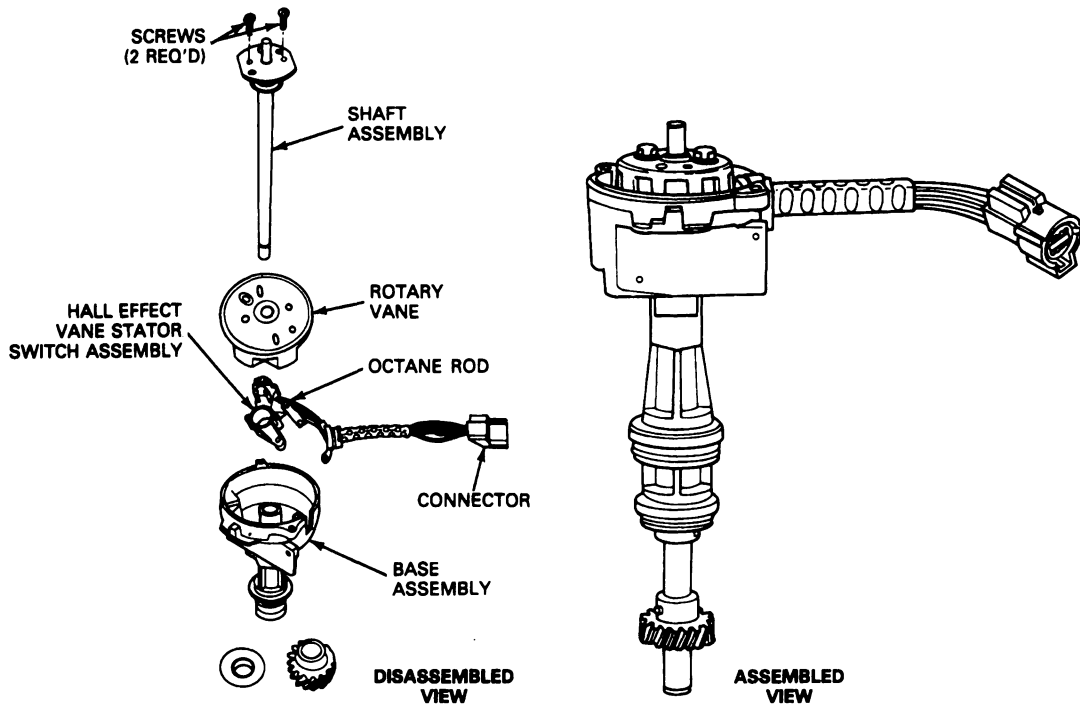


8. Remove the thrust washer from distributor (4.9L engine only).
9. Deburr and polish shaft with emery paper and wipe such that shaft slides out freely from distributor base.
10. Remove shaft assembly.
11. Remove stator assembly screw and retain.
12. Remove octane rod and screw, and retain.
13. Remove stator assembly from top of bowl.
14. Inspect base bushing for wear or signs of excess heat concentration. Replace complete distributor assembly if damaged.
15. Inspect base O-ring for cuts or damage and replace O-ring if necessary.
16. Inspect base for cracks and wear. Replace complete distributor assembly if damage is found.

² Can be purchased as a separate item.

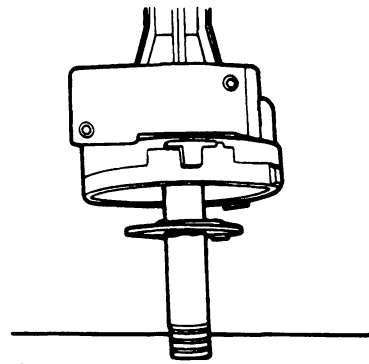
REMOVAL AND INSTALLATION (Continued)

Closed Bowl Distributor



Installation

1. Place stator assembly over bushing and press down to seat.
2. Place stator connector in position. Tab should fit in notch on base and fastening eyelets aligned with screw holes.
3. Position wires away from moving parts.
4. Install stator screw and tighten to 1.7-4.0 N·m (15-35 in-lb).
5. Install octane rod and screw, and tighten to 1.7-4.0 N·m (15-35 in-lb).
6. Apply a light coat of clean, fresh motor oil to distributor shaft below armature.
7. Insert shaft through base bushing.
8. Place a 1/2-inch deep well socket over shaft, invert and place on arbor plate.
9. Install gear thrust washer (4.9L only).



10. Install collar and collar pin (5.0L).
11. Place the distributor gear on shaft end. Line up the mark on armature and gear.

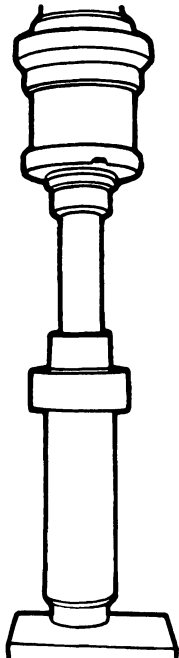
NOTE: The hole in the shaft and gear must be lined up as accurately as possible to allow for easy pin insertion.

CAUTION: The gears on EEC-IV distributors are not released for service. EEC-IV distributor gears are matched to the distributor at assembly and should never be replaced. Although some service gears for breaker point distributors will physically fit EEC-IV distributors, they should not be used. Do not replace distributor gears on EEC-IV distributor. Install a new EEC-IV distributor assembly.

REMOVAL AND INSTALLATION (Continued)

12. Place a 5/8-inch deep well socket over the shaft and gear and press gear to align with original drill hole.

NOTE: If the gear holes do not align, the gear must be removed and repressed on. A drift punch will not align the holes.



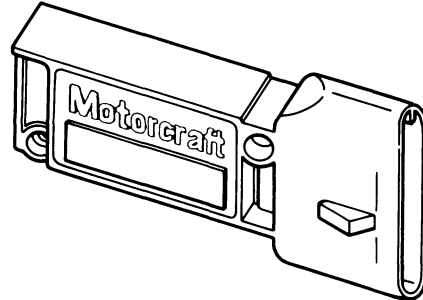
B4142-A

13. Insert new roll pin through gear and shaft. Pin should have proper extrusion.
14. Replace armature and tighten screws to 2.8-4.0 N·m (25-35 in-lb).
15. Check distributor for free movement over full rotation of shaft.
NOTE: If the armature contacts the stator, replace the entire distributor.
16. Install the distributor into block per distributor replacement procedure.
17. Connect distributor to wiring harness.
18. Replace rotor.
19. Replace cap and tighten screws to 2.0-2.6 N·m (18-23 in-lb).
20. Set engine timing.

Ignition Control Module (ICM)**Removal**

1. Remove two screws retaining ignition control module heatsink assembly to left fender apron.
2. Disconnect harness connector from ignition control module.

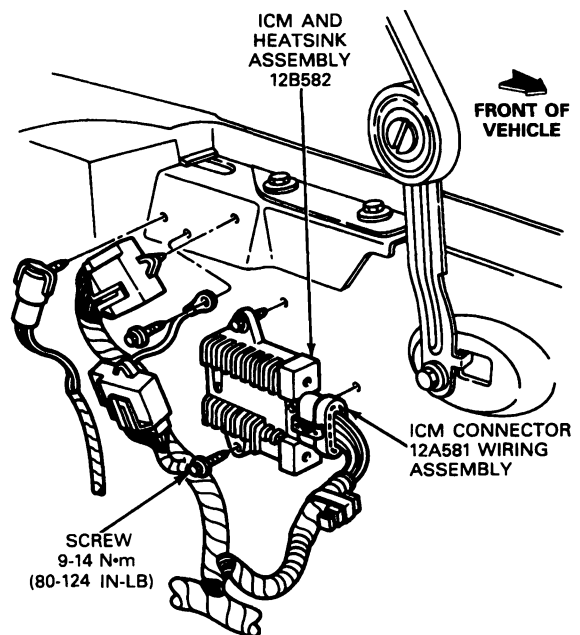
3. Remove two screws retaining ignition control module to heatsink and remove ignition control module.



B5729-A

Installation

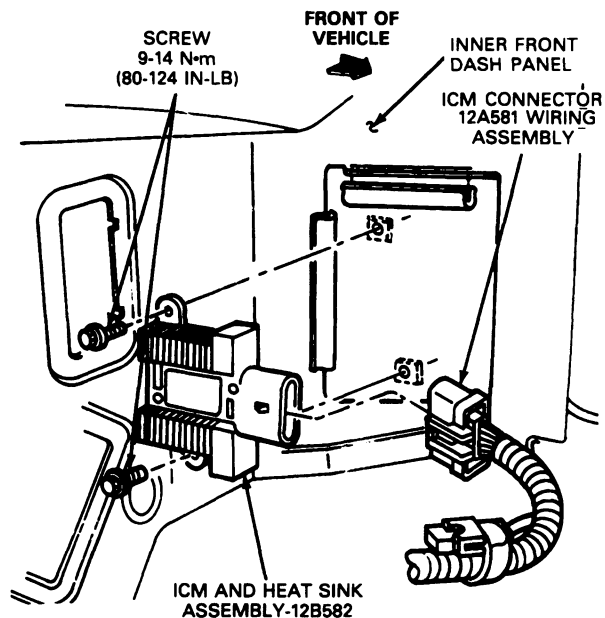
1. Coat metal baseplate of the ICM uniformly with silicone compound, approximately 0.179mm (1/32-inch) thick. Use Silicone Dielectric Compound WA-10 D7AZ-19A331-A (ESE-M1C171-A) or equivalent.
2. Position ICM onto heatsink and tighten two retaining screws to 1.7-4.0 N·m (15-35 in-lb).
3. Install ICM heatsink assembly to left fender apron using two retaining screws, and tighten to 9-14 N·m (80-124 in-lb).
4. Connect wire harness to the ICM.

F-150-250-350, F-Super Duty and Bronco

B5727-A

REMOVAL AND INSTALLATION (Continued)

E-150-250-350



B5728-A

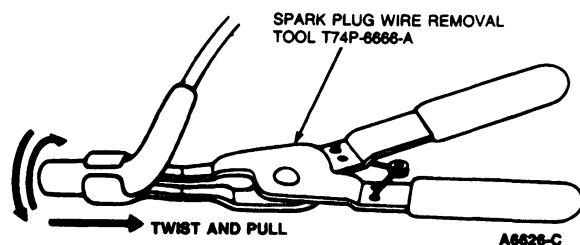
- When removing wires from distributor cap or coil, grasp boot by hand and remove with twisting and pulling motion. **Do not pull on wire.**

Installation

- Whenever a high tension wire is removed for any reason from a spark plug, coil or distributor cap, or a new high tension wire is installed, Silicone Dielectric Compound D7AZ-19A331-A (ESE-M1C17 1-A) or equivalent must be applied to boot before it is reconnected. Using a small clean tool, coat entire interior surface of boot with Silicone Dielectric Compound D7AZ-19A331-A (ESE-M1C17 1-A) or equivalent.
- Insert each wire on proper terminal of distributor cap. Make sure wires are all the way down over their terminals. The No. 1 terminal is identified on cap. Install wires starting with No. 1 terminal.
- Remove wire retaining brackets from old high tension wire set and install them on new set in same relative position. Install wires in brackets on valve rocker arm covers.
- Connect wires to proper spark plugs.
- Install coil wire.

Spark Plug Wires**Removal**

- When removing wires from spark plugs, use Spark Plug Wire Removal Tool T74P-6666-A. Grasp and twist the boot back and forth on plug insulator to free boot. Use special tool to pull boot from plug. Do not pull on wire directly, or it may become separated from connector inside boot.

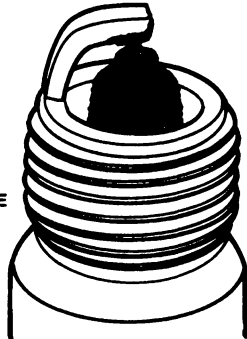
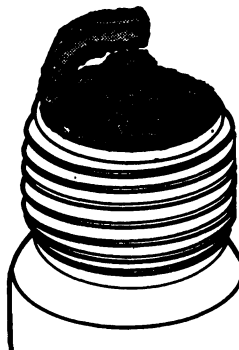
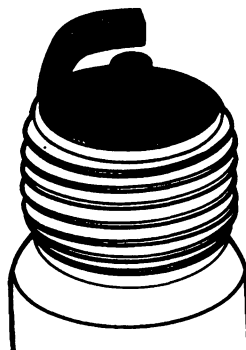
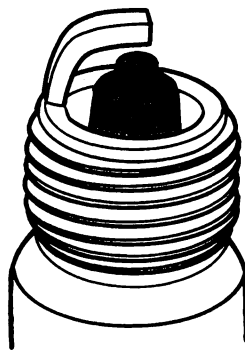
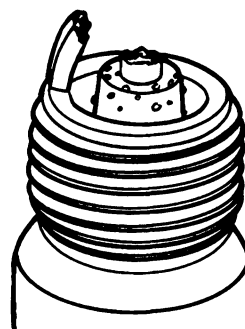
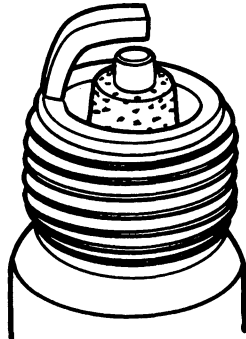
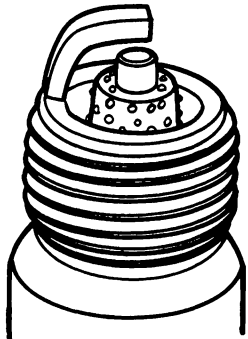
**Spark Plugs****Removal and Installation**

Refer to the appropriate engine section for spark plug removal and installation.

Refer to the Spark Plug Inspection Chart to determine the condition of the spark plugs.

REMOVAL AND INSTALLATION (Continued)

Spark Plug Inspection Chart

<p>GAP BRIDGED</p>  <p>IDENTIFIED BY DEPOSIT BUILD-UP CLOSING GAP BETWEEN ELECTRODES.</p> <p>CAUSED BY OIL OR CARBON FOULING. REPLACE PLUG, OR, IF DEPOSITS ARE NOT EXCESSIVE THE PLUG CAN BE CLEANED.</p>	<p>OIL FOULED</p>  <p>IDENTIFIED BY WET BLACK DEPOSITS ON THE INSULATOR SHELL BORE ELECTRODES.</p> <p>CAUSED BY EXCESSIVE OIL ENTERING COMBUSTION CHAMBER THROUGH WORN RINGS AND PISTONS, EXCESSIVE CLEARANCE BETWEEN VALVE GUIDES AND STEMS, OR WORN OR LOOSE BEARINGS. CORRECT OIL PROBLEM. REPLACE THE PLUG.</p>	
<p>CARBON FOULED</p>  <p>IDENTIFIED BY BLACK, DRY FLUFFY CARBON DEPOSITS ON INSULATOR TIPS, EXPOSED SHELL SURFACES AND ELECTRODES.</p> <p>CAUSED BY TOO COLD A PLUG, WEAK IGNITION, DIRTY AIR CLEANER, DEFECTIVE FUEL PUMP, TOO RICH A FUEL MIXTURE, IMPROPERLY OPERATING HEAT RISER OR EXCESSIVE IDLING. CAN BE CLEANED.</p>	<p>NORMAL</p>  <p>IDENTIFIED BY LIGHT TAN OR GRAY DEPOSITS ON THE FIRING TIP.</p>	<p>PRE-IGNITION</p>  <p>IDENTIFIED BY MELTED ELECTRODES AND POSSIBLY BLISTERED INSULATOR. METALIC DEPOSITS ON INSULATOR INDICATE ENGINE DAMAGE.</p> <p>CAUSED BY WRONG TYPE OF FUEL, INCORRECT IGNITION TIMING OR ADVANCE, TOO HOT A PLUG, BURNT VALVES OR ENGINE OVERHEATING. REPLACE THE PLUG.</p>
<p>OVERHEATING</p>  <p>IDENTIFIED BY A WHITE OR LIGHT GRAY INSULATOR WITH SMALL BLACK OR GRAY BROWN SPOTS AND WITH BLuish-BURNT APPEARANCE OF ELECTRODES.</p> <p>CAUSED BY ENGINE OVERHEATING, WRONG TYPE OF FUEL, LOOSE SPARK PLUGS, TOO HOT A PLUG, LOW FUEL PUMP PRESSURE OR INCORRECT IGNITION TIMING. REPLACE THE PLUG.</p>	<p>FUSED SPOT DEPOSIT</p>  <p>IDENTIFIED BY MELTED OR SPOTTY DEPOSITS RESEMBLING BUBBLES OR BLISTERS.</p> <p>CAUSED BY SUDDEN ACCELERATION. CAN BE CLEANED IF NOT EXCESSIVE, OTHERWISE REPLACE PLUG.</p>	

84084-E

REMOVAL AND INSTALLATION (Continued)

Spark Plug Hole Taperset Installation

CAUTION: Use protective eye glasses at all times.

NOTE: Cylinder head must be removed from vehicle to prevent metal shavings from entering engine.

Refer to appropriate engine section for cylinder head removal and installation.

Tap

1. Thoroughly clean spark plug counterbore walls and seat of all dirt and foreign material.
2. Lubricate cutting threads of tap with cutting oil.
3. Engage tap pilot into spark plug port threads.
4. Using ratchet wrench and keeping tap aligned, rotate tap until depth stop collar bottoms on face of port and tightens against retaining ring.

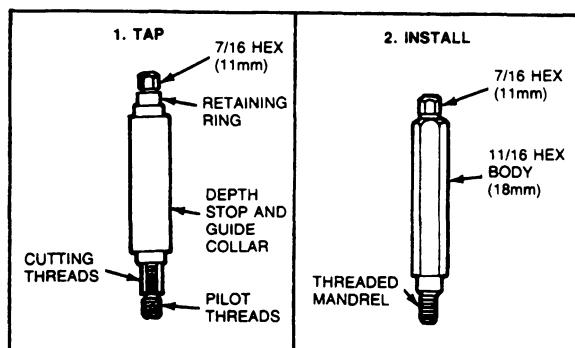
NOTE: Use of power tools is not approved for installation of tapersets.

5. Using an air hose, blow out as many shavings as possible.
6. If stop collar is loose, tap has not penetrated to full depth.
7. Remove tap from hole.
8. Clear shavings from hole and cylinder with compressed air.

Installation

CAUTION: Repeat Steps 1 through 8 above to make sure threads are clean.

1. Lubricate mandrel threads and taperset with aluminum cutting oil. Then thread taperset onto mandrel with larger counterbore end toward 18mm (11/16-inch) hex body until one thread of mandrel shows beyond tip of taperset.



B4031-B

2. Install taperset into tapped hole. Tighten 18mm (11/16-inch) hex to 68 N-m (50 ft-lb).
3. Holding 11mm (7/16-inch) hex mandrel to prevent rotation, loosen 18mm (11/16-inch) hex body approximately one-half turn to achieve breakaway action.
4. Remove tool from installed taperset.

NOTE: Taperset should be flush to 1mm (0.039 inch) below spark plug gasket seat.

5. Thoroughly clean cylinder head before installing spark plug. Tighten spark plugs to 9-20 N-m (7-15 ft-lb) for all engines except 4.9L. Tighten spark plugs to 20-27 N-m (15-20 ft-lb) on 4.9L applications.

CLEANING AND INSPECTION

Ignition Coil

Wipe coil tower with a clean cloth dampened with soap and water. Remove any soap film and dry with compressed air. Inspect for cracks, carbon tracking and dirt.

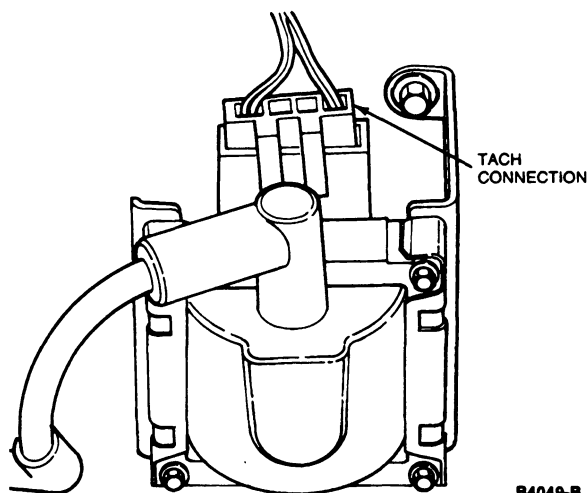
Spark Plug Wires

Without removing the high tension wires from the spark plugs, distributor cap or coil, wipe the wires with a clean, damp cloth and inspect them for visible damage such as cuts, pinches, cracks or torn boots. Replace only wires that are damaged. Refer to Spark Plug Wire Removal and Installation.

Tachometer Connection

The ignition coil connector allows a tachometer connection using an alligator clip, without removing the coil connector. This is accomplished by inserting the alligator clip into the back of the connector, onto the dark green / yellow dotted wire.

CAUTION: Do not allow this clip to accidentally ground to a metal surface. It may permanently damage the coil.




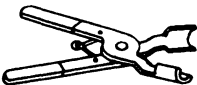
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SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Lb-Ft
Distributor Hold-down Bolts	23-34	17-25
Stator Assembly Screws	1.7-4.0	15-35 (In-Lb)
Spark Plugs, 4.9L	20-27	15-20
Spark Plugs (except 4.9L)	9-20	7-15
ICM-to-Heatsink Screws	1.7-4.0	15-35 (In-Lb)
ICM/Heatsink Assembly-to-Left Fender Apron Screws	9-14	80-124 (In-Lb)
Distributor Cap Hold-down Screws	2.0-2.6	18-23 (In-Lb)
Octane Rod Retaining Screw	1.7-4.0	15-35 (In-Lb)
Distributor Adapter to Distributor Base	2.8-4.0	25-35 (In-Lb)
Armature Retaining Screws	1.7-4.0	15-35 (In-Lb)
Taperset Hex Body	68	50

Tool Number	Description
D84L-950-A	Bearing Removal Tool

SPECIAL SERVICE TOOLS

Tool Number/ Description	Illustration
T75L-1165-B Axle Bearing / Seal Plate	 T75L-1165-B
T74P-6666-A Spark Plug Wire Removal Tool	 T74P-6666-A

SECTION 03-08 Engine Emission Control

SUBJECT	PAGE	SUBJECT	PAGE
SERVICE INFORMATION	03-08-1	VEHICLE APPLICATION	03-08-1

VEHICLE APPLICATION

All Vehicles

SERVICE INFORMATION

Refer to the 1993 Powertrain Control / Emissions Diagnosis Manual¹ for service information on Engine Emission Control Systems.

SECTION 03-12 Air Intake

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION AND OPERATION		REMOVAL AND INSTALLATION (Cont'd.)	
Air Cleaner, Diesel Engine.....	03-12-1	Air Cleaner, Gasoline Engines	03-12-1
Air Cleaner, Gasoline Engines	03-12-1	SPECIFICATIONS	03-12-16
REMOVAL AND INSTALLATION		VEHICLE APPLICATION	03-12-1
Air Cleaner, Diesel Engine.....	03-12-13		

VEHICLE APPLICATION

Light Truck Vehicles Equipped with Gasoline and Diesel Engines

DESCRIPTION AND OPERATION

Air Cleaner, Gasoline Engines

Dry-type air cleaners are standard on all light truck vehicles.

Air enters the air cleaner and travels through a chemically treated and pleated paper element before entering the engine induction system. The air filter element should be inspected, cleaned, or replaced periodically according to the schedule in Section 00-03. The air cleaner system has a heat sensor mounted in the cleaner assembly to control engine inlet air temperature (on some models).

Air Cleaner, Diesel Engine

A dry-type air cleaner is standard equipment on all Ford trucks equipped with diesel engines. Air is filtered through a pleated, chemically treated, water resistant paper element to remove contaminants before entering the engine induction system.

REMOVAL AND INSTALLATION

Air Cleaner, Gasoline Engines

Refer to the illustrations in this section for removal and installation of the various types of air cleaners. Reference to the illustrations will enable the service technician to perform the required removal and installation and/or repair operations. For all engines, refer to the following procedure.

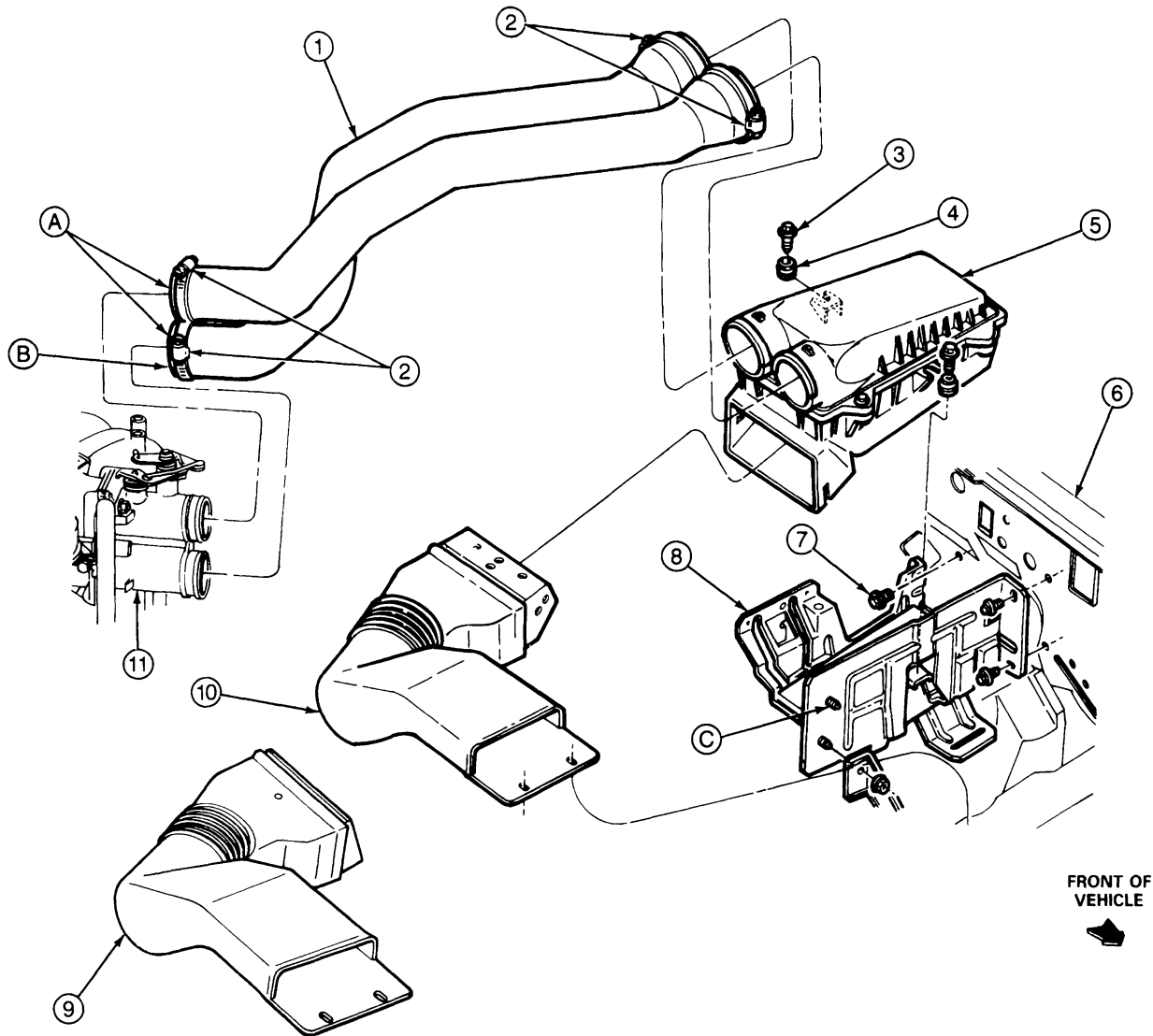
Removal

1. Loosen two hose clamps securing hose assembly to air cleaner.
2. Remove two screws attaching air cleaner to bracket.
3. Disconnect hose and inlet tube from air closure hose / filter pack. (On E-Series, disconnect hose and inlet tube(s) from Secondary Air Injection (AIR), pump inlet.)

4. Remove screws attaching air cleaner cover.
5. Remove air filter and tubes.

Installation

1. Set air filter into proper position.
2. Position air cleaner cover to tray. Make sure filter is seated while positioning cover.
3. Install screws to secure cover.
4. Install two bolts to secure air cleaner to support bracket.
5. Install fresh air inlet tube to air closure hose / filter pack. (On E-Series, connect hose and inlet tube(s) to Secondary Air Injection (AIR) pump inlet.)
6. Install air supply tube to air cleaner and retain with clamps. Tighten clamps.

REMOVAL AND INSTALLATION (Continued)**Air Cleaner Installation, F-150-250 and Bronco 5.0L and 5.8L Engines (Except 5.8L Lightning)**

V5913-E

Item	Part Number	Description
1	9R504	Air Cleaner Outlet Tube Assembly
2	—	Hose Clamp 2-3 N·m (18-27 In-Lb)
3	N611062-S2	Screw and Washer Assembly (2 Required)
4	17C431	Grommet Assembly (2 Required)
5	9600	Air Cleaner Assembly
6	—	Left Fender (Reference)
7	N610958-S2	Screw (3 Required)
8	9647	Air Cleaner Bracket Assembly

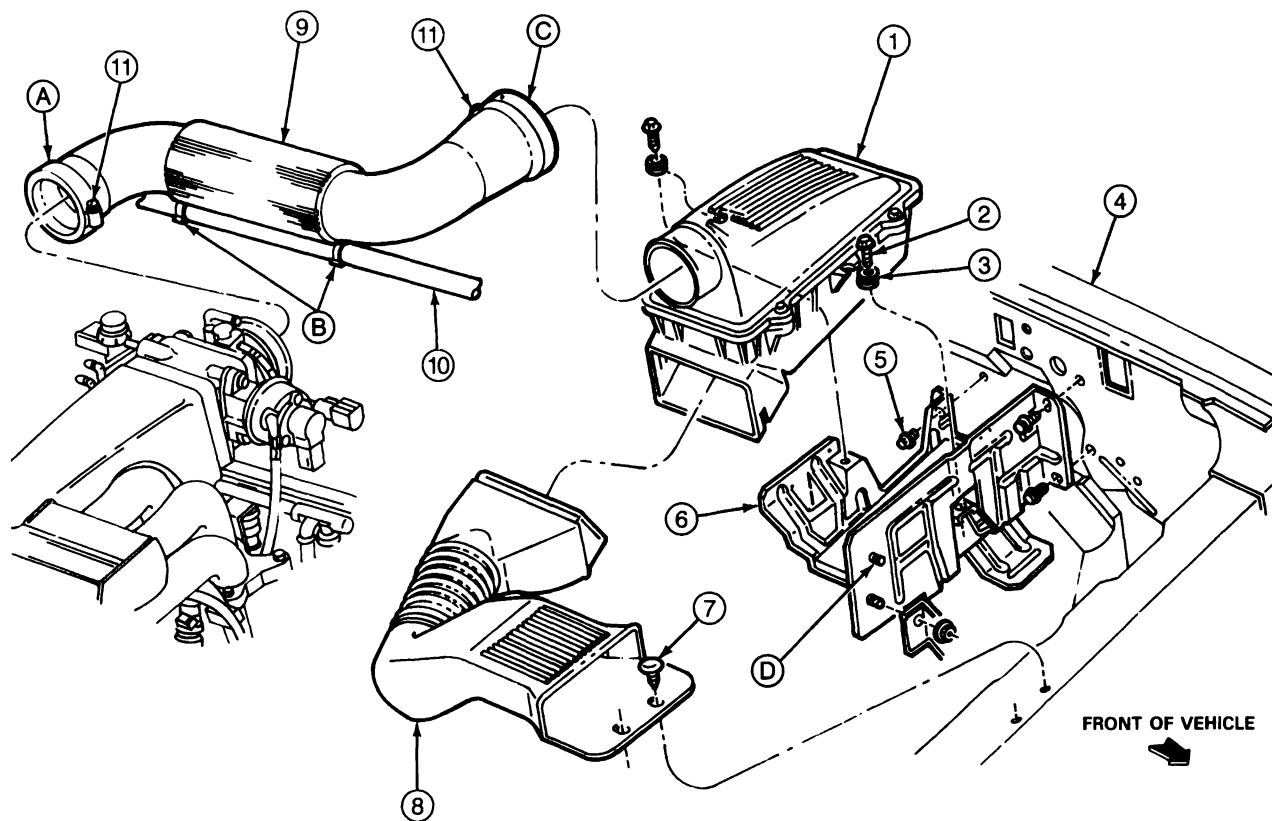
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Item	Part Number	Description
9	9C675	Fresh Air Intake Tube and Duct Assembly (5.8L Only)
10	9C675	Fresh Air Intake Tube and Duct Assembly (5.0L Only)
11	—	Throttle Body (Reference)
A	—	Use Water or Rubber Lubricant D9A2 - 19583-A or Equivalent to Facilitate Installation of Hose Assembly to Throttle Body
B	—	Surface Must Meet Against Throttle Body Stop Flange for 360° (Both Tubes)
C	—	Water Bottle Affixed at This Location

TV5913A

REMOVAL AND INSTALLATION (Continued)

Air Cleaner Installation, 5.8L Lightning



A17884-A

Item	Part Number	Description
1	9600	Air Cleaner Assembly
2	N611062-S2	Screw (2 Required)
3	17C431	Grommet (2 Required)
4	—	Left Fender (Reference)
5	N610958-S2	Screw (3 Required)
7	388577-S150	Pushpin, Nylon
8	9A675	Air Cleaner Intake Tube Assembly
9	9R504	Air Cleaner Outlet Tube Assembly
10	—	Heater Return Line

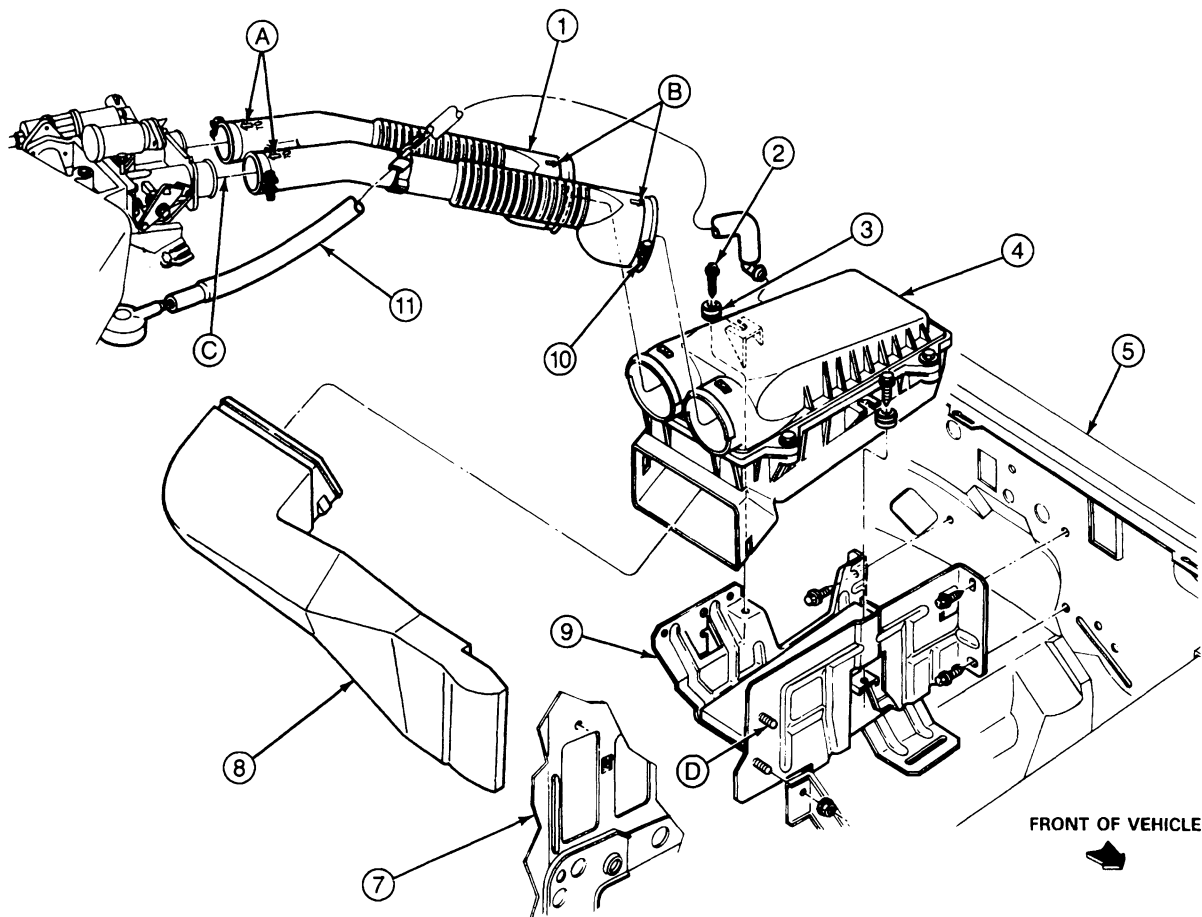
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Item	Part Number	Description
A	—	Surface Must Meet Against Throttle Body Stop Flange for 360°
B	—	Snap Heater Return Line Into Clamps on Underside of Outlet Tube Assembly
C	—	Fully Seat Outlet Tube Against Cover Before Clamp is Tightened
11	—	Clamp, Air Cleaner Outlet Tube Assembly, 2-3 N·m (18-27 In·Lb)

TA17884A

REMOVAL AND INSTALLATION (Continued)

Air Cleaner Installation, F-150-250-350 and Bronco 4.9L MFI Engine



V5828-E

Item	Part Number	Description
1	9R504	Air Cleaner Outlet Tube Assembly
2	N611062-S2	Screw and Washer Tap Assembly (2 Required)
3	17C431	Grommet Assembly (2 Required)
4	9600	Air Cleaner Assembly
5	—	Left Fender (Reference)
6	N610959-S2	Screw (4 Required)
7	—	Radiator Support (Reference)
8	9A675	Fresh Air Intake Tube Assembly

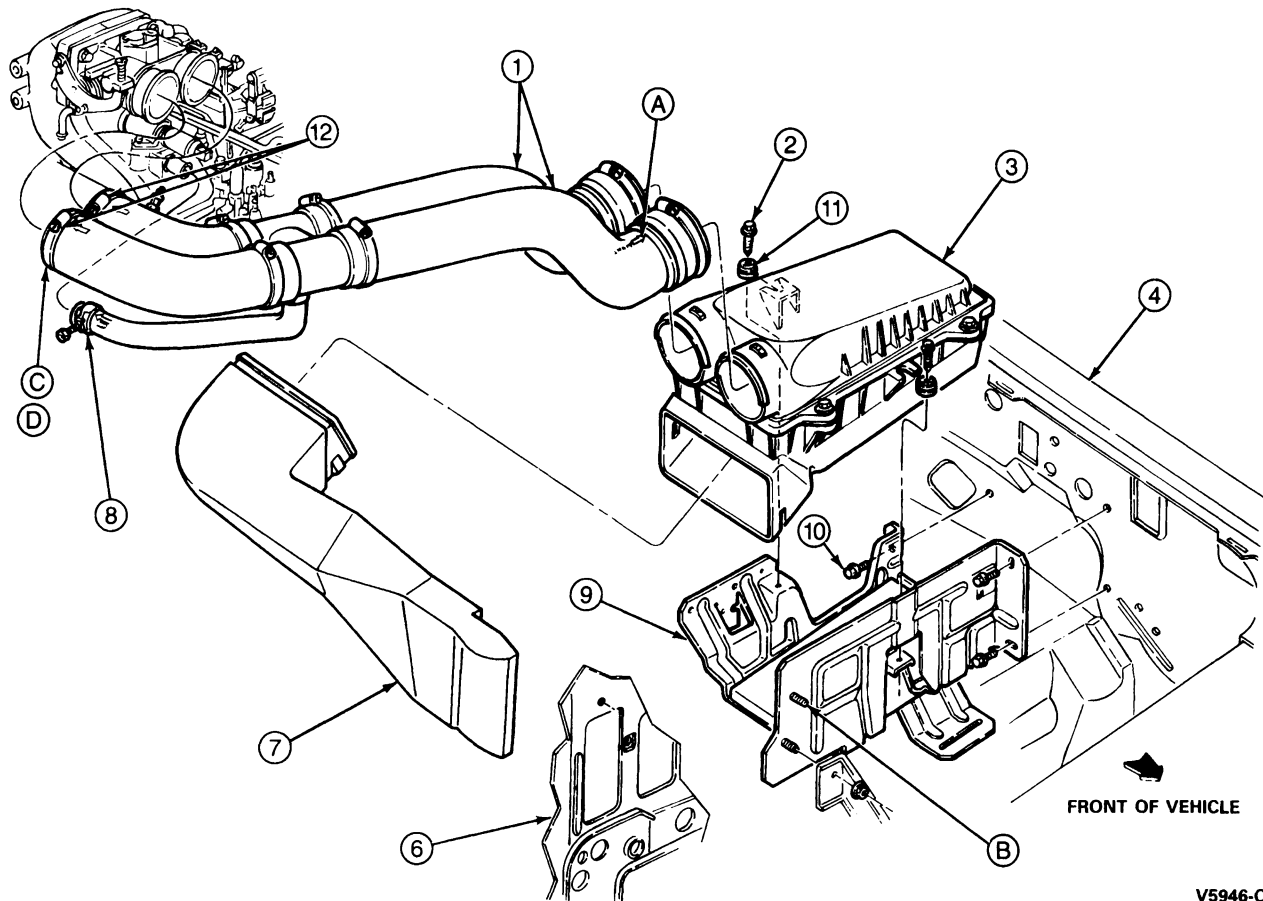
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Item	Part Number	Description
9	9647	Air Cleaner Bracket Assembly
10	—	Clamp (4 places) 1-2 N-m (9-18 In-Lb)
11	—	Crankcase Ventilation Hose
A	—	Hose Assembly Arrows Must be in Line With Locators on Throttle Body
B	—	Hose Assembly Arrows Must be in Line With Air Cleaner Cover Arrow $\pm 2^\circ$
C	—	Surface Must Meet Against Throttle Body Stop Flange for 360° (Both Tubes)

TV5828A

REMOVAL AND INSTALLATION (Continued)

Typical Air Cleaner Installation, F-250 HD, F-350 and F-Super Duty Chassis Cab, 7.5L MFI Engine



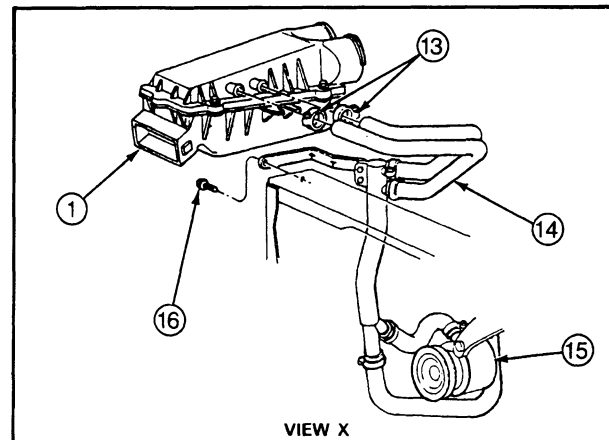
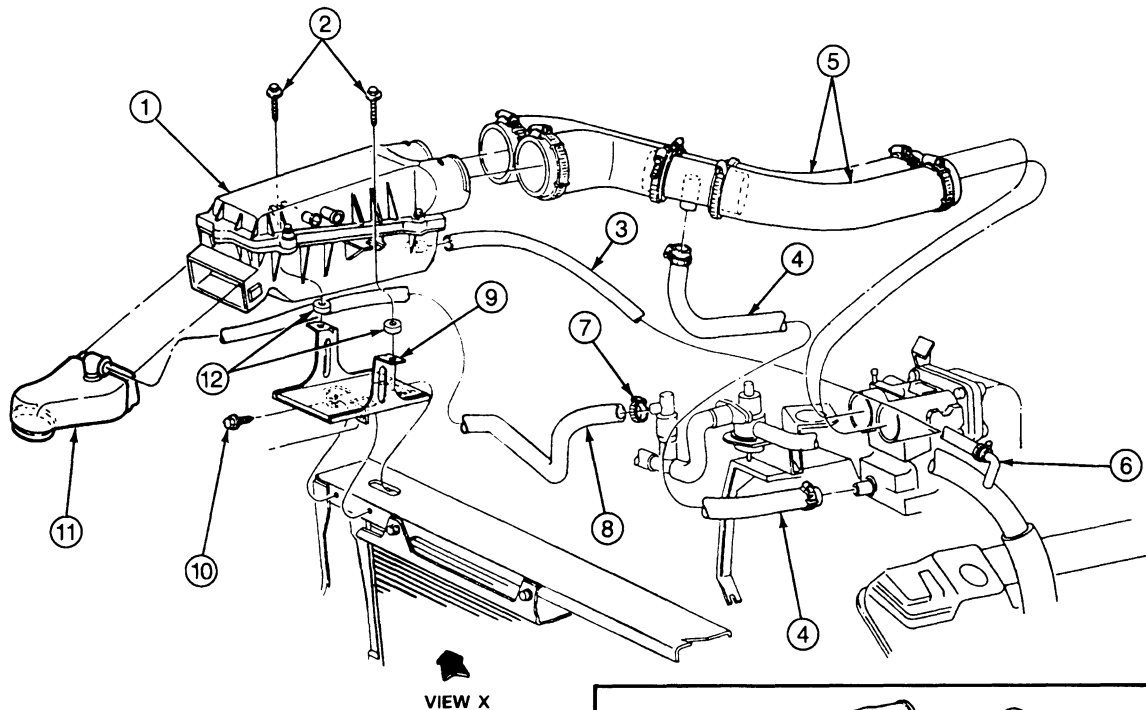
V5946-C

Item	Part Number	Description
1	9R504	Air Cleaner Outlet Tube Assembly
2	N611062-S2	Tapscrew and Washer Assembly (2 Required)
3	9600	Air Cleaner Assembly
4	—	Left Fender (Reference)
6	—	Radiator Support (Reference)
7	9A675	Fresh Air Intake Tube Assembly
8	—	Clamp 2-3 N·m (18-27 In-Lb)
9	9647	Air Cleaner Bracket Assembly
10	N610958-S2	Screw (4 Required)

(Continued)

Item	Part Number	Description
11	17C431	Grommet (2 Required)
12	—	Clamp (4 Places) 2-3 N·m (18-27 In-Lb)
A	—	Hose Assembly Arrows Must Be In Line With Air Cleaner Cover Arrows $\pm 2^\circ$
B	—	Water Bottle Affixed At This Location
C	—	Surface Must Meet Against Throttle Body Stop Flange for 360° (Both Tubes)
D	—	Hose Assembly Arrows Must Be In Line with Locators On Throttle Body $\pm 2^\circ$

TV5946A

REMOVAL AND INSTALLATION (Continued)**Air Cleaner Installation, F-Super Duty Motorhome Chassis, 7.5L MFI Engine**

V7792-D

Item	Part Number	Description
1	9600	Air Cleaner Assembly
2	—	Screw 9-11 N·m (70-97 In-Lb)
3	6C342	Crankcase Ventilation Hose
4	9H308	Idle Air Control Hose
5	9R504	Air Cleaner Outlet Tube Assembly
6	—	Crankcase Vent
7	—	Clamp 2-3 N·m (18-27 In-Lb)
8	9J435	Hose
9	9646	Air Cleaner Bracket Assembly

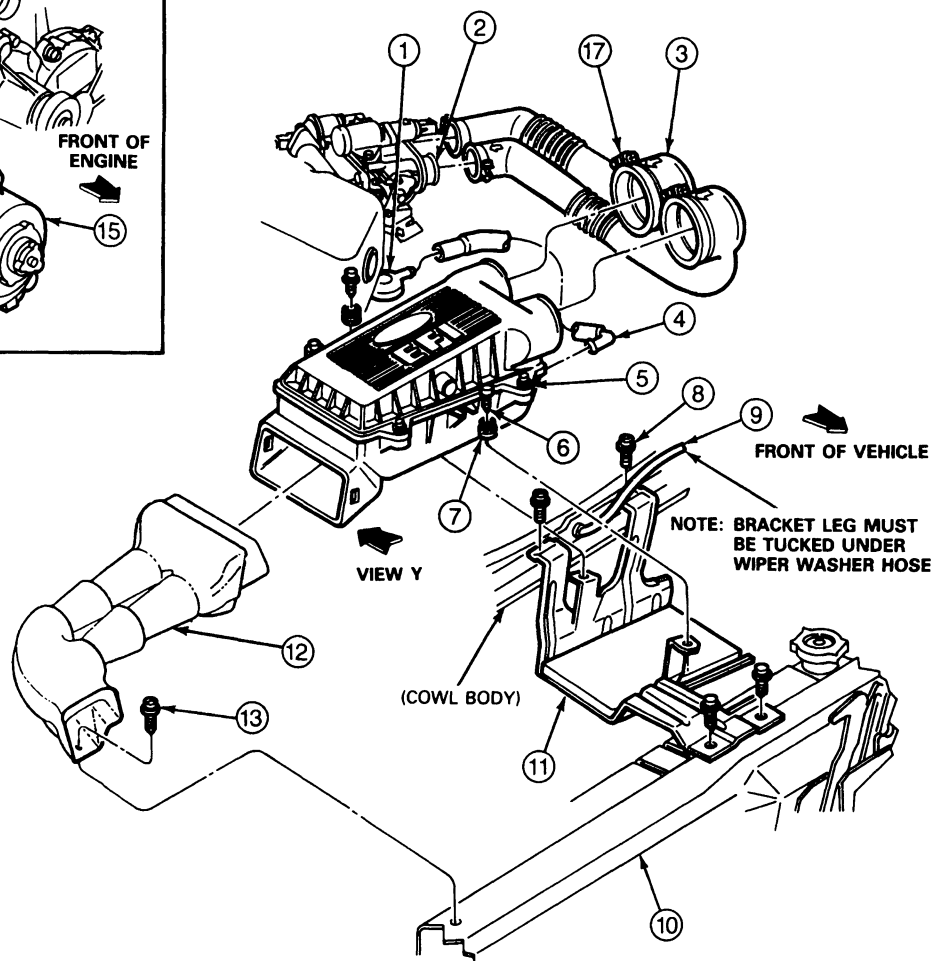
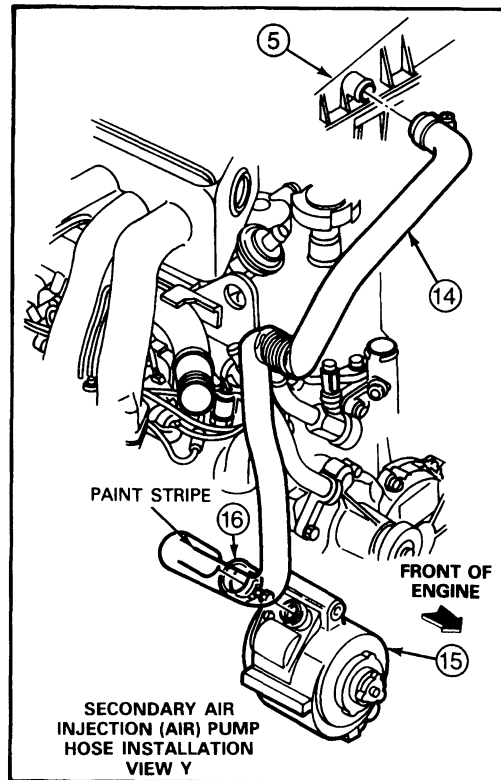
Item	Part Number	Description
10	N610958	Screw (2 Required)
11	9C675	Air Inlet Tube Assembly
12	17C431	Grommet Assembly (2 Required)
13	—	Clamp 2-3 N·m (18-27 In-Lb)
14	9B458	Secondary Air Injector (AIR) Exhaust Hose
15	—	Secondary Air Injector (AIR) (Reference)
16	—	Screw 9-11 N·m (80-97 In-Lb)

(Continued)

TV7792A

REMOVAL AND INSTALLATION (Continued)

Air Cleaner Installation, E-150-250-350 4.9L Engine



A15823-B

Item	Part Number	Description
1	6A768	Crankcase Vent Tube Filter Assembly
2	9E926	Throttle Body

(Continued)

Item	Part Number	Description
3	9R504	Engine Air Cleaner Outlet Tube Assembly
4	6C342	Crankcase Vent Hose Assembly

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
5	9600	Air Cleaner Assembly
6	N611062-S2	Screw M6.3-1.81 x 32 (2 Req'd.)
7	17C431	Grommet Assembly (2 Req'd.)
8	N605889-S53B	Bolt M6-1 x 12 (4 Req'd.) 9-11 N·m (6-8 Ft-Lb)
9	17A605	Windshield Washer Hose (Air Filter Bracket Leg Must be Tucked Under Washer Hose)
10	—	Upper Radiator Support

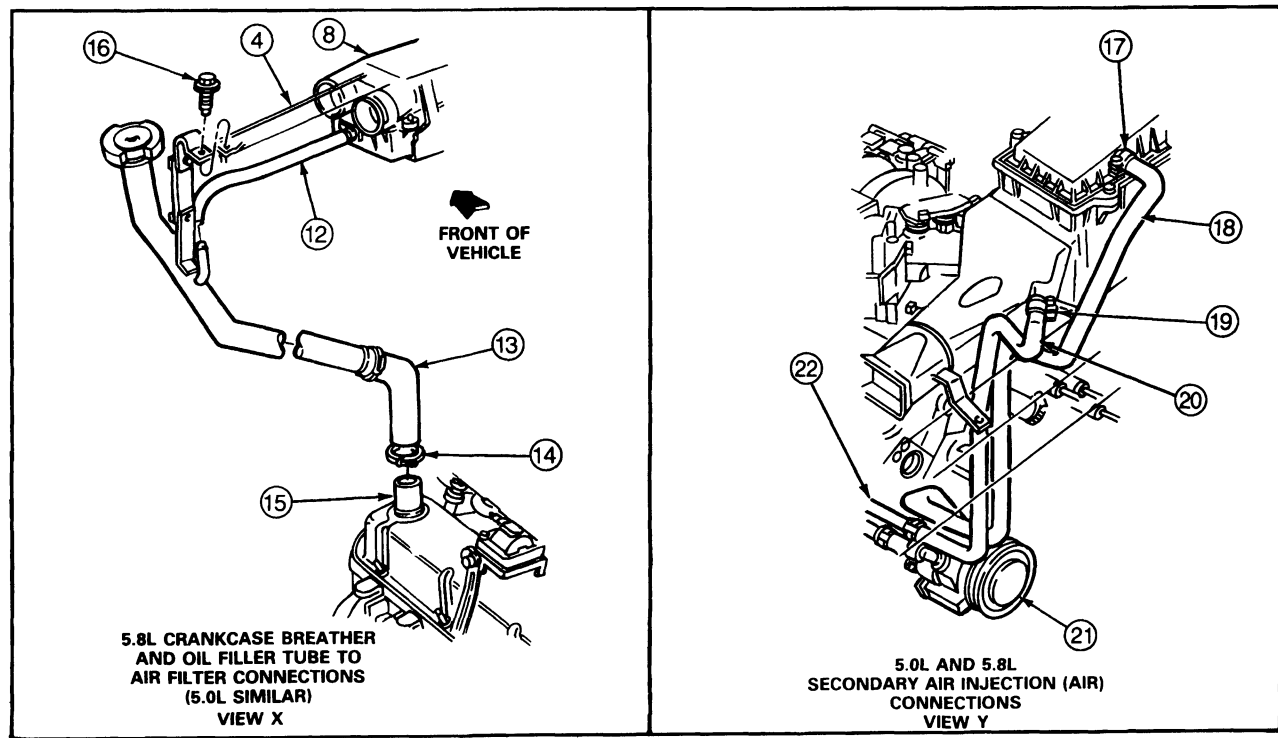
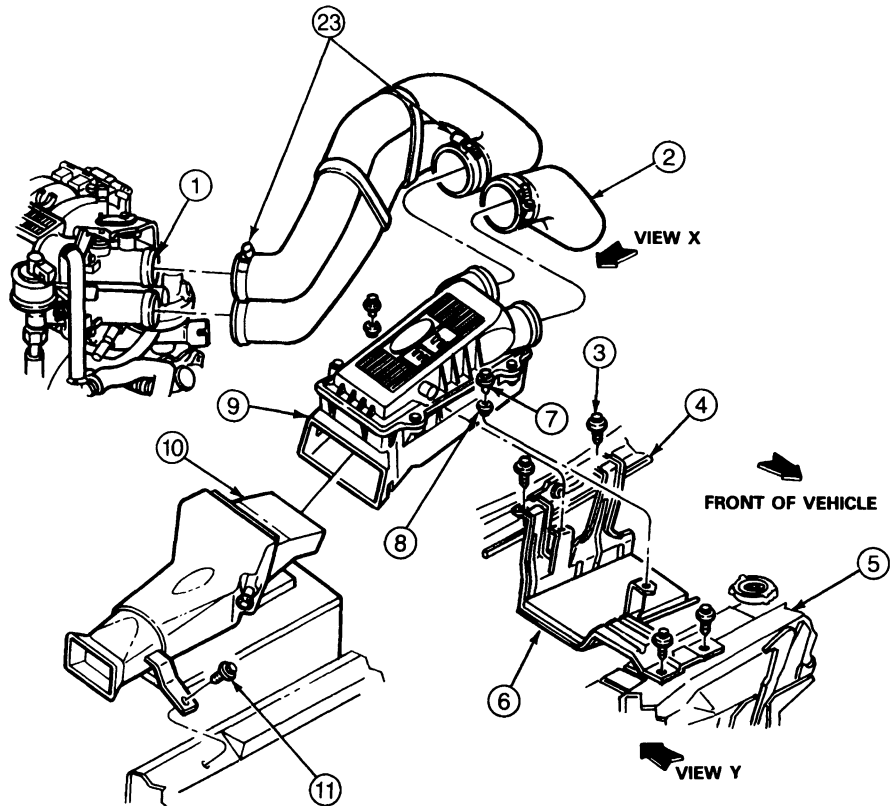
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Item	Part Number	Description
11	9647	Air Cleaner Bracket Assembly
12	9A675	Engine Air Cleaner Inlet Tube
13	N606675-S2	Bolt M6.3-1 x 16 (5 Required)
14	95449	Exhaust Air Supply Pump Inlet Hose
15	9A486	Exhaust Air Supply Pump Clamp
16	386951-S100	Clamp, Air Cleaner Outlet Tube, 2-3 N·m (18-27 In-Lb)
17		

TA15823A

REMOVAL AND INSTALLATION (Continued)

Air Cleaner Installation, E-150-250-350 5.0L (1993 Model Year, Without Mass Air Flow) and 5.8L Engines



A15825-B

REMOVAL AND INSTALLATION (Continued)

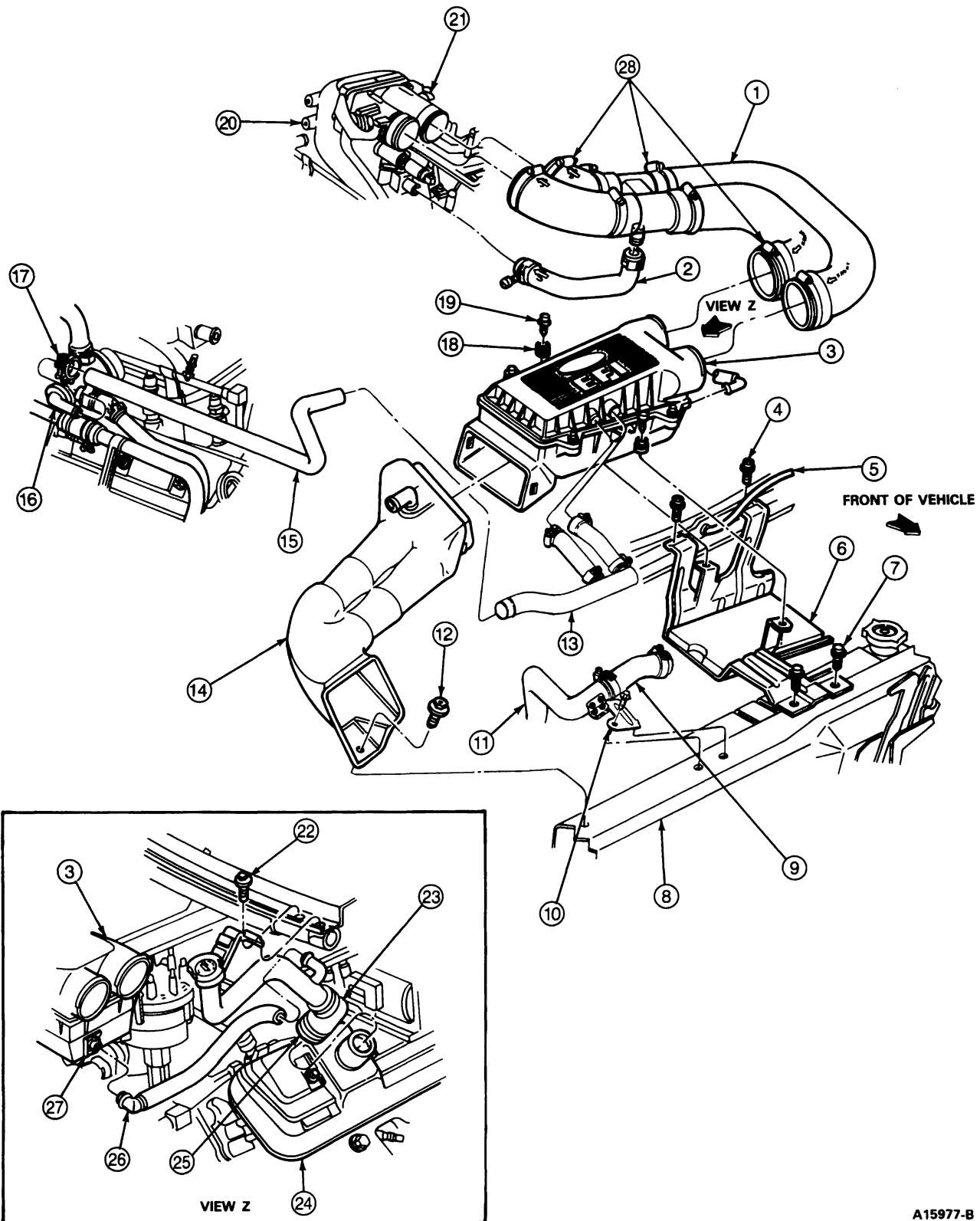
Item	Part Number	Description
1	9E926	Throttle Body Assembly
2	9R504	Air Cleaner Outlet Tube Assembly
3	12A581	IAT Sensor Connector
4	—	Closure Hose (Part of Item #2)
5	12A697	Intake Air Temperature Sensor
6	9600	Air Cleaner Assembly
7	N621907-S2	Nut and Washer, M6 x 1 (4 Req'd.)

(Continued)

Item	Part Number	Description
8	9F763	Resonator Assembly
9	(Ref.)	Battery
10	N606675-S2	Screw M6 x 1 x 18.5 1-27 N·m (9-18 In-Lb)
11	N623332-S2	U-Nut M6 x 1
12	(Ref.)	Radiator Support
13	9647	Air Cleaner Bracket Assembly
14	—	Clamp (Part of Item #2) 1-2 N·m (9-18 In-Lb)
15	N606675-S2	Screw M6 x 1 x 18.5 8-11 N·m (71-97 In-Lb)

REMOVAL AND INSTALLATION (Continued)

Air Cleaner Installation, E-150-250-350 7.5L Engine



A15977-B

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9R504	Air Cleaner Outlet Tube Assembly
2	9H308	Idle Air Control Tube Assembly
3	9600	Air Cleaner Assembly
4	N606675-S2	Screw & Washer M6-1.0 x 16 9-11 N·m (80-97 In-Lb)
5	—	Windshield Washer Hose
6	9647	Air Cleaner Bracket
7	N606675-S2	Screw & Washer M6-1.0 x 16 9-11 N·m (80-97 In-Lb)
8	—	Upper Radiator Support
9	—	Hose
10	—	Bracket
11	9D480	Secondary Air Injection (AIR) Lower Air Supply
12	N606675-S2	Screw & Washer M6-1.0 x 16 2-3 N·m (18-27 In-Lb)
13	9B448	Secondary Air Injection (AIR) Right Hand Air Supply Manifold

(Continued)

Item	Part Number	Description
14	9F843	Air Cleaner Intake Tube Assembly
15	9J435	Secondary Air Injection (AIR) Air Supply Silencer Inlet Hose
16	—	Secondary Air Injection (AIR) By-Pass Valve
17	—	Clamp
18	17C431	Grommet
19	N601161-S2	Screw M6.3-1.81 x 32
20	—	Upper Intake Manifold
21	—	Throttle Body
22	N605889-S2	Screw M6-1.0 x 4.5
23	6763	Oil Filler Tube
24	—	Rocker Arm Cover
25	387061-S100	Clamp
26	6C342	Crankcase Vent Hose
27	—	Clip
28	—	Clamp, Air Cleaner Outlet Tube, 2-3 N·m (18-27 In-Lb)

TA15977A

Air Cleaner, Diesel Engine

Removal

- Loosen wing bolt.
- Remove air cleaner assembly as a unit before disassembly.
- Before installing a new element in the air cleaner, check the following items:
 - Gasket surfaces should be clean and undamaged.
 - Inlet tube should be clean and undamaged.
 - Element should be dry and free of holes, ruptures, damaged gaskets or dents in end covers and liners.
 - Element retaining nut or bolt should have the gasket washer attached and it should be in good condition.
 - Inspect water drain hose (F-Series only) for possible restrictions caused by contaminants or kinking. Replace hose (9F765) if cracked or damaged.

Installation

After the air cleaner, element, and other parts are found to be in good condition, reassemble the parts.

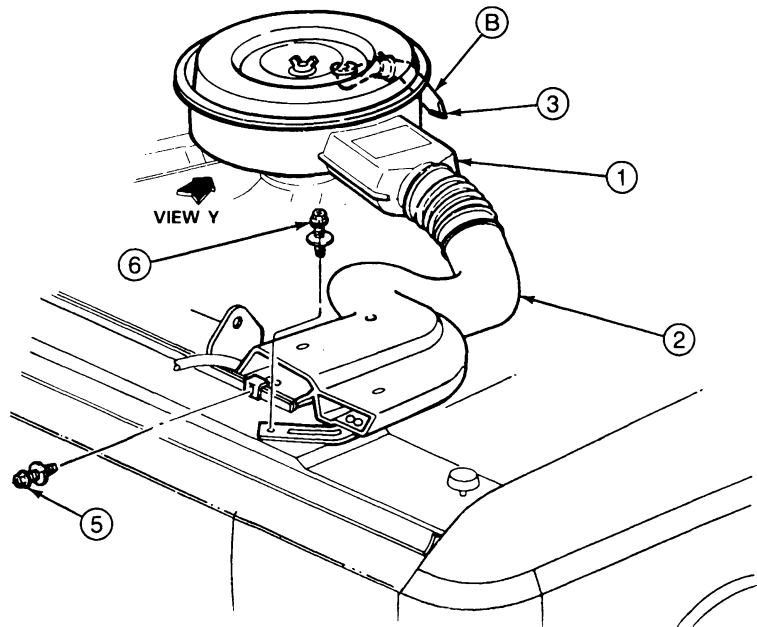
- Install the element. Make sure the rubber face of the washer seals against the element.

CAUTION: A special water resistant element is required. Use only a specific Ford replacement. Use of other elements could result in serious engine damage.

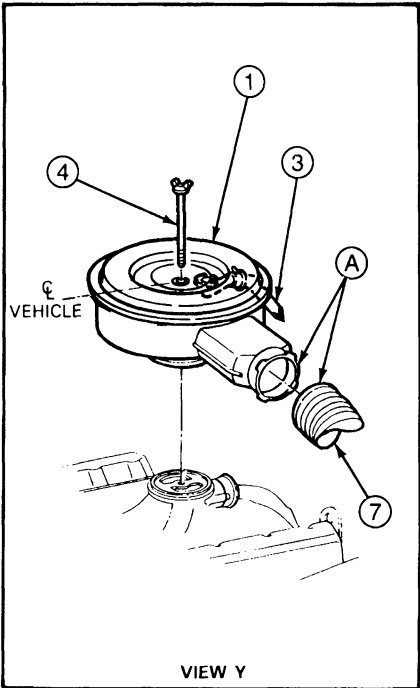
- Install the cover. Make sure gasket, if supplied, is in place. Replace a worn or damaged gasket.
- Install air cleaner assembly and tighten wing bolt securely.
- On F-Series only, make sure that the rubber water drain hose is not doubled under, kinked or bent and is positioned freely.

REMOVAL AND INSTALLATION (Continued)

Air Cleaner Installation, F-250HD, F-350 and F-Super Duty Chassis Cab, 7.3L Diesel Engine



TYPICAL AIR CLEANER INSTALLATION —
F-250 HD, F-350, F-SUPER DUTY CHASSIS CAB



V3566-G

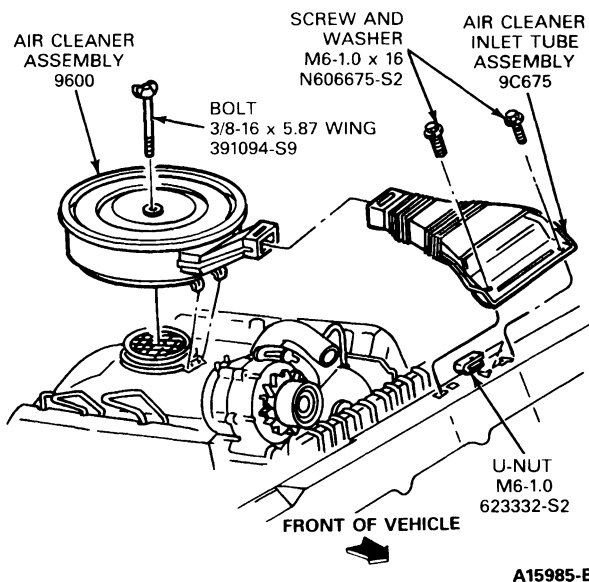
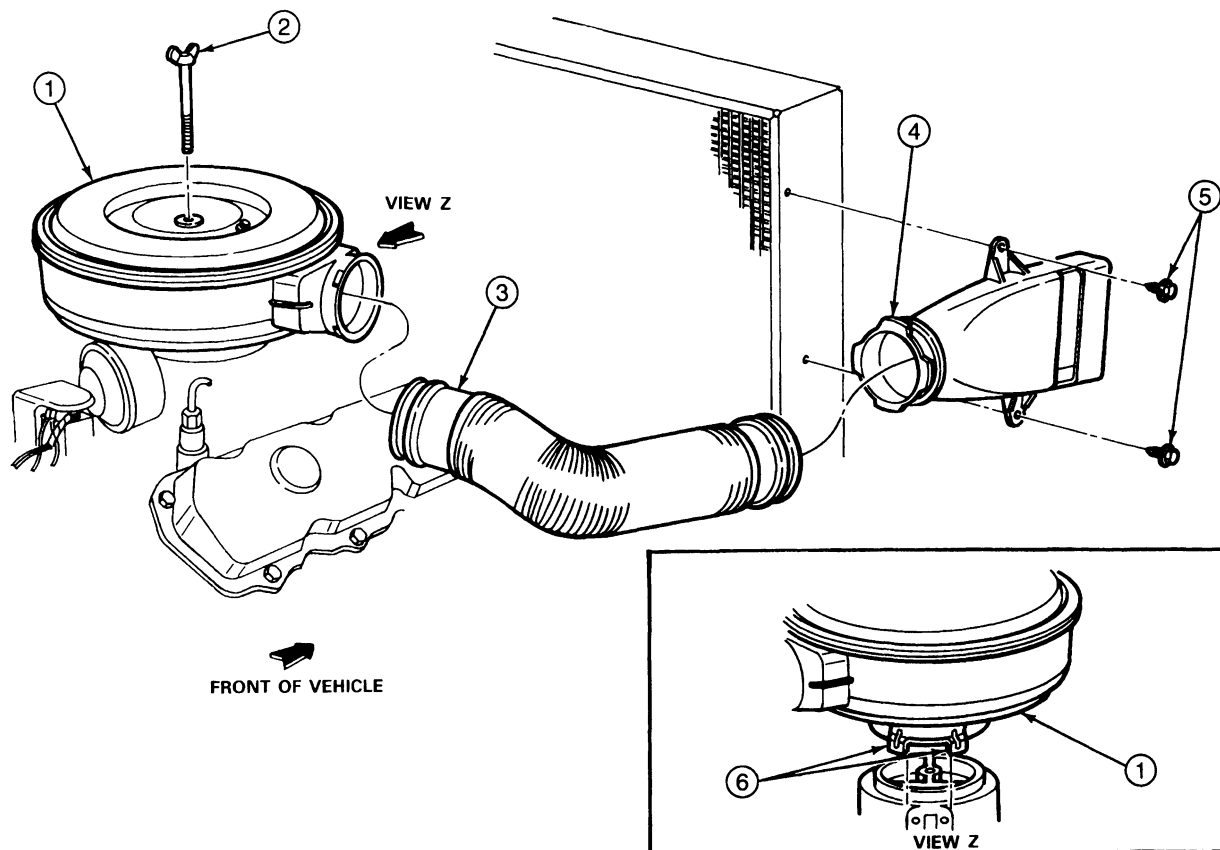
Item	Part Number	Description
1	9600	Air Cleaner Assembly
2	9C675	Intake Tube Assembly
3	—	Water Drain Hose (See B Below)
4	391094-S9	Bolt, 3/8-16x5.87 Wing
5	N805660-S	Rivet

(Continued)

Item	Part Number	Description
6	N606675-S2	Screw and Washer 8-10 N-m (71-89 In-Lb)
7	—	Duct Tube
A	—	Snap Duct Over Tabs at Air Cleaner and at Intake Tube Assembly
B	—	Make sure that Water Drain Hose is not Doubled under Air Cleaner after Installation

TV3566A

REMOVAL AND INSTALLATION (Continued)

Air Cleaner Installation, E-250-350 7.3L Diesel Engine**Air Cleaner Installation, F-Super Duty Commercial Chassis, 7.3L Diesel Engine**

V6282-D

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9600	Air Cleaner Assembly
2	390816	Wing Bolt, 3 N-m (27 In-Lb)
3	9B676	Air Cleaner Duct

(Continued)

Item	Part Number	Description
4	9C676	Air Intake Tube
5	—	Bolt, 11-14 N-m (8-10 Ft-Lb)
6	—	Alignment Tabs

TV6282A

SPECIFICATIONS**TORQUE SPECIFICATIONS**

DESCRIPTION	N-m	In-Lb
F-Series, 5.0L and 5.8L Clamp, Air Cleaner Outlet Tube	2-3	18-27
F-Series, 4.9L Clamp, Air Cleaner Outlet Tube	1-2	9-18
F-Series, 7.5L Clamp, Air Cleaner Outlet Tube	2-3	18-27
Clamp, Idle Air Control Valve Supply Hose	2-3	18-27
F-Super Duty Motorhome, 7.5L Clamp, Air Cleaner Outlet Tube	2-3	18-27
Screw, Air Cleaner Assembly-to-Bracket	9-11	80-97
Clamp, Secondary Air Injection (AIR) Hoses	2-3	18-27
Screw, Secondary Air Injection (AIR) Bracket	9-11	80-97

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

DESCRIPTION	N-m	In-Lb
E-Series, 4.9L Clamp, Air Cleaner Outlet Tube	2-3	18-27
Screw, Air Cleaner Bracket	9-11	80-97
E-Series, 5.0L and 5.8L Clamp, Air Cleaner Outlet Tube	2-3	18-27
Bolt, Air Cleaner Bracket	9-11	80-97
E-Series, 7.5L Clamp, Air Cleaner Outlet Tube	2-3	18-27
Screw, Air Cleaner Bracket	9-11	80-97
Screw, Air Cleaner Inlet Tube	2-3	18-27
E-Series, F-Series, 7.3L Diesel Wing Bolt	2-3	18-27
Screw, Air Cleaner Inlet Tube	8-10	71-89

SECTION 03-13 Evaporative Emissions

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VEHICLE APPLICATION

All Light Truck Vehicles Equipped with 4.9L, 5.0L, 5.8L or 7.5L Gasoline Engines

DESCRIPTION AND OPERATION

Fuel Evaporative Emission System

The evaporative emission system limits the amount of fuel vapor a vehicle may release to the atmosphere, enabling the vehicle to meet current federal and state requirements for fuel evaporation.

The following are components of the evaporative emission system:

- Sealed fuel tank
- Pressure vacuum relief fuel cap
- Fuel tank vapor valve
- Carbon canister
- Purge control valve (some engines)
- Canister purge solenoid or purge regulator valve (some engines)

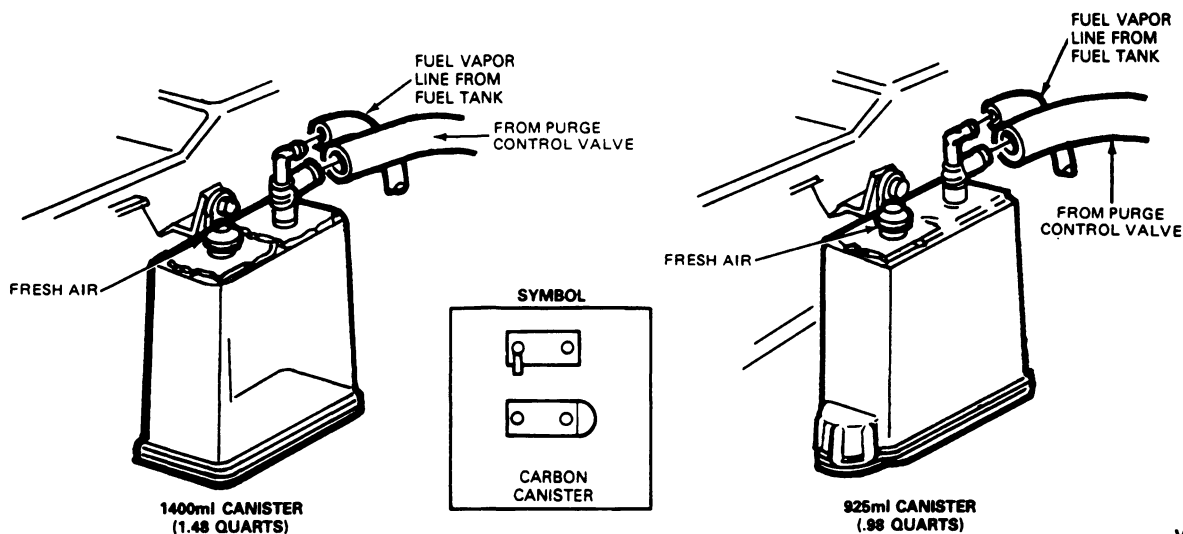
The system works by capturing a very high percentage of fuel vapors that might otherwise escape from the gas tank. It then directs these vapors to the carbon canister where they are stored while the engine is not running. When the engine is running, and conditions are acceptable, the vapors are purged out of the canister and into the engine. This "clears" the canister and allows it to accept more fuel vapors the next time the engine is shut off.

The system is basically the same for all vehicle and engine lines: a hose or tube runs from the top of the fuel tank to the carbon canister to allow fuel vapors to pass from the tank to the carbon canister. A tube or hose runs from the carbon canister to the engine, allowing vapors to be purged from the canister. Some engines use additional valves in one or more of these lines to provide additional control over how much or when fuel vapor will be allowed to pass.

DESCRIPTION AND OPERATION (Continued)**Carbon Canister**

Typical carbon canisters are shown in the following illustration. The carbon canister is normally mounted in or near the engine compartment. Two basic sizes are employed: 925ml or 1400ml. The "925" and "1400" refer to volume of activated carbon contained within the canister. Activated carbon is the working part of the carbon canister. It has the unique ability to absorb (store) and purge (remove) fuel vapors by passing fresh air through the carbon bed. It is able to do this over and over with almost no loss in ability to absorb and purge.

Thus, all sources of fuel vapor (fuel tank and purge control valve) are routed to the carbon canister for absorption of fuel vapor.

Carbon Canisters, Typical**Canister Purge Control Valve (Non-Electrical Control)**

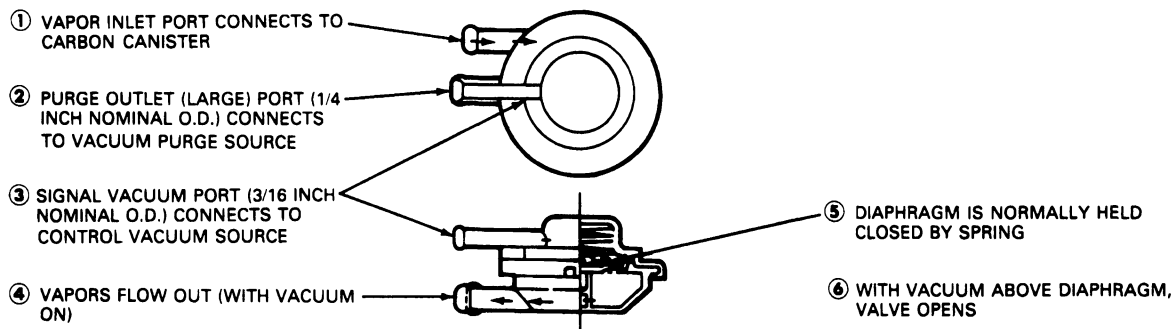
The purge control valve is in line with the carbon canister and controls the flow of fuel vapors out of the canister. It is a normally closed valve that opens with vacuum input. Operation of the valve is shown in the following illustration. Also shown are views of typical purge control valves.

DESCRIPTION AND OPERATION (Continued)

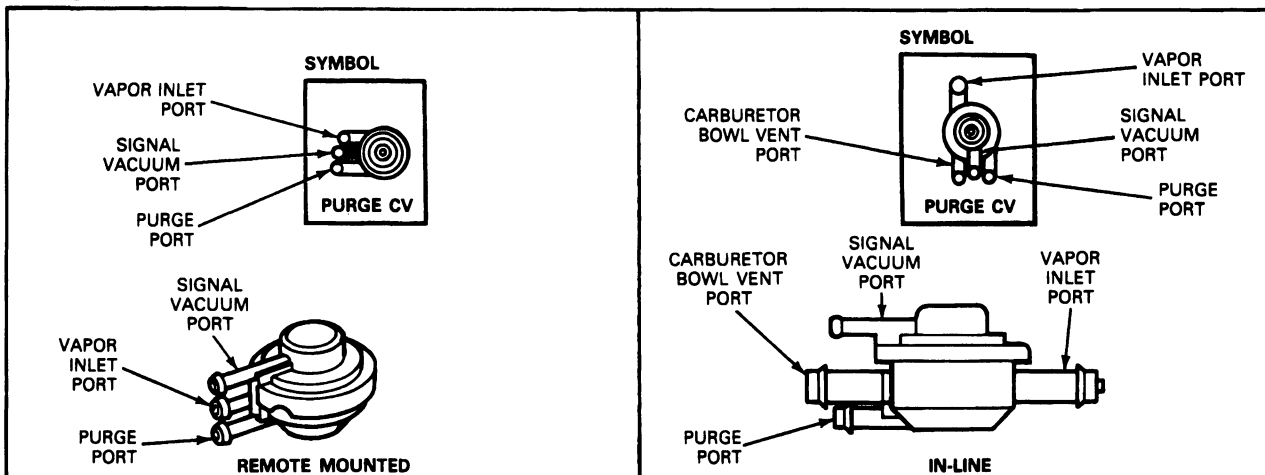
Purge Control Valve, Typical

PURGE CONTROL VALVE OPERATION (PURGE CV) (-9B963-)

- NORMALLY CLOSED
- OPENS VAPOR INLET TO PURGE OUTLET WITH VACUUM APPLIED



TYPICAL PURGE VALVES



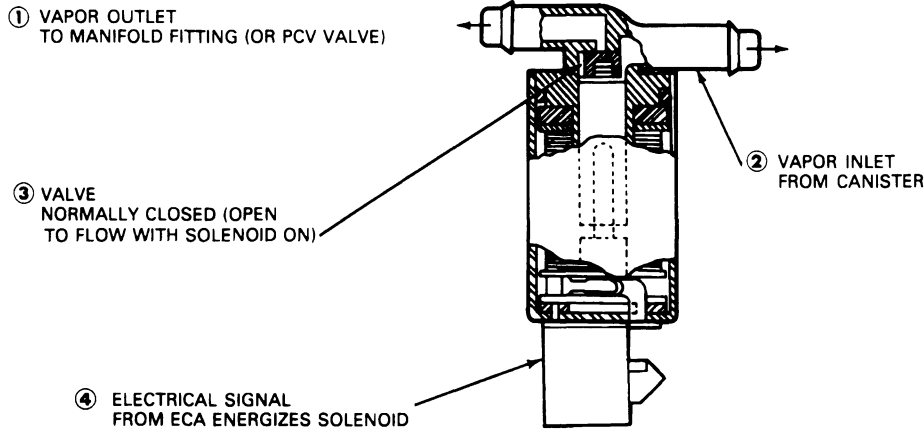
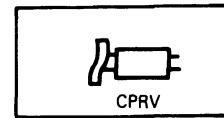
V5581-2B

Canister Purge Solenoid (Canister Purge Regulator Valve)

A typical canister purge solenoid is shown in the following illustration. The canister purge solenoid is located in the vapor line between the carbon canister and the throttle body, and is normally in the closed position until electrically energized.

DESCRIPTION AND OPERATION (Continued)**Canister Purge Solenoid****CANISTER PURGE SOLENOID (CPRV) (-9C915-)**

- USED WITH EEC (ELECTRONIC ENGINE CONTROL)
- NORMALLY CLOSED, SOLENOID VACUUM VALVE
- PURGES ON SIGNAL FROM ECA; USUALLY AT WARM AND HOT CRUISE

SYMBOL

V5582-28

The operation of the canister purge solenoid is controlled by the Powertrain Control Module (PCM). When the engine is off, the canister purge solenoid is not energized and is in a closed, non-flowing condition. When the engine is running, the PCM reads engine rpm, engine load, engine temperature and other variables, and decides the proper time for the engine to accept fuel vapors. When this occurs, the PCM energizes the canister purge solenoid, allowing flow from the carbon canister to the intake manifold. The vapors are then consumed in the engine. This action "purges" the carbon canister of fuel vapors. It occurs as fresh air is sucked into the carbon canister under the fresh air inlet cap of the canister and through the activated carbon bed. This allows the stored fuel vapors to pass from the canister through the fuel vapor return tube and the canister purge solenoid, and into the engine.

Vapor Vent, In-Tank Venting

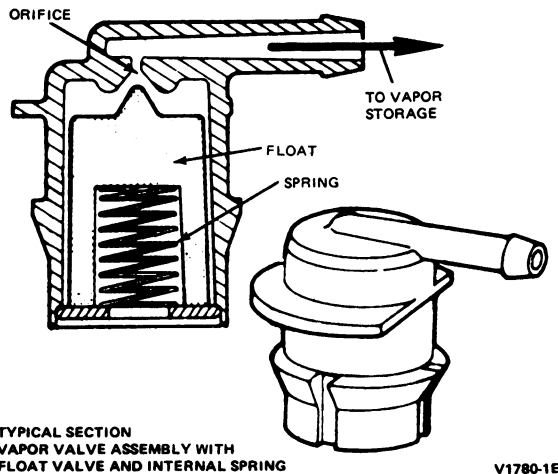
This system provides a vapor space above the gasoline surface in the fuel tank. This area is sufficient to permit adequate breathing space for the tank vapor valve assembly under static and most dynamic conditions. This is accomplished by the tank vapor valve assembly that is centrally located on the upper surface of the tank.

Fill Control/Vent

Fill limiting is accomplished through fill pipe configuration and / or external vent lines within the fill pipe and tank. The vent system is designed to permit at least 10 percent tank volume air space when the tank is filled to capacity. This air space provides for thermal expansion of fuel as well as being an aid to the in-tank vapor vent system.

DESCRIPTION AND OPERATION (Continued)**Tank Vapor Valve, Rollover Valve Assembly**

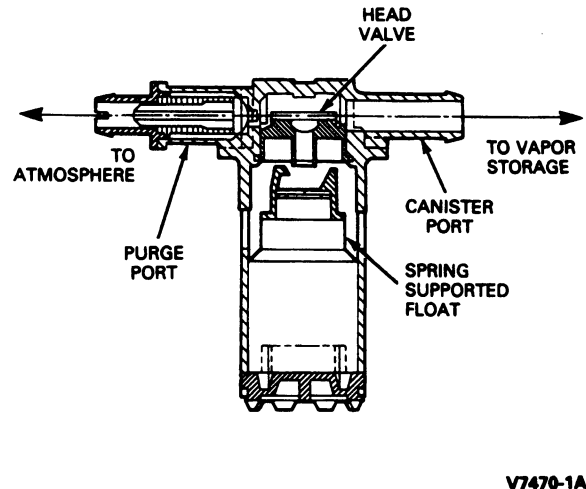
All fuel tank vapor valves make use of a small orifice that tends to allow only vapor and not fuel to pass into the line running forward to the vapor storage canister. On all vehicles except E-Series, the assembly mounts directly to the top of the tank using a rubber grommet seal. E-Series vehicles use a vapor valve that mounts using a cam-lock system similar to a radiator pressure cap.



Fuel vapors trapped in the sealed fuel tank are vented through the orificed vapor valve assembly in the top of the tank. The vapors leave the valve assembly through a single vapor line and continue to the carbon canister for storage, until they are purged to the engine.

Mechanical Rollover Valve, 5.8L MFI and 7.5L MFI Engines

The vapor valve assembly mounted on the top of the fuel tank is used to control the flow of fuel vapor entering the fuel tank vapor delivery line which conducts vapor forward to the canister in normal circumstances. If, due to extreme conditions, excessive pressure is generated inside the tank, the purge port opens up, allowing fuel vapor to escape to the atmosphere, and stabilizes pressure inside the tank. The valve assembly has a head valve which prevents the fuel tank from overfilling during refueling operation. The valve assembly also has a spring supported float assembly, which prevents liquid fuel from entering the vapor delivery line during severe handling, steep grades or in the event of vehicle rollover.

Mechanical Rollover Valve, F-Series with 5.8L MFI and 7.5L MFI, E-Series Similar**Pressure and Vacuum Relief System****Fuel Fill Cap**

The fuel fill cap is sealed and includes a built-in pressure-vacuum relief valve. Fuel system vacuum relief is provided after 3.5 kPa (0.50 psi) and pressure relief after 11.0 kPa (1.6 psi). Under normal operating conditions, the fill cap operates as a check valve, allowing air to enter the tank as fuel is used, while preventing vapors from escaping the tank through the cap.

NOTE: Use of an aftermarket fuel fill cap other than an authorized Ford / Motorcraft service part could result in damage to the fuel system or improper system operation if not properly designed / manufactured for pressure vacuum relief. Customer warranty is void for fuel tank and / or fuel system damage resulting from the use of such caps.

Pressurized Fuel Systems

Nylon fuel tubes with plastic push-connect fittings or PTFE (Teflon®) and stainless steel fuel tubes with stainless steel push-connect fittings are used on MFI engines.

Push-Connect Fittings

Push-connect fittings are used to make most fuel line connections in pressurized fuel systems. This fitting must be serviced using the procedures outlined in Section 10-01. Service is not possible if the fitting is damaged, except to replace a damaged retaining clip. Hairpin clips on plastic push-connect fittings should be replaced whenever a connector is removed.

Fuel Lines

Fuel lines are pressurized for fuel injected engines. Refer to Section 10-01 for service information.

DESCRIPTION AND OPERATION (Continued)**Gasoline Octane Rating**

Vehicles equipped with catalytic converters must use **UNLEADED GASOLINE ONLY** (as specified on the fuel gauge and adjacent to the fuel filler opening). Leaded gasoline can damage the catalytic converter and affects other emission components. When the engine is adjusted to recommended specifications, you may use a gasoline with a minimum octane rating as designated by any of the following numbers.

- Research Octane Number (RON) — 91
- Average of Research Octane Number and Motor Octane Number
- (Antiknock Index) — 87

Octane rating and unleaded gasoline availability may vary between gasoline stations.

Fuel Tank Filling

The filler tube openings for the fuel tanks on trucks with multiport fuel injection (MFI) engines have been made smaller to prevent accidental filling with other than unleaded fuel. Gasoline pumps in the United States and Canada dispensing unleaded fuel are equipped with nozzles to accommodate the smaller filler opening on the filler neck.

Expansion of fuel due to temperature increases, or overfilling ("topping off") causes fuel overflow at the filler cap when the vehicle is standing or the cap is removed. To minimize this condition, it is recommended that the amount of fuel put in the tank when filling be limited to the automatic pump shutoff. If vehicle has two tanks, use fuel from both tanks after fill up to reduce fuel levels.

Fuel Tank Draining**All F-Series**

Use Rotunda Gasoline Storage Tanker 034-00002 and Adapter Hose 034-00012 or equivalents to drain the fuel tank(s). The adapter hose outside diameter will accommodate the flow restricting baffle built into filler necks on vehicles requiring unleaded fuel.

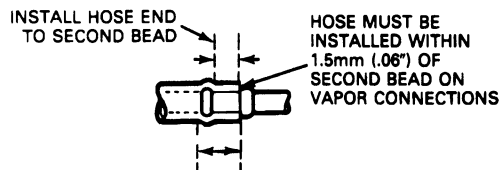
E-Series

On E-Series vehicles, it is impossible to drain the fuel tank through the filler pipe due to an anti-expulsion valve located inside the tank. Drainage is accomplished by removing the rear vapor valve and inserting Adapter Hose 034-00012 or equivalent into the hole. Connect the hose to Rotunda Gasoline Storage Tanker 034-00002 or equivalent and pump the tank out as usual.

NOTE: this operation does not require the fuel tank to be lowered.

Vapor Hoses

Vapor hoses should be assembled with the minimum engagement shown.



V2351-D

DIAGNOSIS

Physical damage, leaks, and missing items are the major answers to diagnosis of emission system complaints. Fill cap damage or contamination that renders the pressure-vacuum valve inoperative may result in deformation of the tank. Care should always be exercised to make sure a proper fill cap (in working order) is used. Refer to Powertrain Control/Emissions Diagnosis Manual¹ for individual components.

¹ Can be purchased as a separate item.

REMOVAL AND INSTALLATION

WARNING: THE EVAPORATIVE EMISSION SYSTEM CONTAINS FUEL VAPOR AND CONDENSED FUEL VAPOR. ALTHOUGH NOT PRESENT IN LARGE QUANTITIES, IT STILL PRESENTS THE DANGER OF EXPLOSION OR FIRE. DISCONNECT THE BATTERY GROUND CABLE FROM THE BATTERY TO MINIMIZE THE POSSIBILITY OF AN ELECTRICAL SPARK OCCURRING, POSSIBLY CAUSING A FIRE OR EXPLOSION IF FUEL VAPOR OR LIQUID FUEL ARE PRESENT IN THE AREA.

Evaporative emissions systems have been designed and tested to exceed 193,080 km (120,000 miles) or 10 years of vehicle use. No maintenance or service should be required. However, if components have been damaged and need to be replaced, or there is a need to remove and reinstall or disconnect components for other reasons, such as diagnosis, refer to the following procedures and illustrations to aid in servicing the system.

Evaporative emission systems are shown in the illustrations that follow. Refer to these illustrations for component location and installation instructions.

Use Ford-approved parts for replacement of fuel and vapor hoses and tubes. Original equipment components are designed to resist most environmental conditions encountered in the evaporative emission system.

Fuel Lines and Hoses

CAUTION: Fuel supply lines on vehicles with fuel injected engines will remain pressurized for long periods of time after engine shutdown. The pressure must be relieved before servicing the fuel system. Refer to fuel system pressure relief. For servicing information on fuel lines refer to Section 10-01.

Vapor Tube

Removal and Installation

1. Loosen fuel tank straps and lower fuel tank as much as possible.
2. Disconnect vapor tube at tank and remove tube from clip.

For Installation, follow removal procedures in reverse order.

Carbon Canister

Removal and Installation

Refer to the appropriate illustration for component location.

1. Disconnect vapor hoses from canister to be removed.

2. Remove screw retaining canister to bracket or fender apron.
3. Lift canister to disengage tab on back side of canister, and remove canister.

For installation, follow removal steps in reverse order. Refer to illustration or Specifications chart at the end of this section for torque specification.

Hose Replacement

1. Securely grip component with one hand, and hose with the other hand as close as possible to connection.
2. Sharply twist hose along its axis to "break" the temporary bond between hose and component. (No adhesive is used to make hose connections during vehicle assembly, but natural aging of the connections causes a temporary bond to exist.)
If the joint is stubborn and the above method does not work, grip the hose with a pair of pliers directly over the joint and twist again.
3. Once the hose / component joint has been broken, disconnect by securely gripping the component with one hand and hose with the other. Twist hose and at the same time pull apart.

WARNING: MOST CONNECTIONS IN THE EVAPORATIVE EMISSION SYSTEM ARE VERY SECURE. A STRONG PULLING AND SIMULTANEOUS TWISTING ACTION IS REQUIRED TO DISCONNECT. WHEN DISCONNECTION OCCURS, BOTH HANDS COULD SHARPLY AND UNCONTROLLABLY MOVE IN THE DIRECTION OF PULLING. BE CAREFUL THAT NO SHARP OR POSSIBLY DAMAGING OBJECTS ARE IN LINE WITH THE DIRECTION OF PULL TO PREVENT PHYSICAL INJURY AND/OR DAMAGE TO THE OBJECTS.

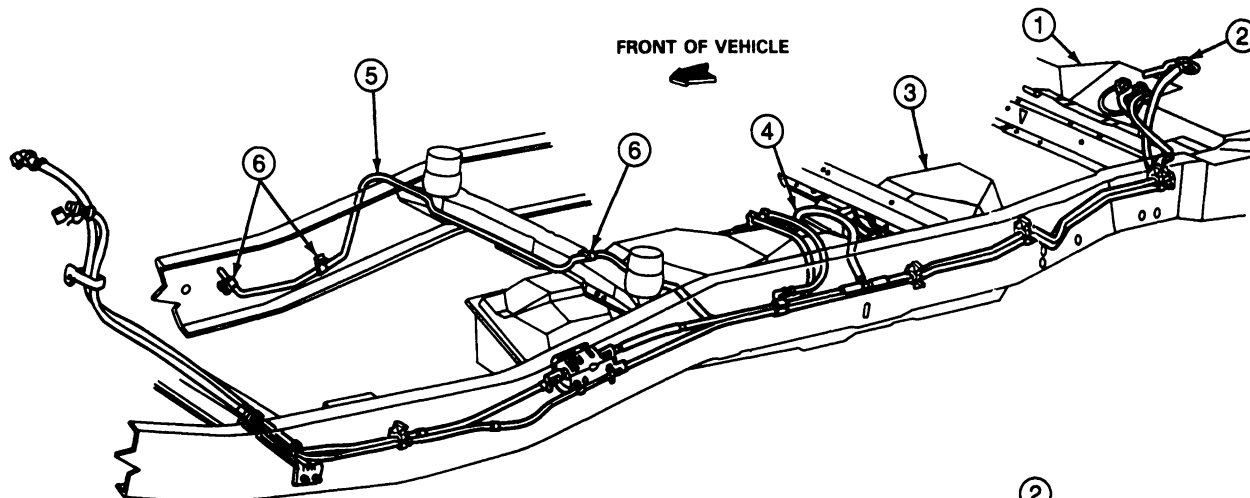
4. To reconnect a hose to a component, wet the hose with a small amount of water and push onto component.
5. Use Ford-approved vacuum hoses for replacement of damaged hoses. Original equipment hoses are designed to resist most environmental conditions encountered in the evaporative emission system.

Starting / Priming for Drained Fuel System, MFI Engines

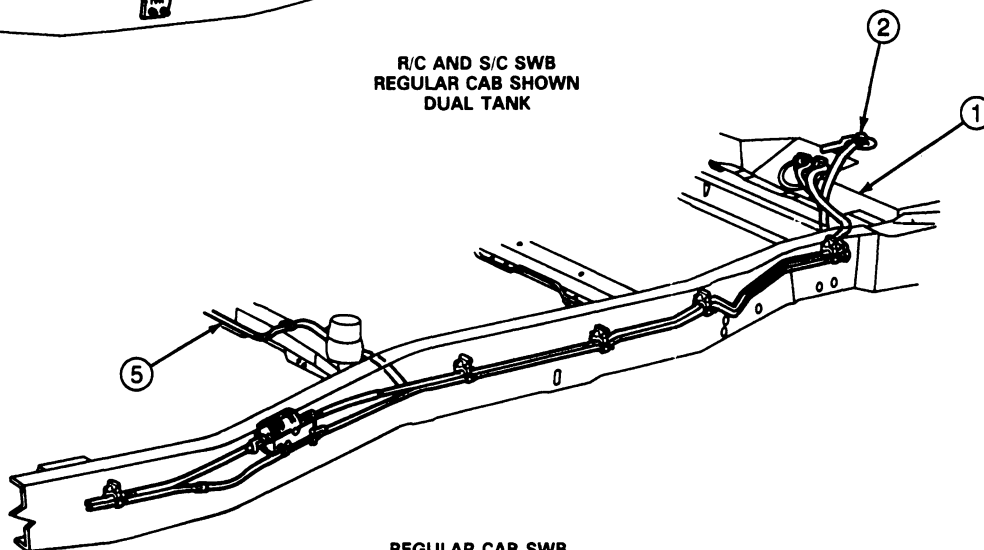
Priming is accomplished by cycling the ignition between ON and OFF. The ignition should be left on for five seconds, then turned off. The ignition should be cycled this way twenty times before attempting to start the engine. If the engine does not start after fifteen seconds of cranking, it will be necessary to repeat the procedure again.

REMOVAL AND INSTALLATION (Continued)

Vapor Lines, F-Series, Short Wheelbase



R/C AND S/C SWB
REGULAR CAB SHOWN
DUAL TANK



REGULAR CAB SWB
AFT AXLE TANK

A17885-A

Item	Part Number	Description
1	9104	Fuel Tank, Aft of Axle
2	9C987	Evaporative Valve Assembly
3	9002	Fuel Tank, Midship

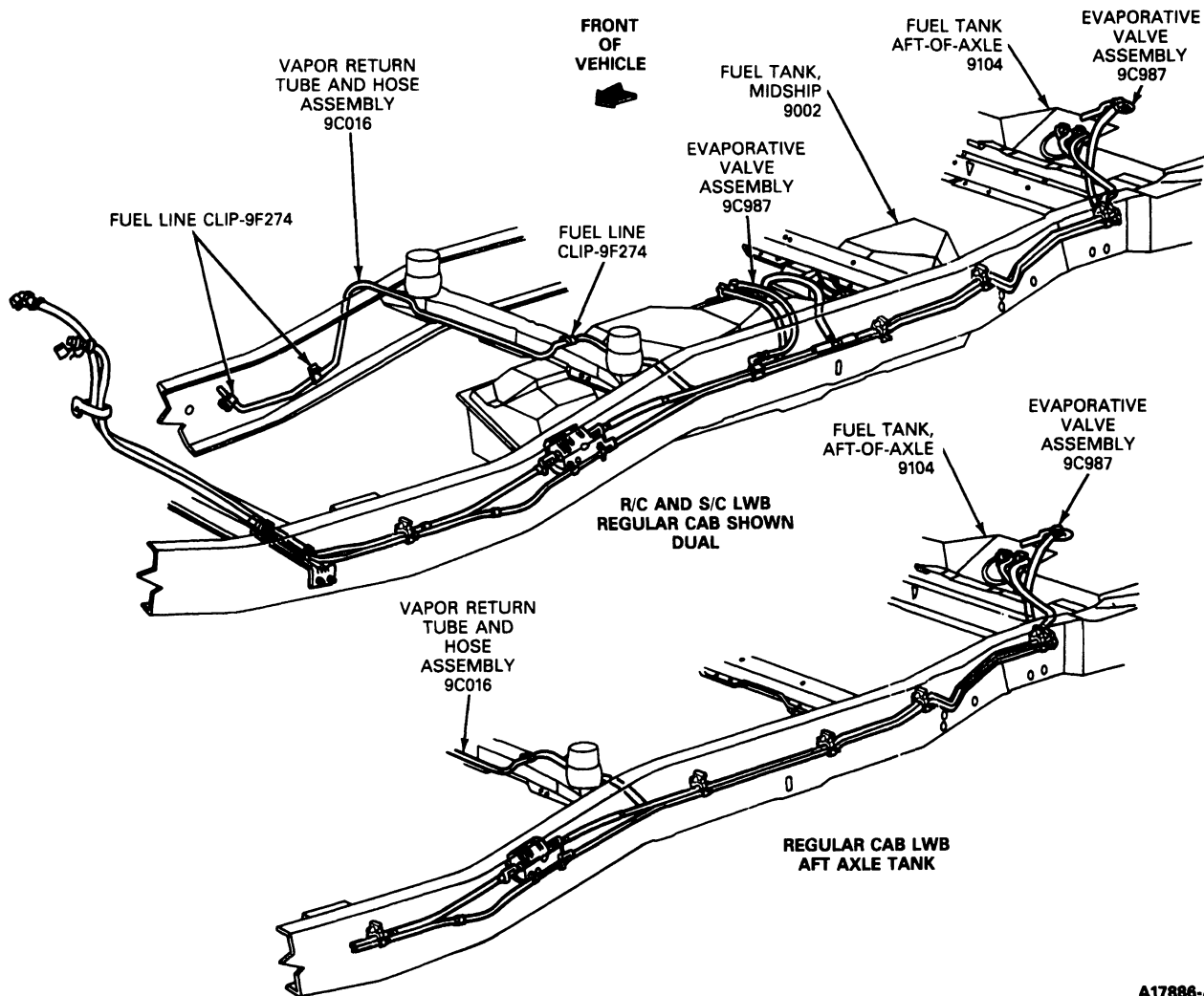
(Continued)

Item	Part Number	Description
4	9B227	Evaporative Hose and Valve Assembly
5	9C016	Vapor Return Tube and Hose Assembly
6	9F274	Fuel Line Clip

TA17885A

REMOVAL AND INSTALLATION (Continued)

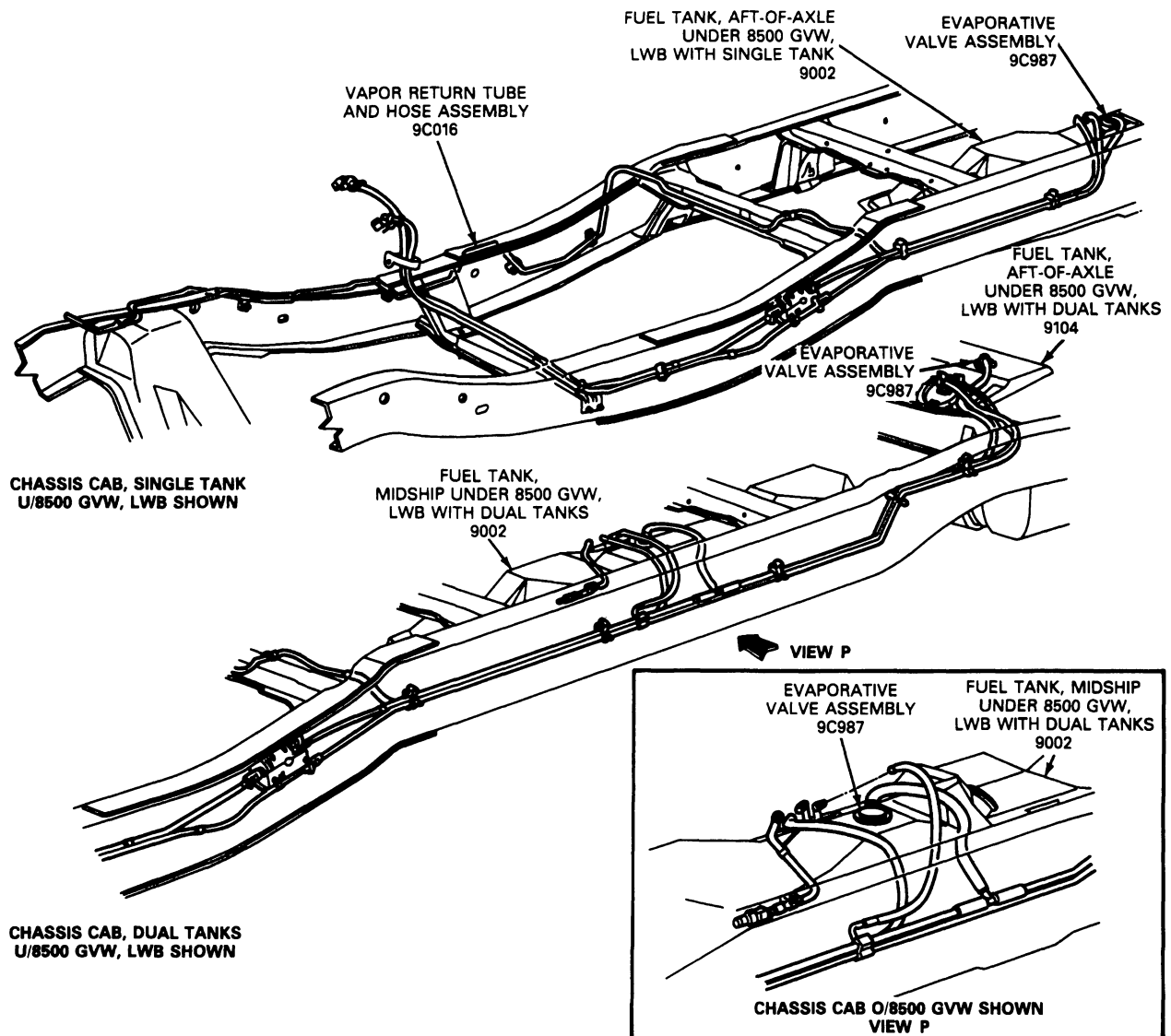
Vapor Lines, F-Series, Long Wheelbase



A17886-A

REMOVAL AND INSTALLATION (Continued)

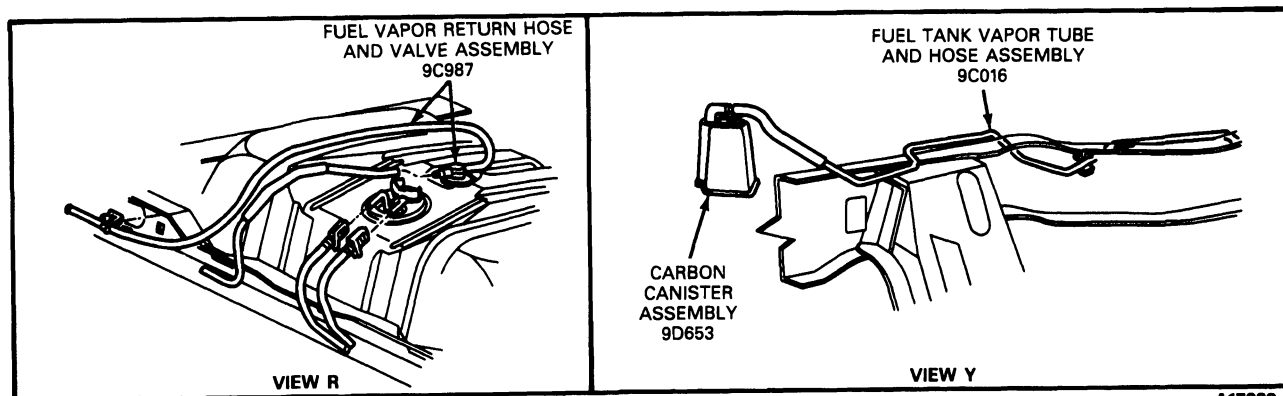
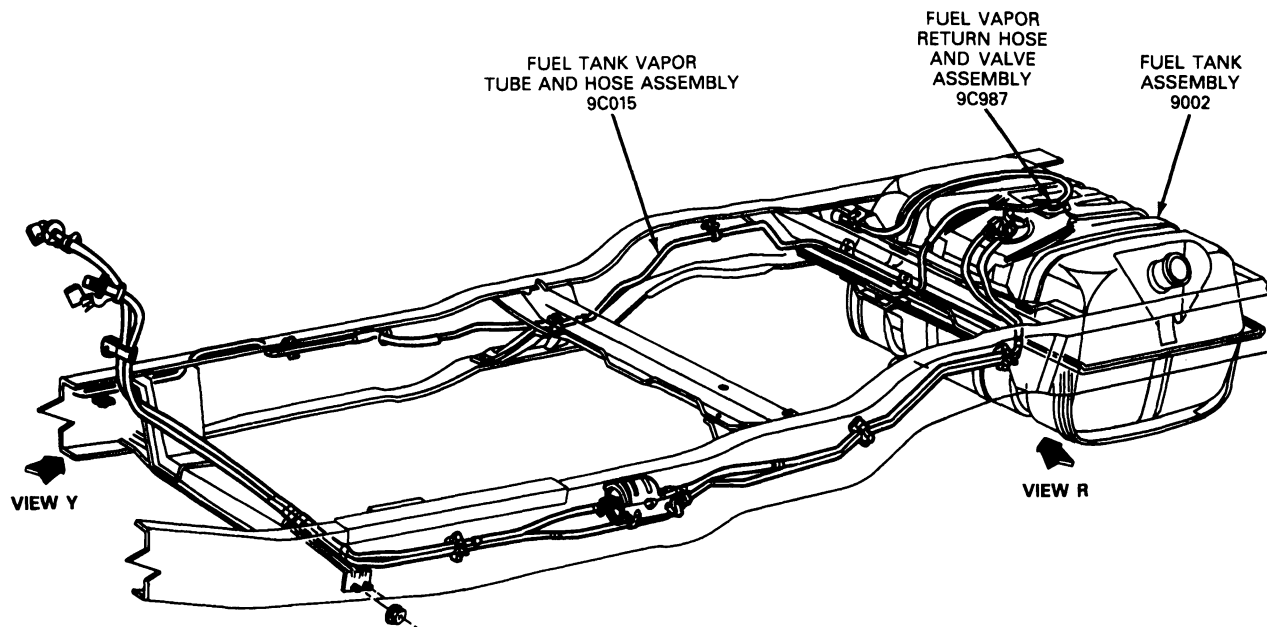
Vapor Lines, F-Series Chassis Cab



A17887-A

REMOVAL AND INSTALLATION (Continued)

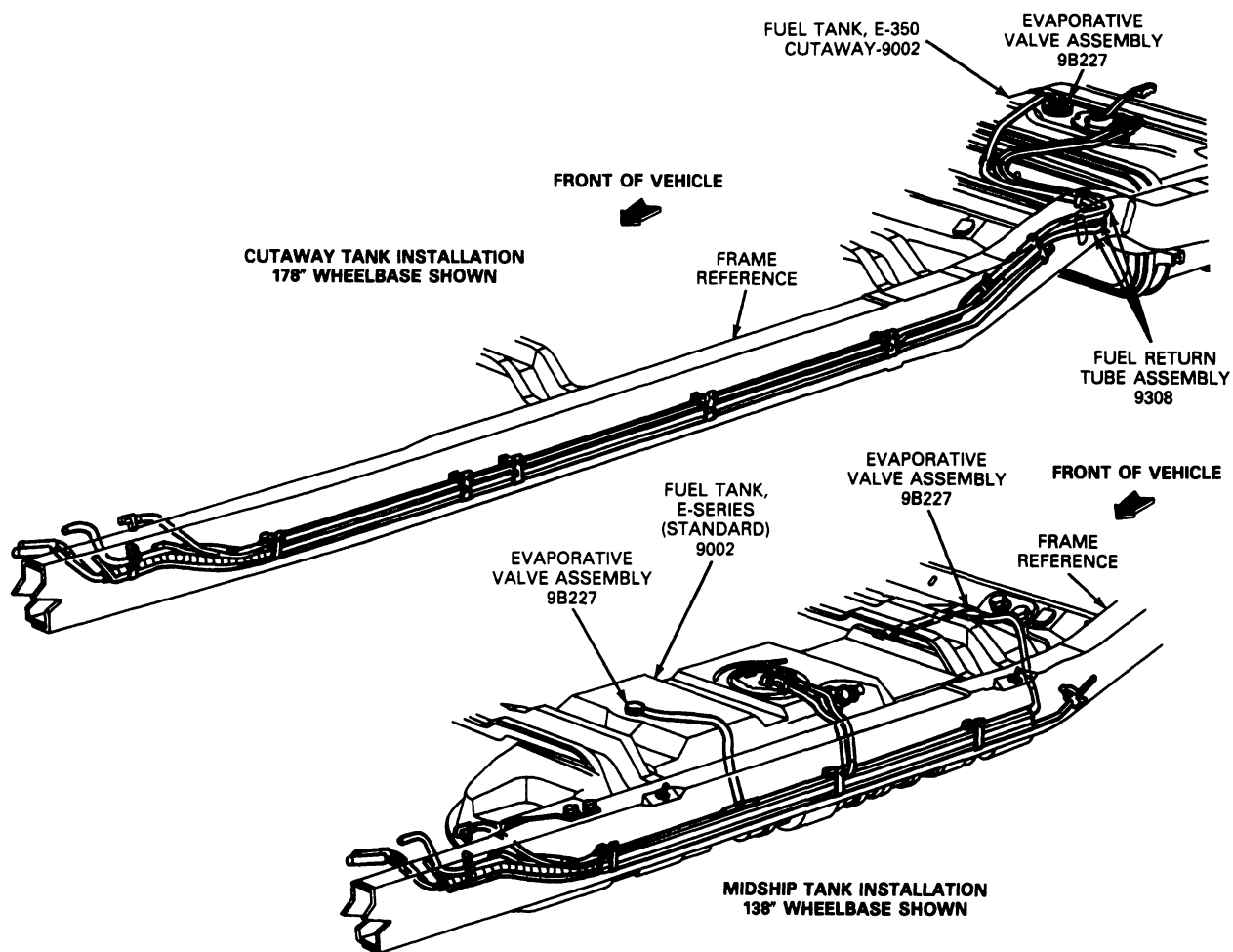
Vapor Lines, Bronco



A17888-A

REMOVAL AND INSTALLATION (Continued)

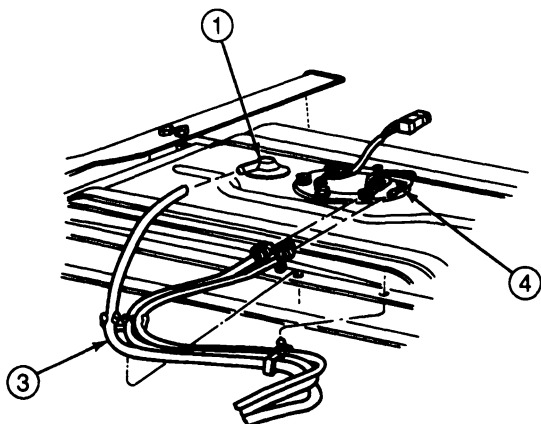
Vapor Lines, E-Series, All



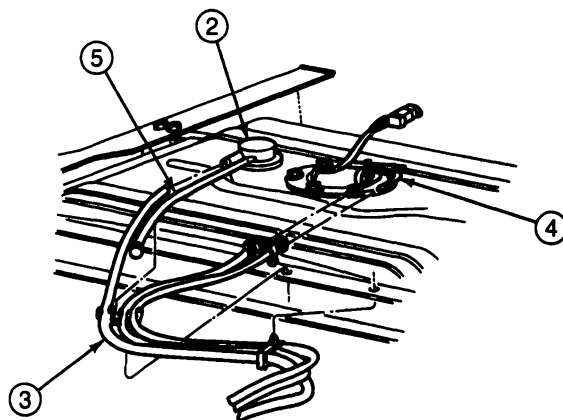
A17889-A

REMOVAL AND INSTALLATION (Continued)

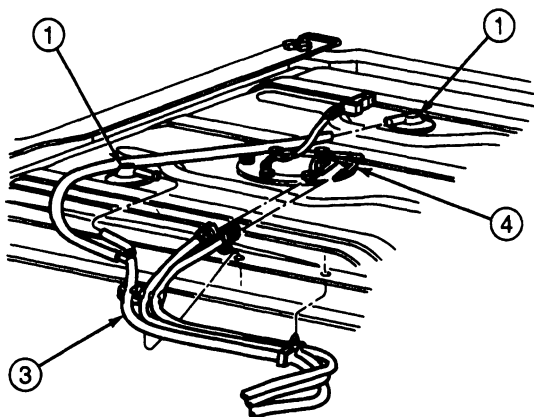
Fuel Tank Vapor Lines, E-Series, All



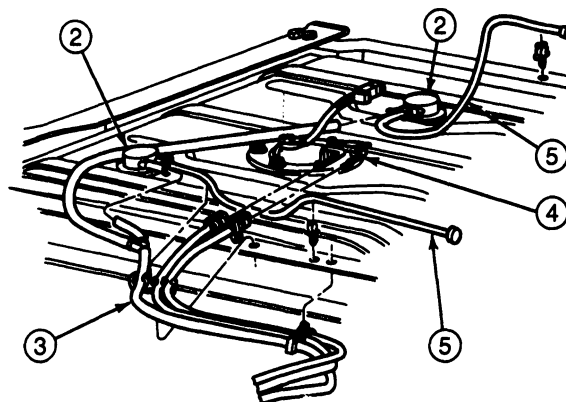
35 GALLON TANK
5.8L, 7.5L AND 7.3L



35 GALLON TANK
4.9L AND 5.0L



52 GALLON TANK
5.8L, 7.5L, 7.3L



52 GALLON TANK
4.9 AND 5.0L

A17890-A

Item	Part Number	Description
1	9B227	Evaporative Valve and Hose Assembly
2	9B593	Evaporative Valve and Hose Assembly

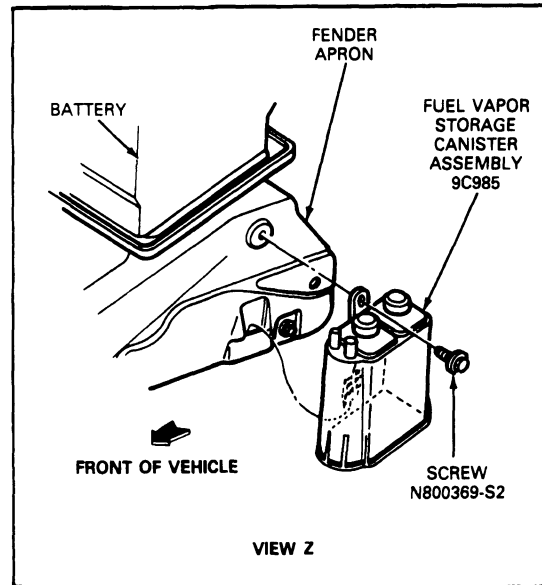
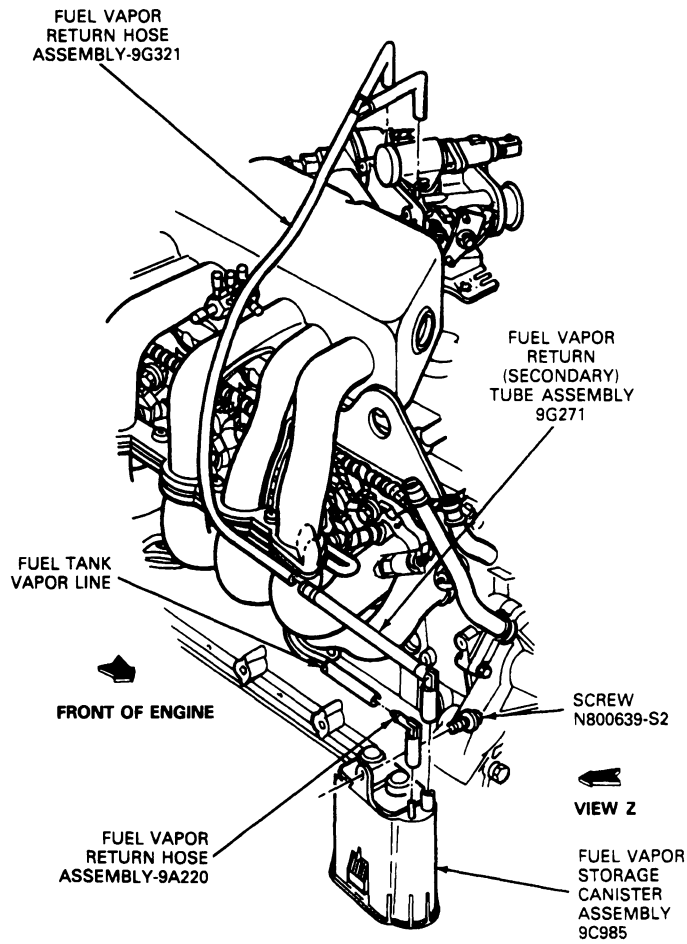
(Continued)

Item	Part Number	Description
3	9B296	Fuel Tank Tube Assembly
4	—	In-Tank Reservoir (Reference)
5	—	Vent Hose (Part of 9B593)

TA17890A

REMOVAL AND INSTALLATION (Continued)

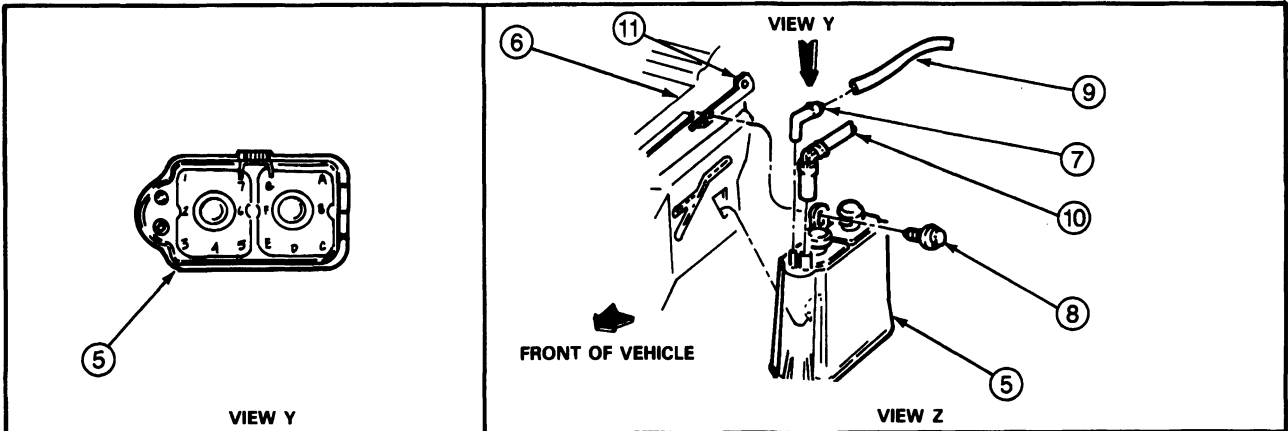
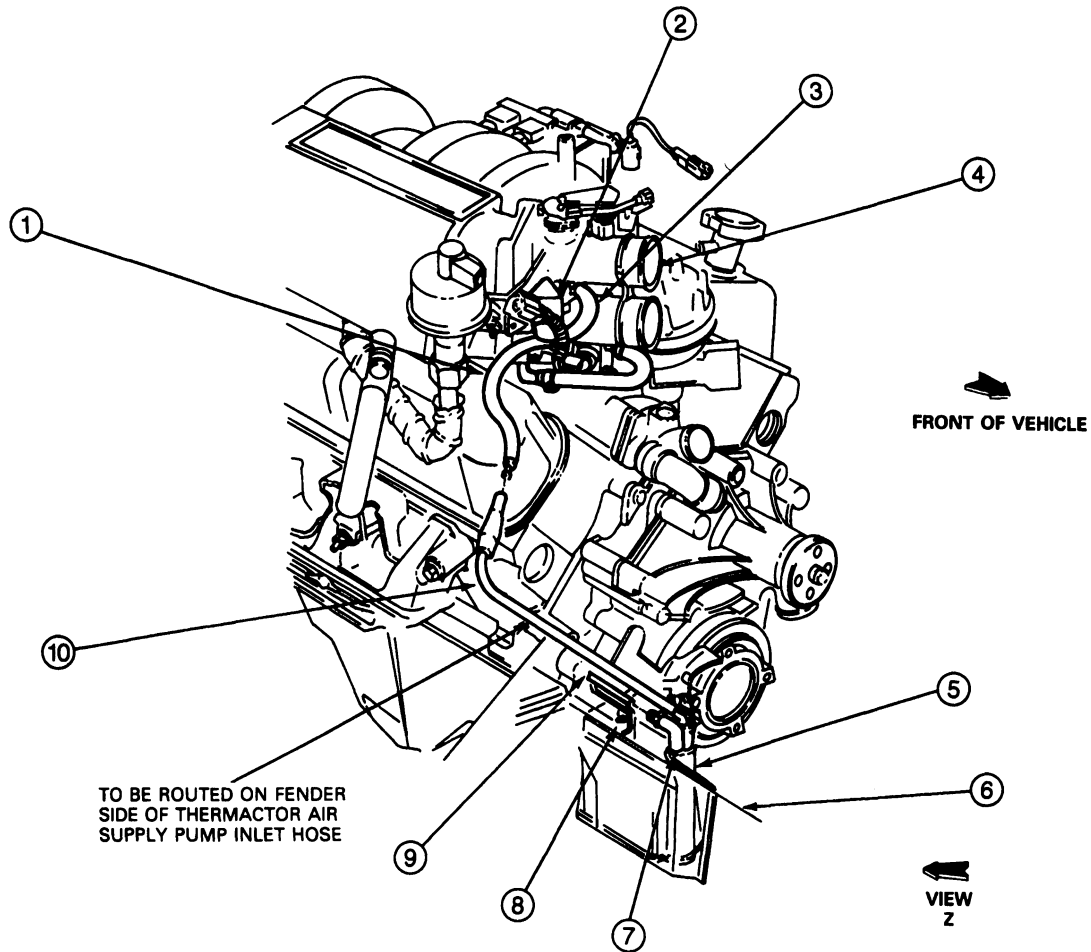
Engine Vapor Lines, F-Series and Bronco, 4.9L



V5589-2C

REMOVAL AND INSTALLATION (Continued)

Engine Vapor Lines, F-Series and Bronco, 5.0L



A16221-A

Item	Part Number	Description
1	9C987	Hose and Valve Assembly — Fuel Vapor Return
2	9C915	Fuel Vapor Purge Valve Assembly

(Continued)

Item	Part Number	Description
3	—	Hose (Purge Valve-to-Throttle Body, Part of 9C987)
4	9E926	Throttle Body Assembly

(Continued)

REMOVAL AND INSTALLATION (Continued)

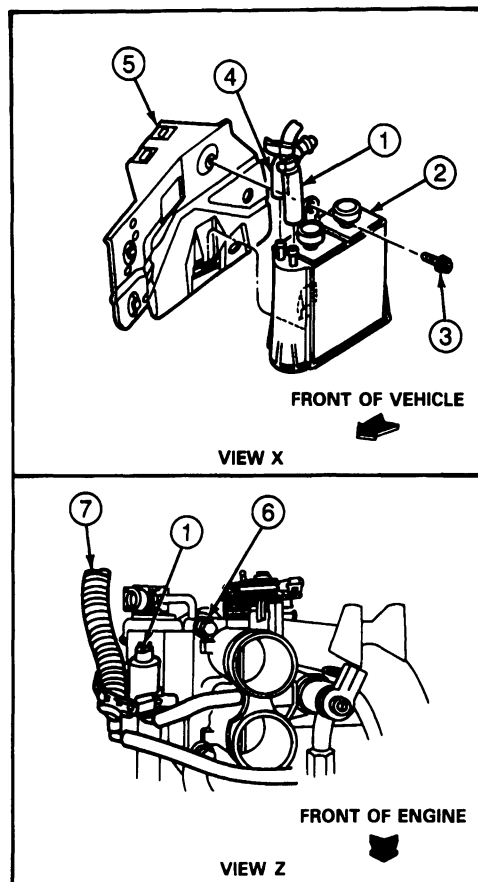
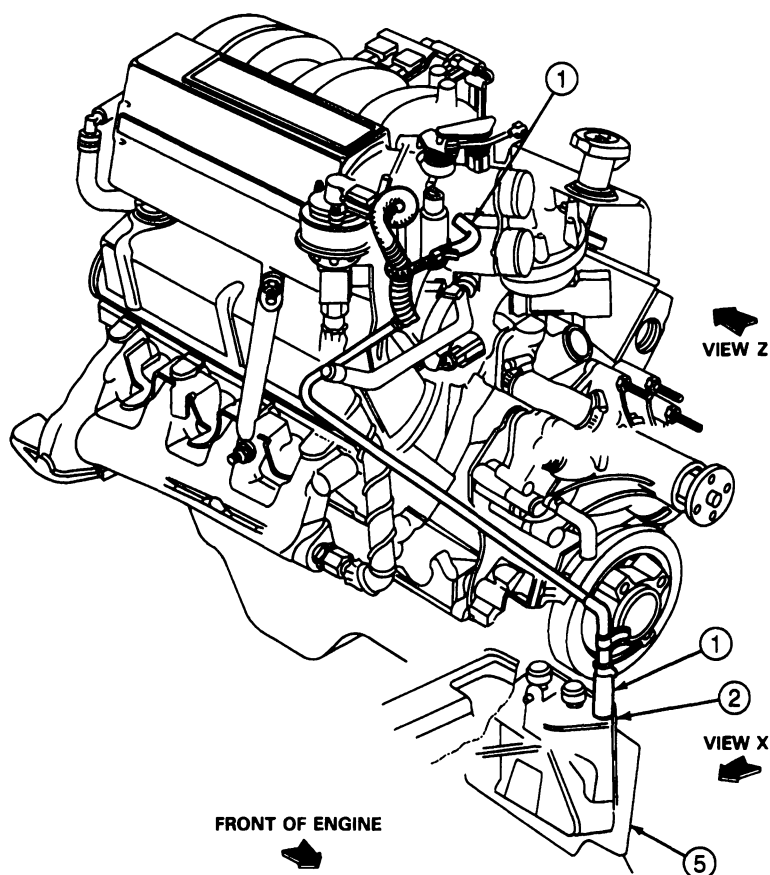
Item	Part Number	Description
5	9C985	Canister and Sleeve Assembly — Fuel Vapor Storage
6	—	Fender Apron
7	9A220	Connector Assembly — Fuel Vapor Return
8	N800369-S2	Screw M6.3-1.81 x 16

(Continued)

Item	Part Number	Description
9	9C016	Evaporative Tube (Refer to Fuel Line Installation Illustrations in This Section)
10	9G271	Tube Assembly — Fuel Vapor Return
11	9D665	Bracket

TA16221A

Engine Vapor Lines, F-Series and Bronco, 5.8L (Except 5.8L Lightning)



A17891-A

Item	Part Number	Description
1	9C987	Fuel Vapor Return Hose and Valve Assembly
2	9C985	Carbon Canister Assembly
3	N800369-S2	Screw M6.3 x 1.81 x 16.0 5-7 N·m (44-62 In-Lb)

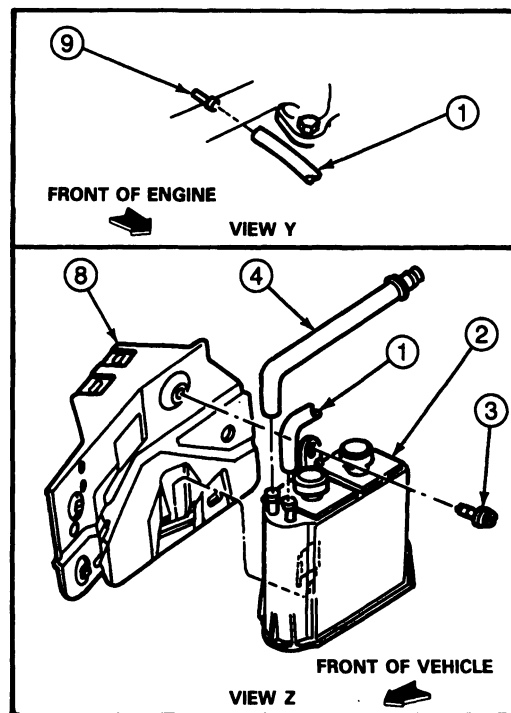
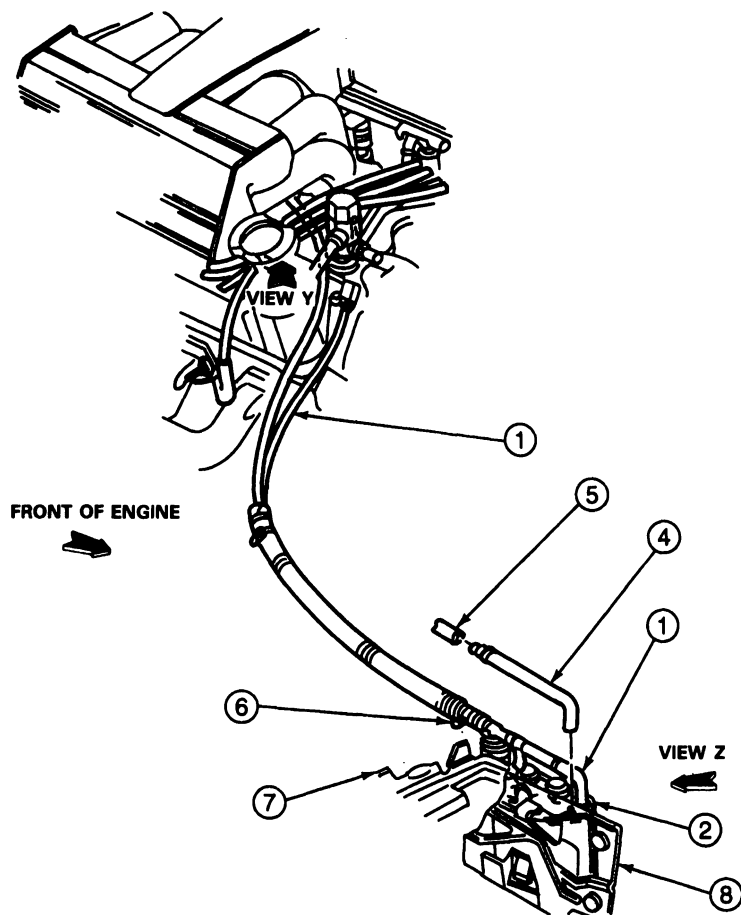
(Continued)

Item	Part Number	Description
4	9A220	Fuel Vapor Return Hose Assembly
5	—	Battery Tray Support (Reference)
6	—	Throttle Body Assembly
7	—	Wiring Assembly

TA17891A

REMOVAL AND INSTALLATION (Continued)

Engine Vapor Lines, 5.8L Lightning



A19021-A

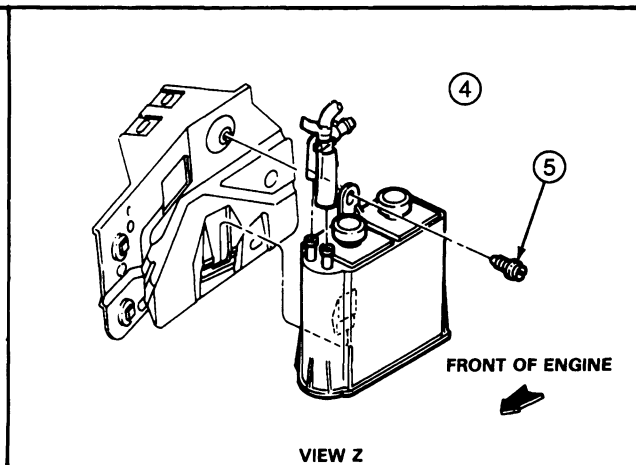
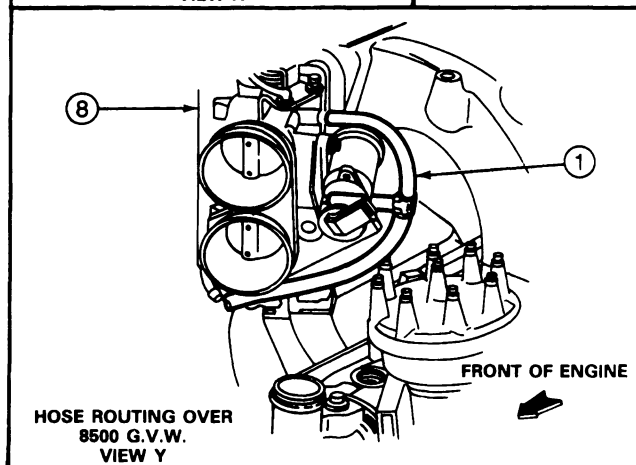
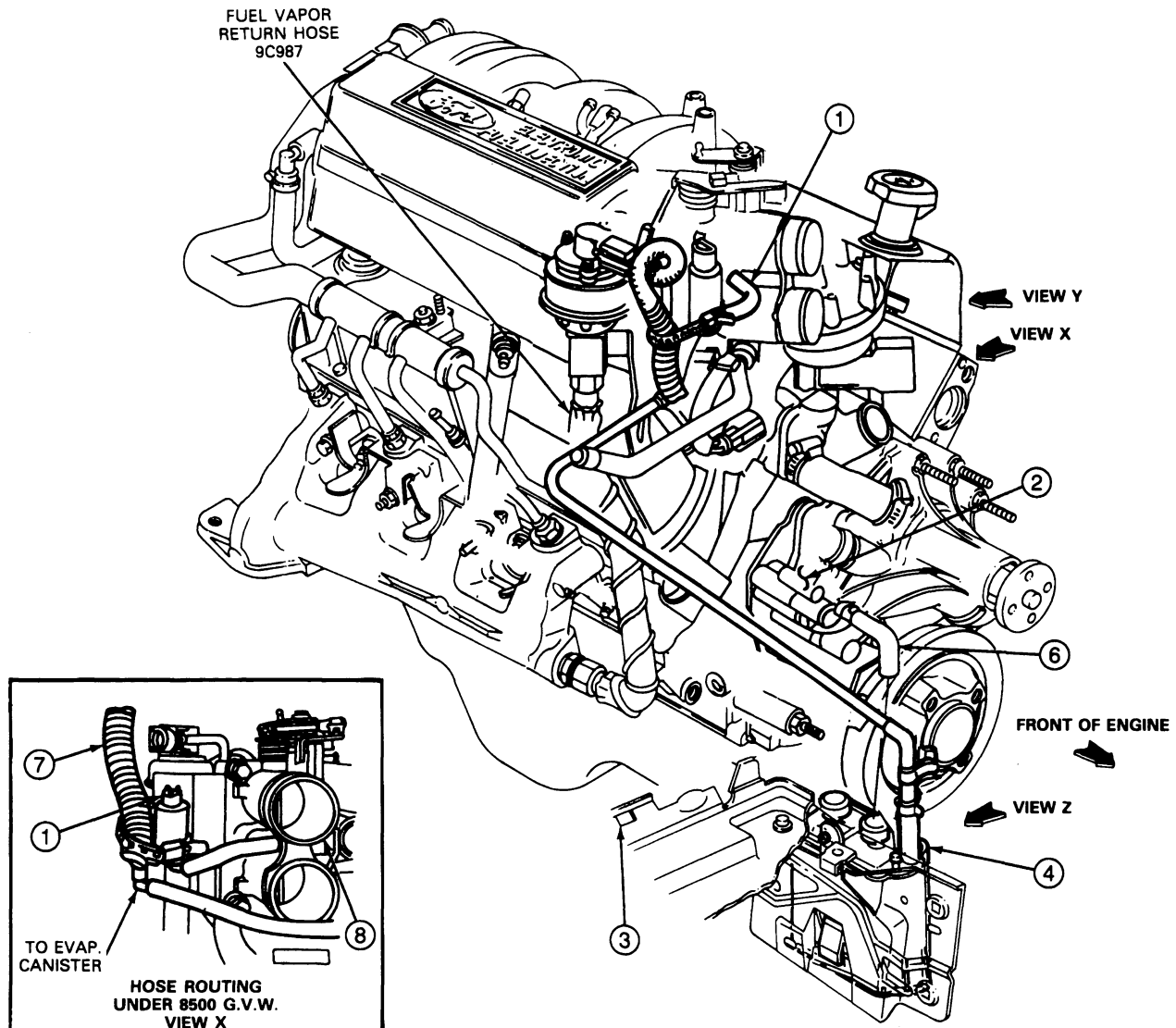
Item	Part Number	Description
1	9C987	Fuel Vapor Return Hose and Valve Assembly
2	9C985	Carbon Canister Assembly
3	N800369-S2	Screw, M6.3 x 1.81 x 16
4	9A220	Fuel Vapor Return Hose Line Assembly

(Continued)

Item	Part Number	Description
5	—	Fuel Tank Vapor Line Assembly
6	—	Pushpin (for Fender Apron Mounting)
7	—	Battery Tray
8	—	Battery Tray Support

REMOVAL AND INSTALLATION (Continued)

Engine Vapor Lines, F-250-350, 5.8L, Over 8500 GVW, Under 8500 GVW Similar



V5948-E

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9C987	Hose and Valve Assembly, Fuel Vapor Return
2	—	Fuel Tank Vapor Line
3	Ref.	Battery Tray
4	9C985	Canister Assembly, Fuel Vapor Storage

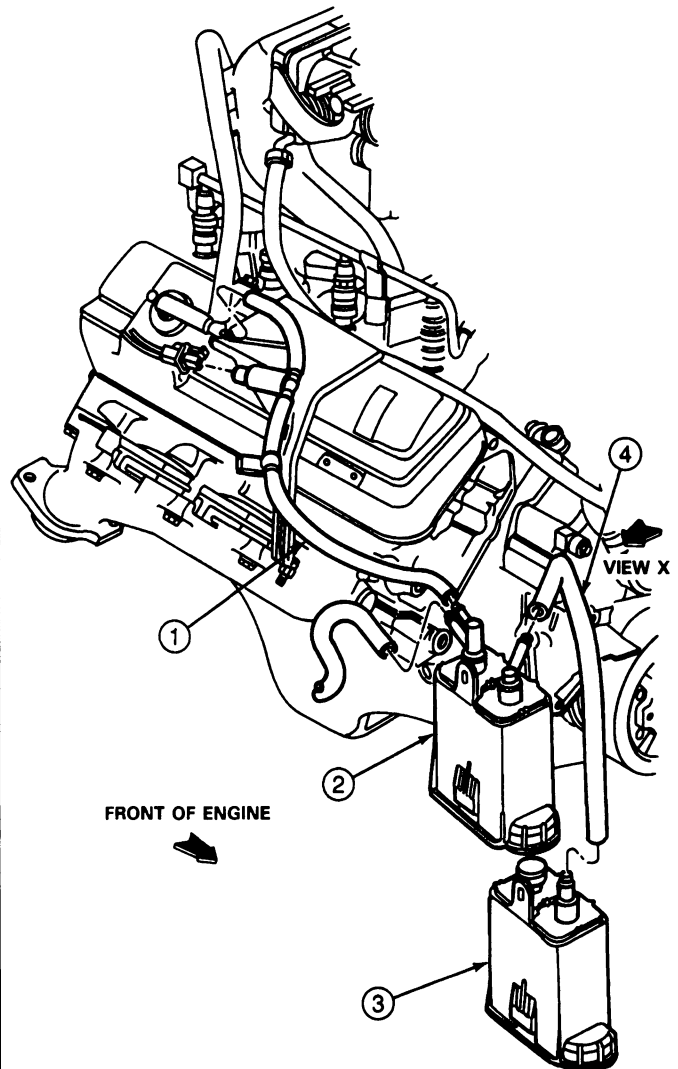
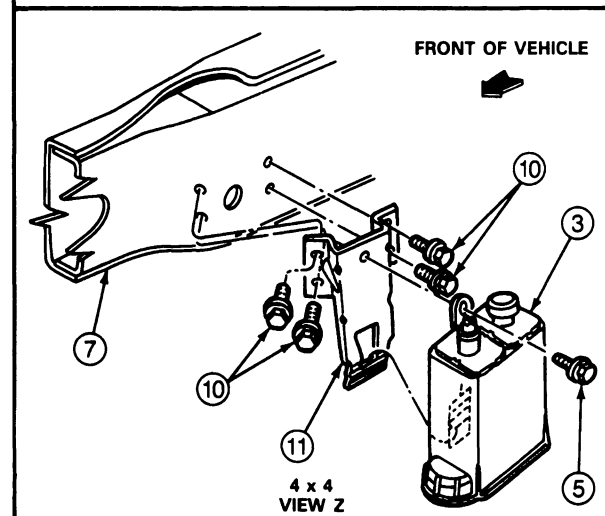
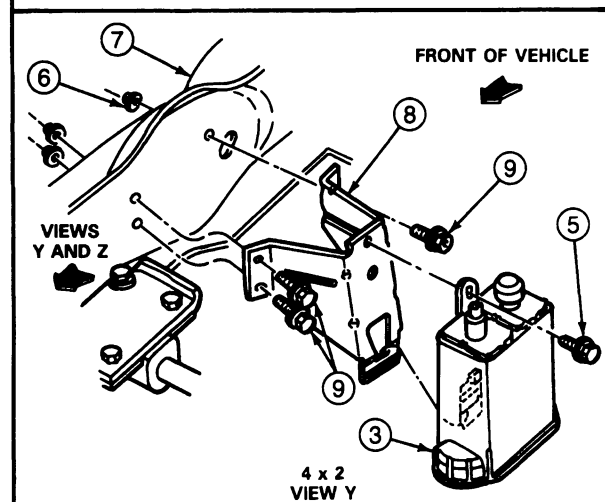
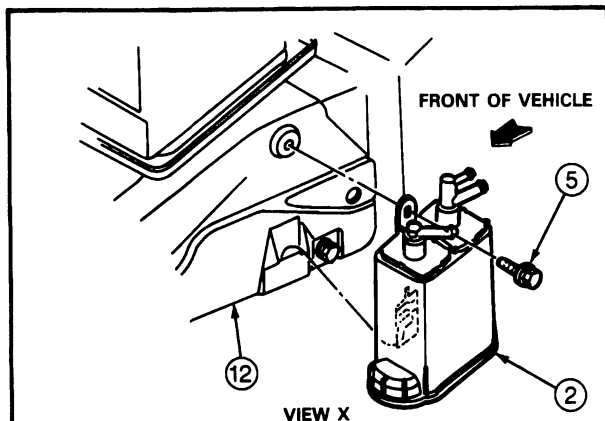
(Continued)

Item	Part Number	Description
5	N800369-S2	Screw
6	9A220	Connector Assembly, Fuel Vapor Return
7	Ref.	Wiring Harness Assembly
8	9E926	Throttle Body Assembly

TV5948A

REMOVAL AND INSTALLATION (Continued)

Engine Vapor Lines, F-250-350, 7.5L



A17892-A

Item	Part Number	Description
1	9C987	Fuel Vapor Return Hose And Valve Assembly
2	9C985	Carbon Canister Assembly
3	9C985	Carbon Canister Assembly

(Continued)

Item	Part Number	Description
4	9G297	Fuel Vapor Return Hose
5	N800369-S2	Screw M6.3 x 1.81 x 16.0 5-7 N·m (44-62 In·Lb)
6	N620481-S2	Nut M8 x 1.25

(Continued)

REMOVAL AND INSTALLATION (Continued)

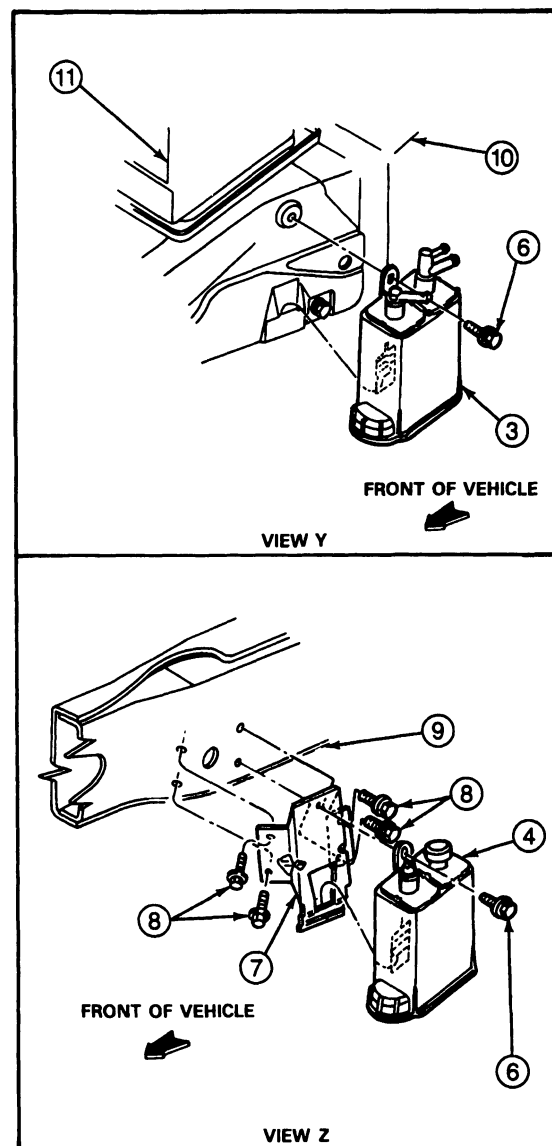
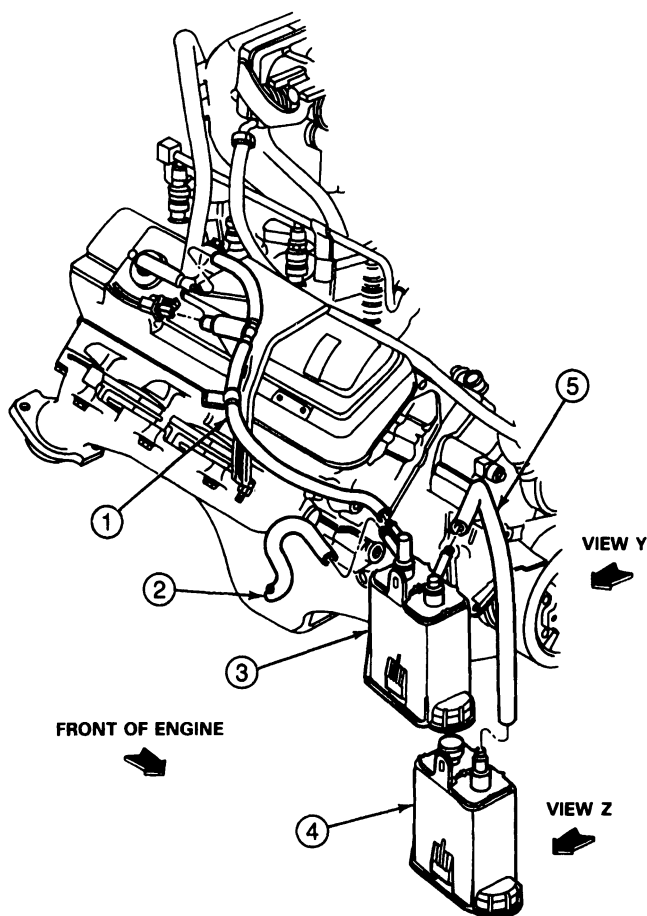
Item	Part Number	Description
7	5005	Frame (Reference)
8	9D665	Bracket (4 x 4 Vehicles)
9	N605786-S2	Bolt M8 x 1.25 x 20 20-30 N·m (15-22 Ft-Lb)

(Continued)

Item	Part Number	Description
10	W611635-S2	Screw M8 x 1.25 x 20 5-7 N·m (44-62 In-Lb)
11	9D665	Bracket (4 x 2 Vehicles)
12	—	Reinforcement Assembly Right Fender Apron

TA17892A

Engine Vapor Lines, F-Super Duty, 7.5L



A17893-A

Item	Part Number	Description
1	9C987	Fuel Vapor Return Hose And Valve Assembly
2	9G247	Fuel Tank Vapor Line
3	9C985	Carbon Canister

(Continued)

Item	Part Number	Description
4	9C985	Carbon Canister
5	9G297	Fuel Vapor Return Hose
6	N800369-S2	Screw M6.3 x 16.0 5-7 N·m (44-62 In-Lb)

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
7	9D665	Bracket
8	W611635-S2	Screw M8 x 1.25 x 20 5-7 N·m (44-62 In-Lb)
9	5005	Frame (Reference)

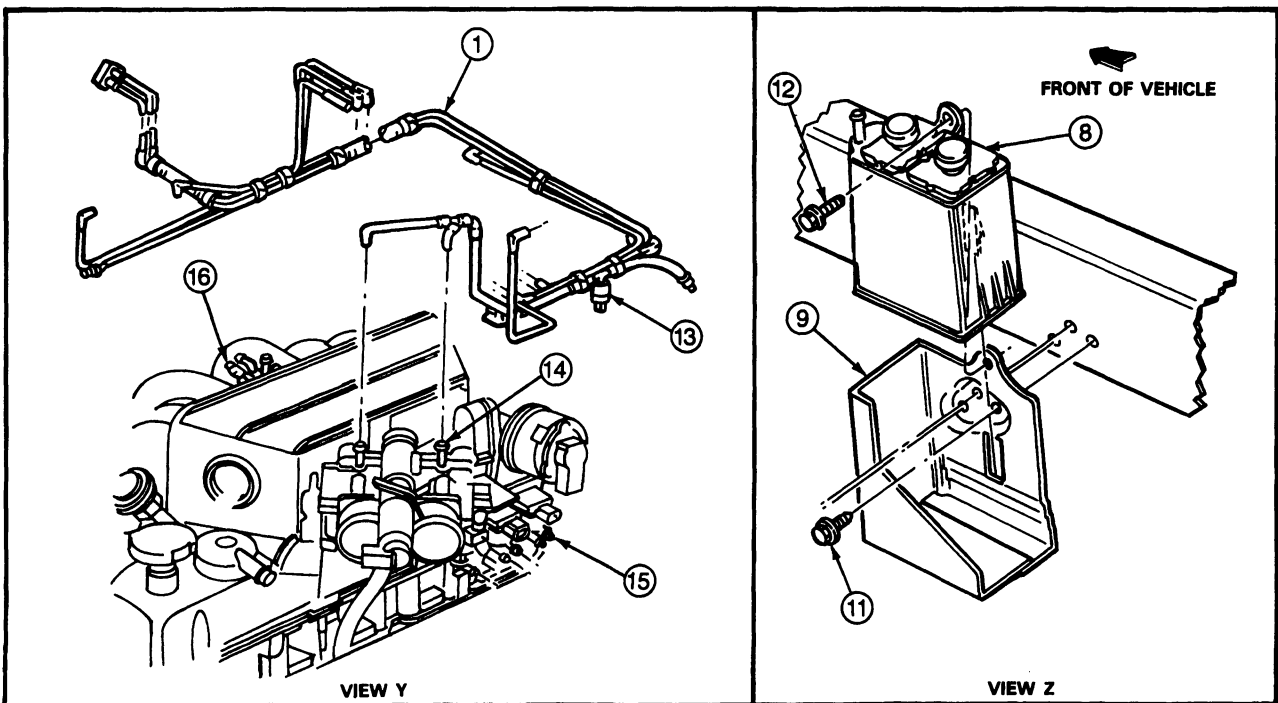
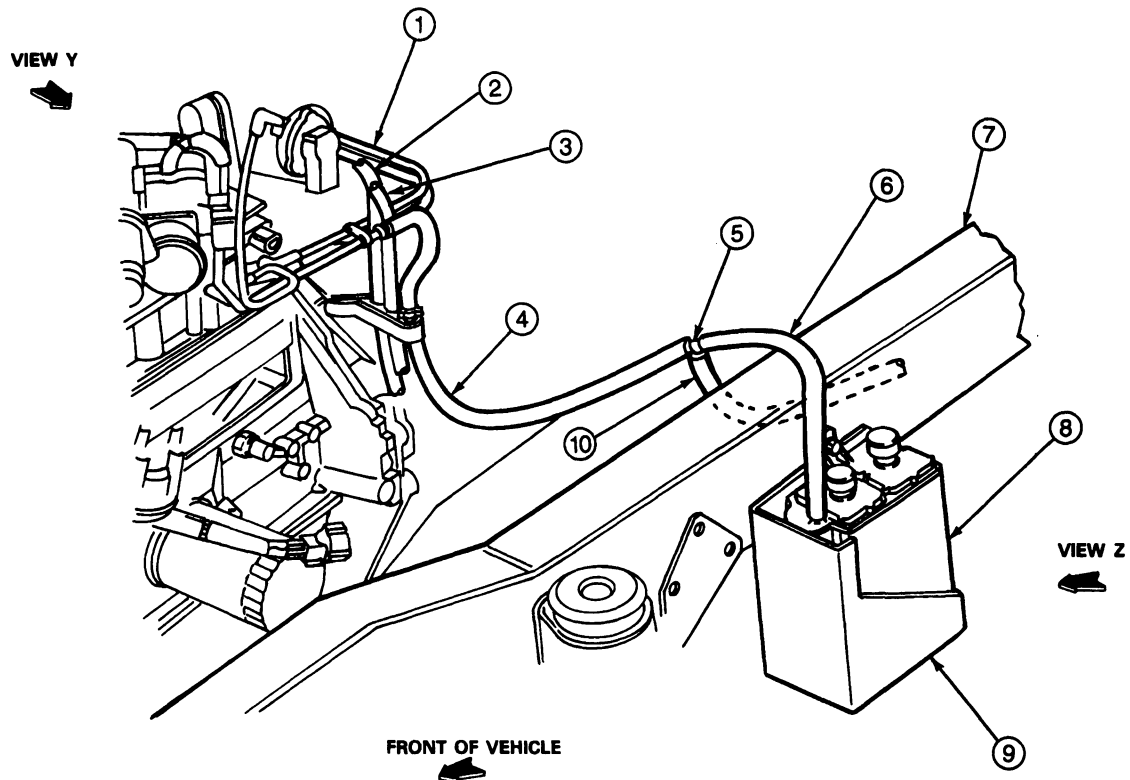
(Continued)

Item	Part Number	Description
10	—	Right Fender Apron (Reference)
11	—	Battery (Reference)

TA17893A

REMOVAL AND INSTALLATION (Continued)

Engine Vapor Lines, E-Series, 4.9L



A18219-A

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9E498	Emission Vacuum Control Connector Assembly
2	9J332	Tube Assembly, Fuel Line Extension Return
3	9K328	Tube Assembly, Fuel Line Extension
4	9G271	Fuel Vapor Hose (Cut From Bulk Fuel Line Hose 9324)
5	383041-S	Tee
6		Hose (Cut From Bulk Fuel System Hose 9324)
7		Frame
8	9D653	Fuel Vapor Charcoal Canister
9	9D665	Fuel Vapor Storage Canister Bracket

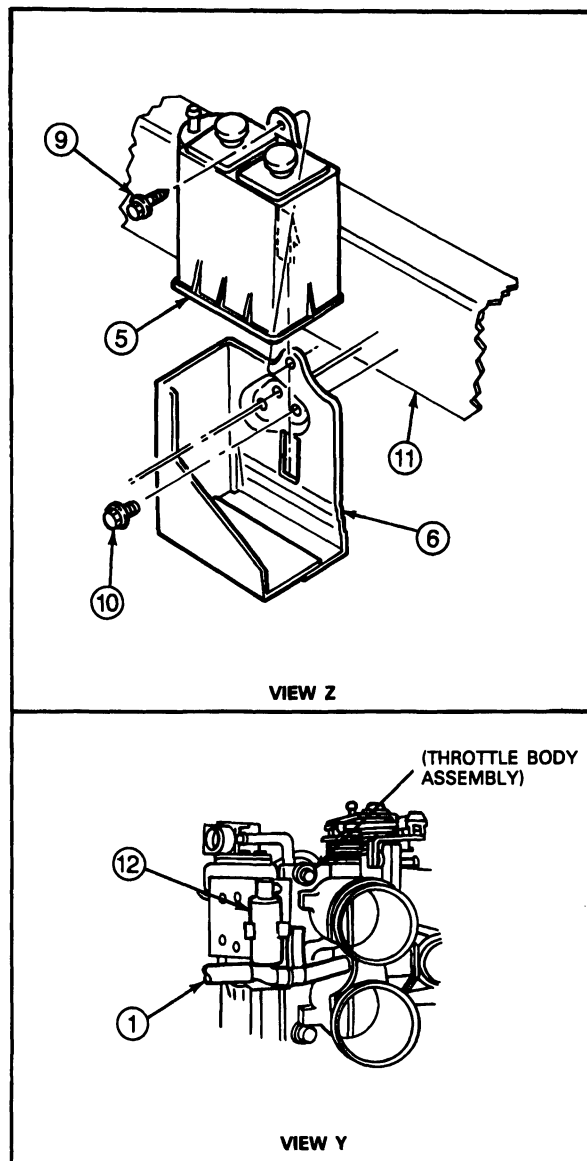
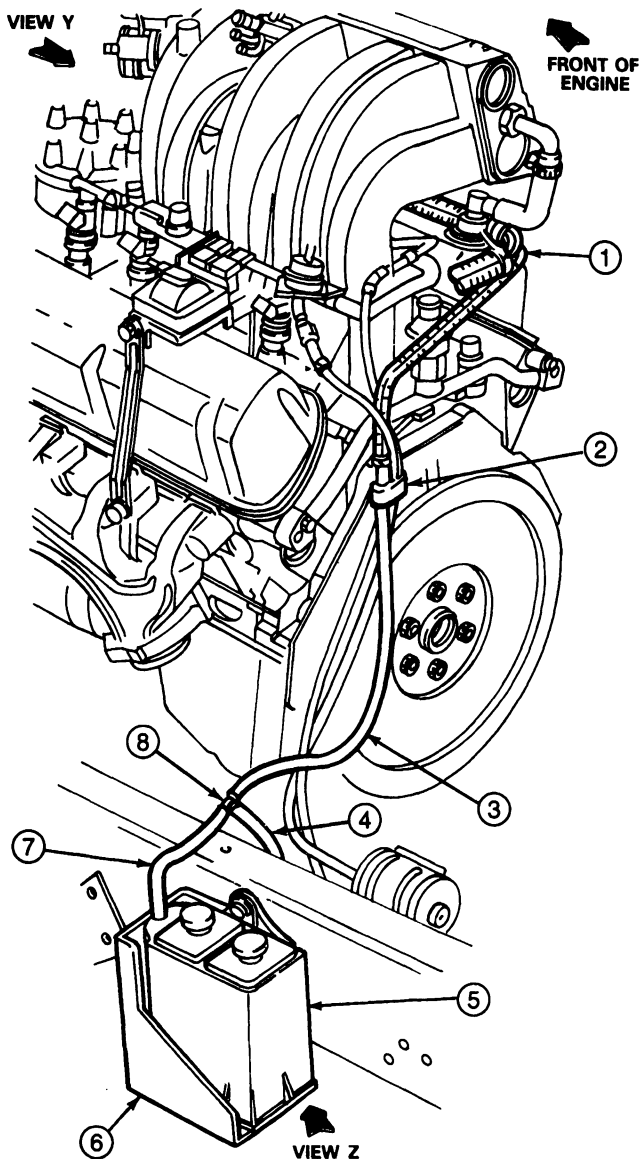
(Continued)

Item	Part Number	Description
10	9K328	Fuel Tank Vapor Hose (Part of 9S296 Organizer Assembly, Refer to Fuel Line Installation Illustration This Section)
11		Screw
12		Screw
13	9C915	Fuel Vapor Purge Valve Assembly (Used On: E-150 — E-350 49 State, Canada, High Altitude with C-6 Transmission HD-350 with C6 Transmission. 49 State and Canada)
14	9E926	Throttle Body Assembly
15	9J459	EVR Solenoid Assembly
16	9A474	Vacuum Fitting

TA16219A

REMOVAL AND INSTALLATION (Continued)

Engine Vapor Lines, E-Series, 5.0L



A16223-A

Item	Part Number	Description
1	9E498	Connector Assembly — Emission Vacuum Control
2	9D676	Tube Assembly — Fuel Delivery and Return
3	9G271	Fuel Vapor Hose (Cut from Bulk Fuel Line Hose 9324)
4	9K328	Fuel Vapor Hose (Part of 9S296 Organizer Assembly. Refer to Fuel Line Installation Illustration this Section)

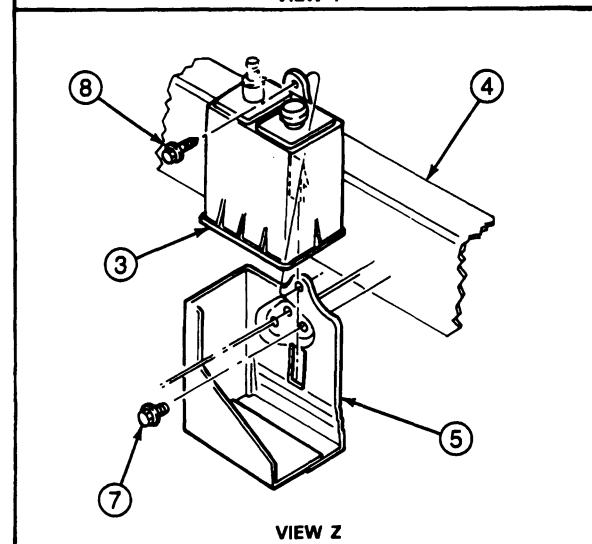
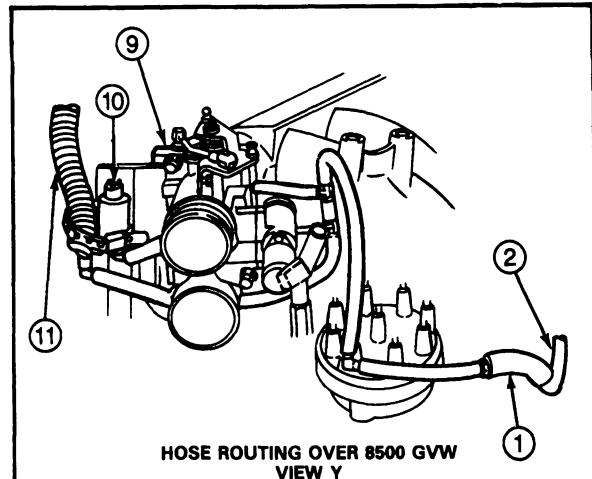
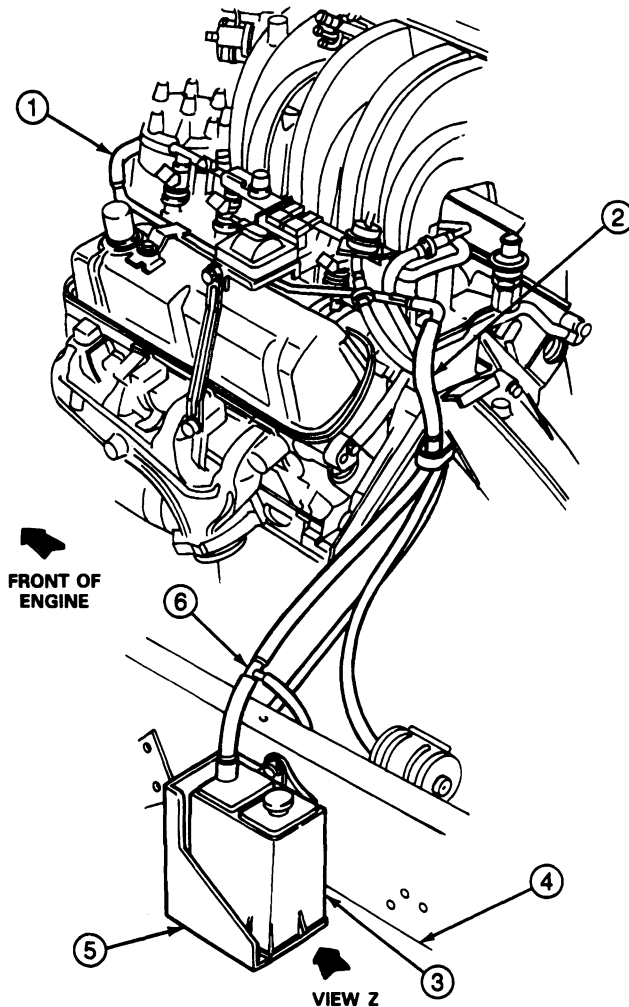
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Item	Part Number	Description
5	9D653	Canister and Sleeve Assembly — Fuel Vapor Storage
6	9D665	Fuel Vapor Storage Canister Bracket
7	—	Hose (Cut From Bulk Fuel System Hose 9324)
8	383041-S	Tee
9	40920-S2	Screw # 12-24 x .50
10	381877-S2	Screw 5/ 16-18 x .75
11	—	Frame
12	9C915	Fuel Vapor Purge Valve Assembly

TA16223A

REMOVAL AND INSTALLATION (Continued)

Engine Vapor Lines, E-Series, 5.8L



A16225-B

Item	Part Number	Description
1	9C987	Hose and Valve Assembly — Fuel Vapor Return
2	9G271	Tube Assembly — Fuel Vapor Return
3	9C985	Canister and Sleeve Assembly — Fuel Vapor Storage
4	Ref.	Frame

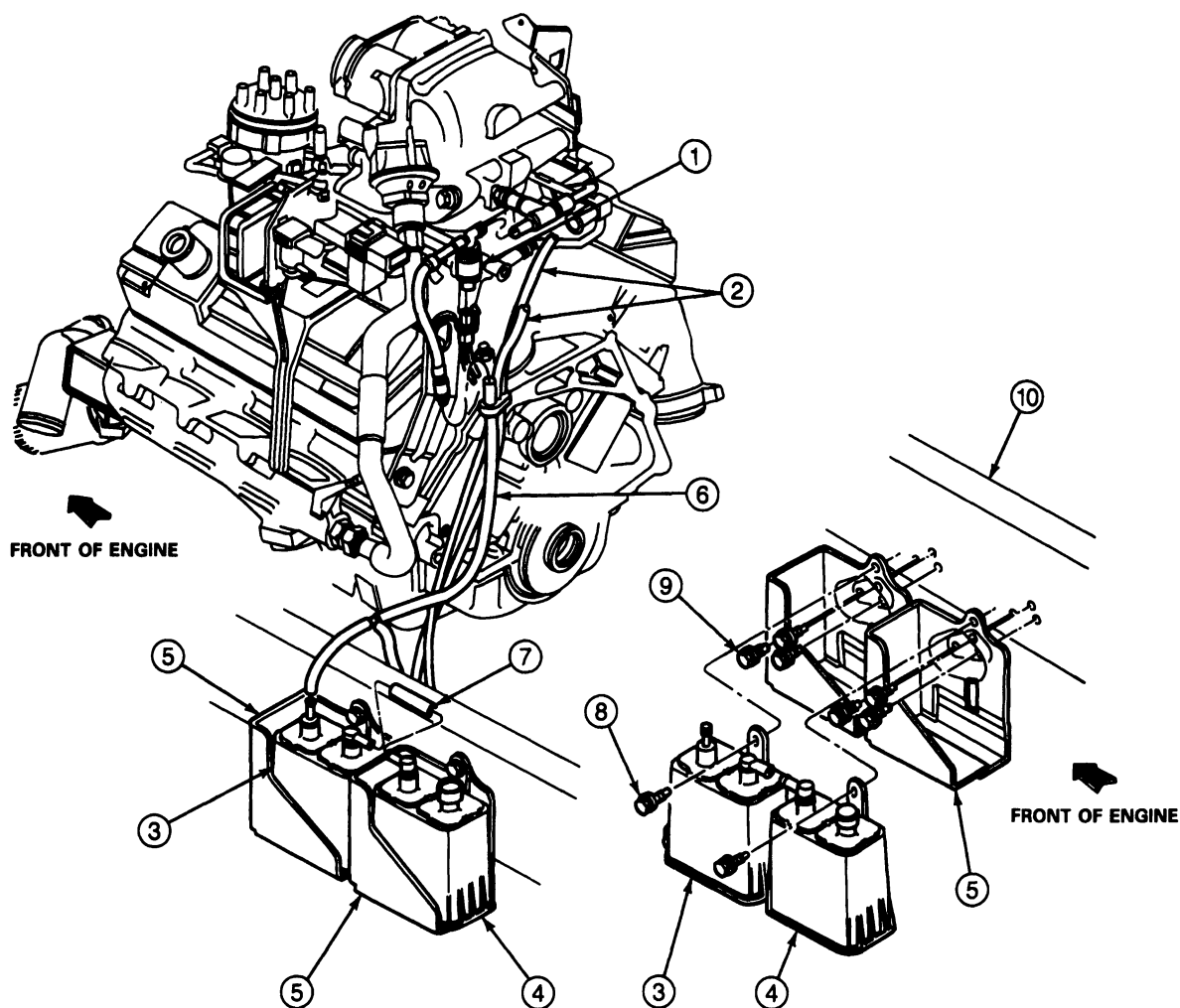
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Item	Part Number	Description
5	9D665	Fuel Vapor Storage Canister Bracket
6	383041-S	Tee
7	381877-S2	Screw
8	40920-S2	Screw
9	9E926	Throttle Body Assembly
10	9C915	Fuel Vapor Purge Valve Assembly (Part of 9C987)
11	Ref.	Wiring Harness Assembly

TA16225A

REMOVAL AND INSTALLATION (Continued)

Engine Vapor Lines, E-Series, 7.5L



A17894-A

Item	Part Number	Description
1	9C987	Fuel Vapor Return Hose and Valve Assembly
2	—	Fuel Lines (Reference)
3	9C985	Carbon Canister Assembly
4	9C985	Carbon Canister Assembly
5	9D665	Bracket

(Continued)

Item	Part Number	Description
6	9G271	Fuel Vapor Return Tube Assembly
7	381402-8040A	Hose 3/8 inch I.D.
8	N800369-S2	Screw (2 Required) 5-7 N·m (44-62 In·Lb)
9	381877-S2	Screw (6 Required) 5-7 N·m (44-62 In·Lb)
10	5005	Frame (Reference)

TA17894A

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	In-Lb
Screw, Carbon Canister-to-Fender Apron or Bracket, All	5-7	44-62
Bolt, Bracket-to-Frame, F-250-350, 4x2	20-30	15-22 Ft-Lb
Bolt, Bracket-to-Frame F-250-350, 4x4	5-7	44-62
Screw, Bracket-to-Frame, E-Series, 7.5L	5-7	44-62

SPECIAL SERVICE TOOLS/EQUIPMENT**ROTUNDA EQUIPMENT**

Tool Number	Description
034-00002	Gasoline Storage Tanker
034-00012	Adapter Hose

GROUP

DRIVELINE

05

(00)

SECTION TITLE	PAGE	SECTION TITLE	PAGE
AXLE, FORD 10.25-INCH RING GEAR	05-02A-1	DIFFERENTIAL, TRACTION-LOK FORD, 8.8-INCH	
AXLE, FRONT DRIVE, DANA MODEL 60		RING GEAR	05-02H-1
MONOBEAM	05-02J-1	DRIVELINE GENERAL	05-00-1
AXLE 8.8 INCH RING GEAR	05-02G-1	DRIVESHAFT	05-01-1
AXLE, REAR DANA	05-02D-1	WHEEL HUBS AND BEARINGS REAR, DANA FULL	
AXLES, FRONT DRIVE, DANA MODELS 44 AND		FLOATING AXLE	05-02E-1
50	05-02K-1	WHEEL HUBS AND BEARINGS, FORD FULL	
DIFFERENTIAL, DANA LIMITED-SLIP	05-02F-1	FLOATING AXLE	05-02B-1
DIFFERENTIAL, LIMITED-SLIP, FORD 10.25-INCH		WHEEL HUBS AND BEARINGS, FRONT WHEELS,	
RING GEAR	05-02C-1	4-WHEEL DRIVE	05-02L-1

SECTION 05-00 Driveline, General

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		DIAGNOSIS AND TESTING (Cont'd.)	
Alternate In-Vehicle Driveshaft Balancing		Dana Design Axles	05-00-19
Procedure	05-00-25	Diagnosis Guides, Driveshaft	05-00-18
Axle Adjustments	05-00-27	Diagnosis Guides, Driving Axle	05-00-21
Axle Lubrication	05-00-28	Driveline Angle Correction	05-00-12
Driveshaft Balancing	05-00-24	Driveline Angularity	05-00-7
Pinion and Ring Gear Adjustments	05-00-27	Driveline Vibration	05-00-4
Rear Wheel Bearing and Seal Removal and		Ford Design Axles	05-00-19
Installation	05-00-29	Half Round Companion Flange Runout Check,	
Ring Gear Replacement Dana Axles	05-00-28	Rear Axle	05-00-14
Shim Selection	05-00-28	Limited-Slip Differential Operation	
CLEANING AND INSPECTION		Check	05-00-20
Inspection After Carrier Disassembly	05-00-30	Noise Acceptability	05-00-20
Inspection Before Carrier Disassembly	05-00-29	Rear Axle Alignment Inspection	
DESCRIPTION AND OPERATION		Procedure	05-00-15
Anti-lock Braking System	05-00-4	Rear Axle Companion Flange Runout	
Driving Axle	05-00-3	Check	05-00-13
Driving Axle (Rear on 2WD and Front and Rear		Road Test	05-00-4
on 4WD)	05-00-4	Slip-Yoke Spline	05-00-13
Front Driveshaft	05-00-3	Total Axle Backlash Check	05-00-20
Rear Driveshaft	05-00-2	Two-Piece Driveshaft Service	05-00-12
DIAGNOSIS AND TESTING		U-Joint Phasing	05-00-7
Axle Testing	05-00-19	SPECIAL SERVICE TOOLS/EQUIPMENT	05-00-38
Coupling Shaft/Center Bearing		SPECIFICATIONS	05-00-30
Alignment	05-00-12	VEHICLE APPLICATION	05-00-1

VEHICLE APPLICATION

All E-150-250-350, F-150-250-350 4x2 and 4x4,
F-Super Duty and Bronco Vehicles

DESCRIPTION AND OPERATION

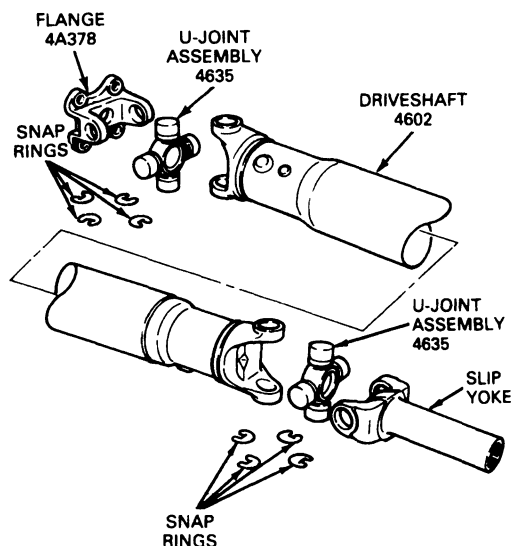
Rear Driveshaft

The driveshaft or coupling shaft is composed of the universal joints (U-joints), connecting shafts, attaching flanges, and slip-yokes. The number of shafts and U-joints used depends on the vehicle application.

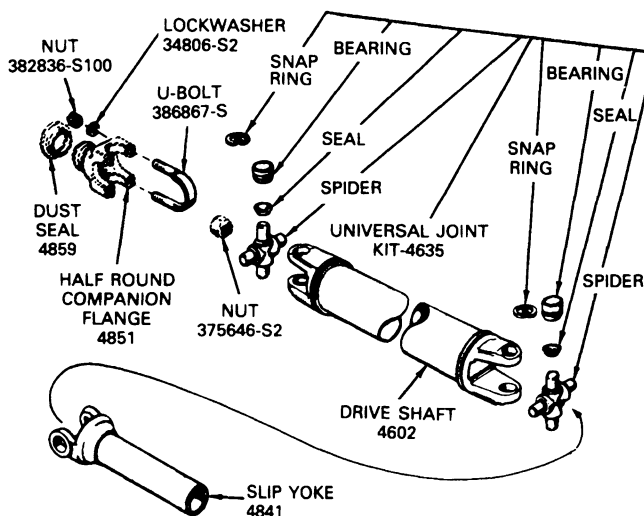
Some vehicles use a one-piece steel or aluminum slip-yoke type driveshaft. A universal joint and splined slip-yoke are located at the transmission end of the shaft, where they are held in alignment by a bushing in the transmission rear extension housing. The splined slip-yoke and transmission output shaft allow fore and aft movement of the driveshaft as the rear axle moves up and down. This provides smooth performance during vehicle operation. An oil seal at the transmission prevents leakage and protects the slip-yoke from dust, dirt and other harmful material. A rear universal joint attached by either two U-bolts or two straps and four bolts is used where the driveshaft mates with the companion flange at the rear axle or a driveshaft rear flange on vehicles equipped with circular axle flange.

Driveshaft Assemblies

E-150/F-150

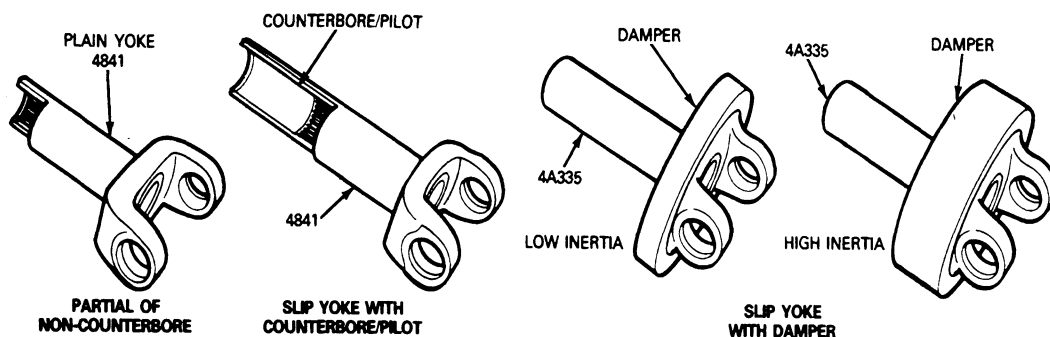


E-250-350/F-250-350



E8275-C

Slip-Yoke Designs



E7758-2A

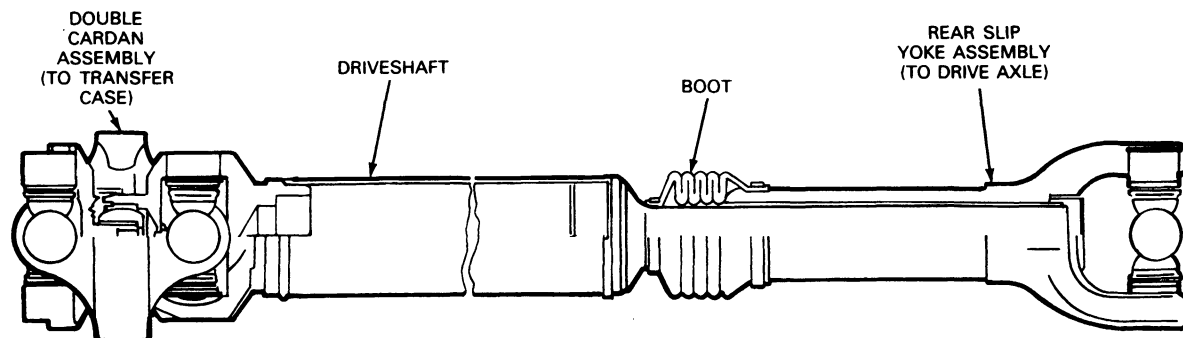
DESCRIPTION AND OPERATION (Continued)

Others use a coupling shaft in conjunction with a driveshaft. Care must be taken to align the shafts as shown in the figures. The two-piece driveline system incorporates a "necked down" coupling shaft stub with a "blindspline" feature which assures positive phasing action (except F-Super Duty Chassis).

All two-piece driveline vehicles are equipped with center support bearings that are prelubricated and sealed for the bearing life.

All U-joints are of the lubed-for-life needle-bearing type. Replacement U-joints equipped with grease fittings should be lubricated at the intervals specified in Section 00-03. The U-joint bearings are retained on the U-joint spiders by snap rings and U-bolts on some applications.

Rear Driveshaft, Bronco



E7158-2A

All driveshafts and coupling shafts are balanced; therefore, if the vehicle is being undercoated, the shafts and all open spline areas must be covered to prevent undercoating material from getting on the shafts.

Two types of driveshaft connecting joints are available on different vehicles:

- single Cardan U-joint
- double Cardan U-joint

The Bronco rear driveshaft assembly is of the double Cardan type which incorporates two U-joints, a centering socket yoke, and a center yoke at the transfer case end of each shaft. A single U-joint is used at the axle end of the shafts.

Front Driveshaft

The front driveshaft connects the power flow from the transfer case to the front drive axle. It incorporates two single Cardan U-joint assemblies, a driveshaft with a splined stub shaft end, a boot with two clamps (one large and one small), and a slip-yoke which attaches to the transfer case. F-350 4x4 vehicles incorporate a double Cardan U-joint in the front driveshaft.

NOTE: Whenever the vehicle is raised on a hoist, inspect the rubber boot for rips or tears. Replace if required.

CAUTION: Under no circumstances are driveshafts to be clamped in the jaws of a vise or similar holding fixture. Denting or localized fracture of the tube may result which could cause driveshaft failure during vehicle operation.

Driving Axle

Five rear axles are available on E- and F-Series and Bronco vehicles: a Ford 8.8-inch and 10.25-inch ring gear rear axle and three Dana Integral Carrier rear axle models. The F-Super Duty has the 11.25-inch model 80, while the single rear wheel E-250-350 have the 9.75-inch model 60-IU. The dual rear wheel E-350 has the 10.5-inch 70-2U and 70-1HD. The Ford 10.25-inch ring gear rear axle is installed on F-250 and F-350, and the Ford 8.8-inch ring gear rear axle is used on the E-150, F-150 and Bronco. Bronco, F-150 and F-250 4x4 are equipped with the Dana Model 44 or 50 front axle. The Dana Model 60 Monobeam front axle is installed on the F-350 4x4.

DESCRIPTION AND OPERATION (Continued)

Driving Axle (Rear on 2WD and Front and Rear on 4WD)

The axle drive pinion receives its power from the engine through the transmission on 2WD and through the transfer case on 4WD vehicles. The pinion gear rotates the differential case through engagement with the ring gear, which is bolted to the case outer flange. Inside the case, two differential pinion gears are mounted on the differential pinion shaft which is pinned with a lock bolt to the case. These pinion gears are engaged with the side gears to which the axle shafts are splined. Therefore, as the differential case turns, it rotates the axle shafts and wheels. When it is necessary for one wheel and axle shaft to rotate faster than the other, the faster turning side gear causes the pinions to roll on the slower turning side gear to allow differential action between the two axle shafts.

Anti-lock Braking System

F-Series (except F-Super Duty) and Econoline vehicles use the Rear Anti-lock Braking System (RABS). Bronco vehicles are equipped with Four Wheel ABS, which incorporates the same rear axle-mounted speed sensor as the RABS system. For a detailed description of the ABS system, refer to Section 06-09B. Axles in vehicles equipped with the RABS contain a sensor and speed sensor ring mounted in the carrier. F-Super Duty Vehicles incorporate the sensor and speed sensor ring as a signal generator, not for a RABS system. The signal is used for the speedometer system along with other vehicle systems that require a road speed signal. F-Super Duty Chassis Vehicles do not incorporate the sensor and speed sensor ring. For a detailed description of the RABS, refer to the Body / Chassis Manual, Section 06-09. The system features a multi-tooth speed sensor ring that is pressed on the differential case behind the ring gear. If the speed sensor ring is removed, it must be discarded and replaced with a new one. The speed sensor ring works in conjunction with an electronic speed sensor. This sensor is retained in a bore at the top of the carrier housing and fastened by one bolt. There is a space provided between the ring gear and speed sensor ring for measuring the ring gear backface runout. For speed sensor ring removal and installation procedures refer to the appropriate rear axle section.

DIAGNOSIS AND TESTING

Road Test

A road test is necessary for any concern of noise and /or vibration that is not eliminated by the on-hoist check of chassis components.

There are four operating conditions or modes in which some axle noises come and go: drive, cruise, coast and float.

It is important to a good diagnosis check to operate in all four modes and check off those in which the noise occurs. The modes are defined in the chart shown.

Be sure to write down the kilometers-per-hour (miles-per-hour) range at which both noise and vibration occur. Transmission noise can be mistaken for rear axle noise when in overdrive.

AXLE DRIVE MODES	
Mode	Conditions
DRIVE	Accelerating the vehicle or climbing a hill; a definite throttle application to determine engine torque.
CRUISE	Maintaining a constant speed on a level surface with the throttle applied.
COAST	Decelerating with the throttle closed.
FLOAT	Matching engine speed with road speed using throttle so driveline is in no-load condition.

CE4950-C

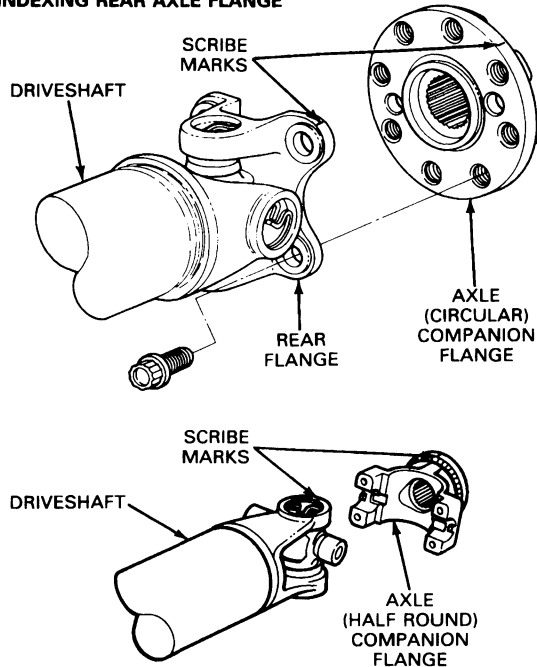
Driveline Vibration

This is a higher-frequency, lower-amplitude vibration than high-speed shake, directly related to road speed, and usually more noticeable at higher road speeds, 72 km / h (45 mph) and up. It is felt in the floor pan or heard as a rumble, hum or boom. It will exist in all drive modes, but may vary somewhat in acceleration, deceleration, float or coast modes. If the vibration is particularly responsive to heavy acceleration or deceleration, especially at lower speeds, driveline angles should be checked. A driveline vibration can usually be duplicated with the axle supported on a hoist or jack stands, though light brake application while accelerating and decelerating to simulate road load resistance may be necessary to bring it out.

1. Raise vehicle promptly after road-testing, on twin-post hoist or jack stands, to prevent tire flat-spotting. Engage drivetrain and run-up to observed road test speed to verify presence of vibration. If not evident, check non-driving wheels with wheel-balancer spinner to rule out imbalance as a possible cause. On 4x4's, unlock front hubs or remove hub covers before spinning wheels. If required, balance non-driving wheels and repeat road test. If vibration is still evident, proceed to driveshaft inspection, Step 3.
2. If vibration appeared in road-speed hoist test, mark relative position of drive wheels on axle or hub lugs to permit re-installation in original position, and remove wheels. Secure brake drums, if present, by installing all lugnuts in reversed position (on single-wheel vehicles) and repeat road-speed run-up. Dual rear wheel lugnuts may be installed in the normal orientation. If vibration is gone, see drive wheel runout and balance procedures in this section. If vibration persists, proceed to Step 3.

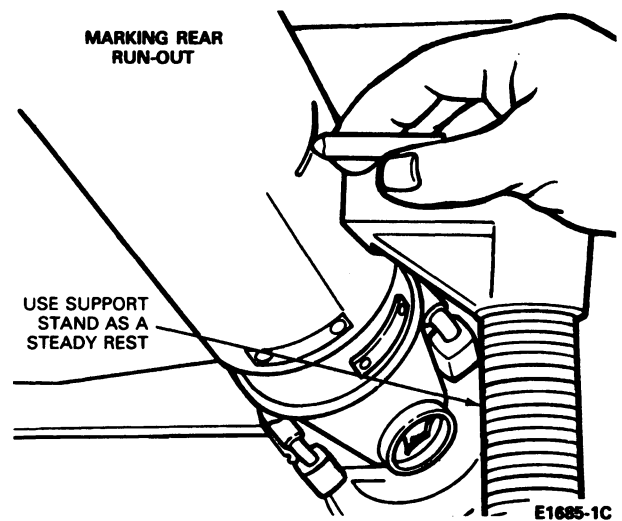
DIAGNOSIS AND TESTING (Continued)

3. Inspect driveshaft for signs of physical damage, missing balance weight, undercoating, or improperly seated, worn, or binding universal joints. Check the index marks (paint spots) on rear of shaft and axle or companion flange. If these marks are more than 90 degrees apart, disconnect shaft and re-index to align marks as close as possible. Clean shaft and repair or replace universal joints as necessary, or replace shaft if damaged. After any corrections are made, re-check vibration at road test speed. If gone, re-install wheels and road test. If vibration persists, proceed to runout check, Step 4.

INDEXING REAR AXLE FLANGE

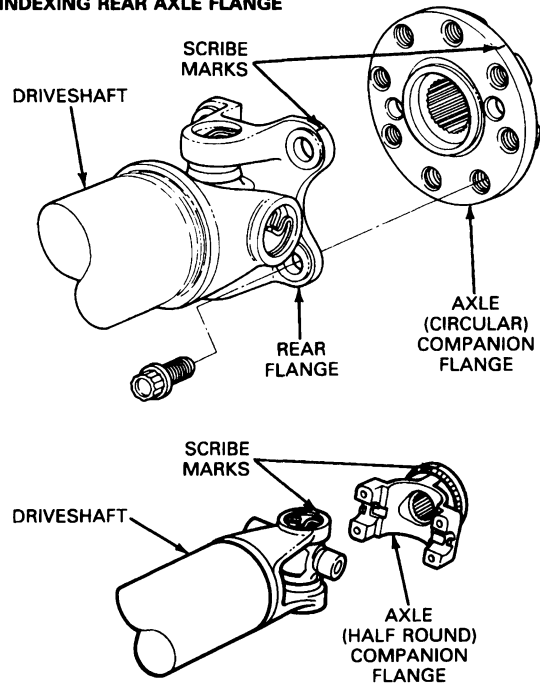
F3931-F

4. With vehicle on hoist and wheels off, measure runout at front, center, and rear of driveshaft with indicator, rotating shaft by turning a brake drum or rotor. On a one-piece shaft, if runout exceeds .89mm (.035 inch) at front or center, the driveshaft must be replaced. If front and center are within this limit, but rear runout is not, mark the rear runout high point and proceed to Step 5. If runout is within limits at all points, proceed to driveshaft balancing, Step 7.



E1685-1C

5. Note or mark the indexing of driveshaft to rear axle companion flange. Disconnect the shaft, re-index 180 degrees, and re-connect. Circular flanges can be indexed in 45 degree increments to fine tune the runout condition; half round companion flanges are limited to two positions. Check runout at shaft rear, and if still over .89mm (.035 inch), mark high point and see Step 6. If runout is no longer excessive, check for vibration at road test speed, and, if still present, re-index the driveshaft slip-yoke on the transmission output shaft 180 degrees and road test the vehicle. If the vibration persists, proceed to Step 7, driveshaft balancing under Adjustments.

INDEXING REAR AXLE FLANGE

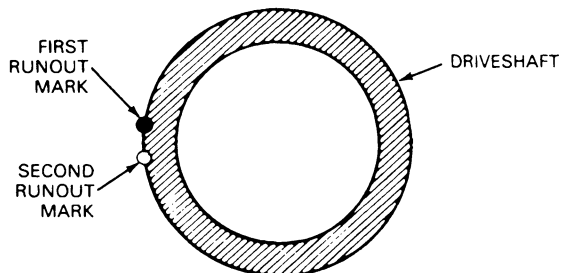
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DIAGNOSIS AND TESTING (Continued)

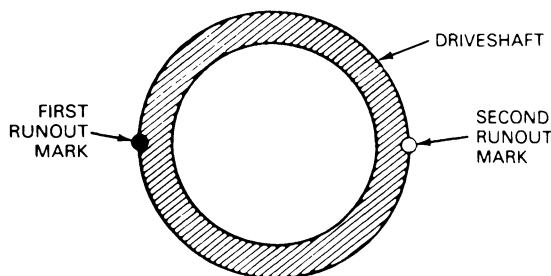
NOTE: Move U-joints in each direction of rotation during re-indexing. If a U-joint feels stiff or has a gritty feel in any direction, replace the U-joint.

6. Excessive driveshaft runout may originate in the shaft itself or in the axle companion flange. To determine which, compare the two high points marked in Steps 4 and 5. If the marks are close together, within about 25mm or 1 inch, the shaft is eccentric, and should be replaced and checked for vibration. If the marks are on opposite sides of the shaft, about 180 degrees apart, the yoke or companion flange is responsible. After replacing check for runout. When replacing a companion flange, driveshaft runout should not exceed .89mm (.035 inch). When runout is within limits, recheck for vibration at road speed. If vibration persists, balance the driveshaft.

CHECKING POSITION OF RUN-OUT MARKS

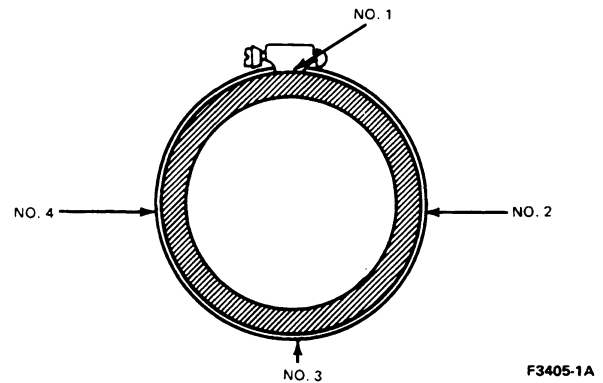


REPLACE DRIVESHAFT



F4595-1B

7. Driveshaft balancing involves installing one or two hose clamps on the driveshaft, near the rear end of a one-piece shaft. Best positioning of the hose clamp head(s) can be determined by trial-and-error, if special balancing equipment is not available. If transducer-and-strobe equipment is available, see Adjustments in this section for balancing procedure.
8. Mark off the rear of the driveshaft into four approximately equal sectors, and number the marks 1 through 4. Install a hose clamp on the shaft with its head at position No. 1. Check for vibration at road speed. Re-check with the clamp at each of the other positions, to find the position for minimum vibration. If two adjacent positions show equal improvement, position the clamp head between them.

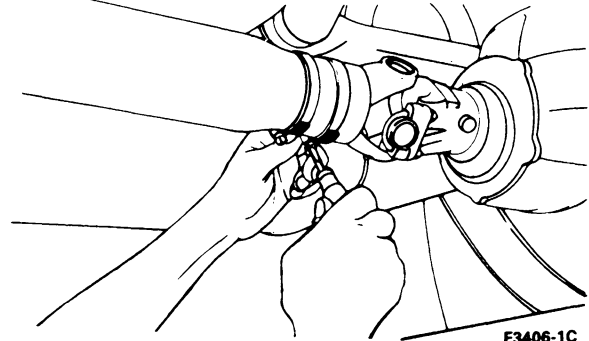


9. If condition is still not acceptable, add a second clamp at the same position and re-check vibration. If no improvement is noted, rotate the clamps in opposite directions, equal distances from the best position determined in Step 8. Initially, separate the clamp heads about 12mm (1/2 inch), and re-check vibration at road speed.

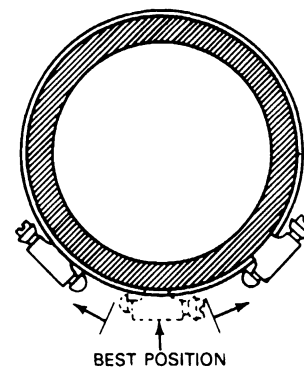
Repeat the process with increasing separation until the best combination is found, or vibration is reduced to an acceptable level.

10. Install wheels and road test, since vibration noticeable on the hoist may not be evident during the road test. If vibration is still not acceptable, replace the axle pinion vibration damper, if so equipped. If road test is not acceptable, replace axle ring gear and pinion set.

ADJUSTING CLAMPS



DETERMINING BEST POSITION FOR CLAMP POSITION



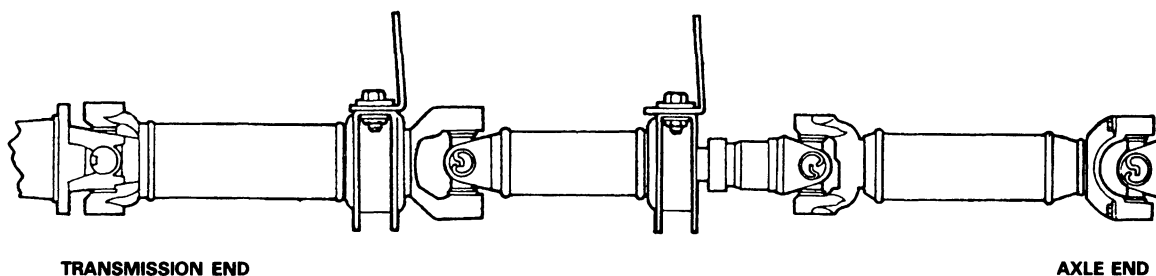
DIAGNOSIS AND TESTING (Continued)

U-Joint Phasing

When assembling a slip between center driveshaft, the U-joint yokes must be assembled to the shaft on the same plane. If not, the assembly may be out of balance, causing a driveline vibration.

To obtain vibration-free operation, check and correct as necessary.

NOTE: Two-piece driveshafts cannot be assembled out of phase due to a master or "blind" spline located on the yoke except F-Super Duty Motorhome and Commercial Chassis.



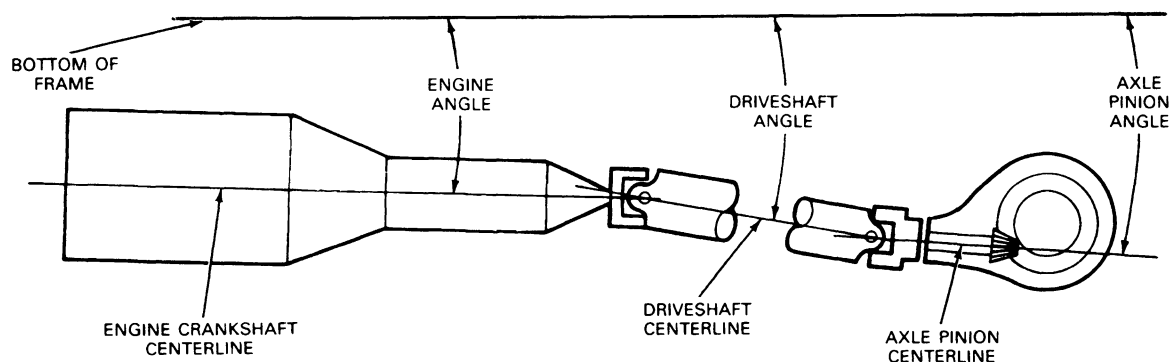
F7927-A

Driveline Angularity

Driveline angularity is the angular relationship between the engine crankshaft, the driveshaft and the rear axle pinion. Factors determining driveline angularity include ride (spring) height, and engine mounts.

Low speed vibration, less than 72 km/h (45 mph), especially when the vehicle is subjected to heavy acceleration or deceleration is an indication of improper driveline angles. When these conditions exist, check the universal joints for proper seating, mounting and operation.

Driveline Angularity



F4559-2A

Universal Joint Inspection

Prior to checking driveline angularity, inspect the universal joints on the driveshaft for proper operation.

Place the vehicle on a frame hoist and rotate the driveshaft by hand. Check for rough operation or seized U-joints. If the U-joint shows signs of seizure, excessive wear or improper seating, scribe alignment marks on the driveshaft and rear axle companion flange. Remove the driveshaft and remove and replace the U-joint. Install the driveshaft in the marked original position.

Driveline Angle Check

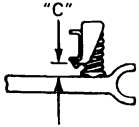
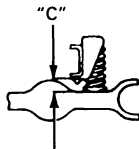
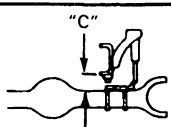
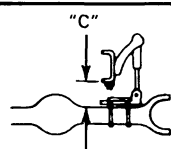
1. Raise the vehicle on a drive-on type hoist or back onto a front-end alignment rack. Bounce the vehicle to normalize the suspension. This makes sure that the suspension components are in the normal-load condition.

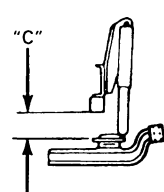
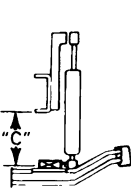
NOTE: Driveline angles are given in relation to a 0 degree longitudinal (fore-aft) unibody frame rail angle and are specified for individual components. Refer to the Specifications portion of this section for the specified engine, driveshaft and pinion angle.

DIAGNOSIS AND TESTING (Continued)

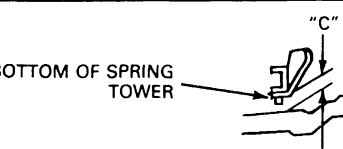
2. Measure the ride height. The vehicle must be in the curb height (empty) condition. Find the recorded ride height in the Driveline Angle chart in the Specifications portion of this section. The specified driveline angles correspond to the measured ride height.

FRONT RIDE HEIGHT, BRONCO, F-150, -250, -350, F-SUPER DUTY SERIES

	F-150/250/350 (4x2) BOTTOM OF SPRING TOWER TO TOP OF AXLE MEASURED AT CENTER FRONT FACE OF JOUNCE BUMPER
	F-150 (4x4) BRONCO BOTTOM OF SPRING TOWER TO TOP OF AXLE MEASURED AT OUTBOARD FRONT FACE OF JOUNCE BUMPER
	F-250 (4x4) BOTTOM OF FRAME TO TOP OF AXLE
	F-350 (4x4) MONOBEAM BOTTOM OF METAL JOUNCE STOP TO TOP OF "SPACER- FRONT SPRING PLATE"

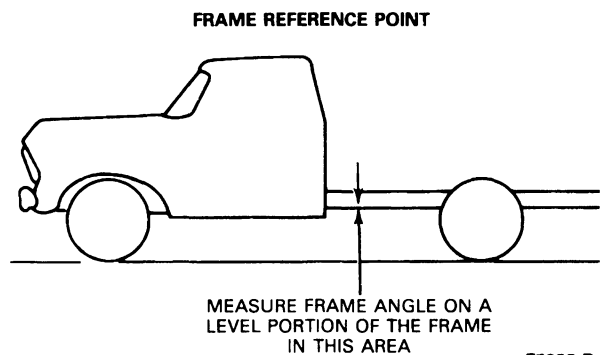
	F-SUPER DUTY CHASSIS CAB (4x2) BOTTOM METAL JOUNCE STOP TO TOP OF SPACER — FRONT SPRING PLATE NOTE CAMBER ANGLES NOT ADJUSTABLE
	F-SUPER DUTY STRIPPED CHASSIS (4x2) BOTTOM OF FRAME TO TOP OF FRONT SPRING SHOCK MOUNTING PLATE AT CENTER OF SPRING

RIDE HEIGHT, ECONOLINE SERIES

	FRONT RIDE HEIGHT
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F7717-A

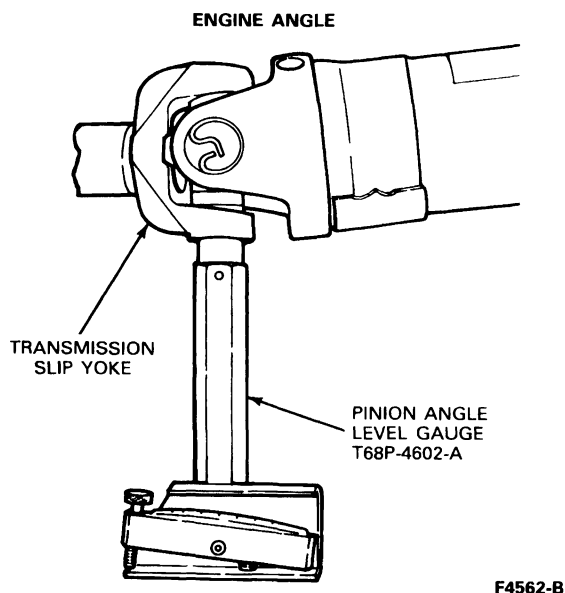
3. Driveline angles are measured with Pinion Angle Level Gauge T68P-4602-A, as described in Step 4, or with an adjustable bubble (spirit level) protractor as described in Step 5. The protractor is used when the tool kit is not available or when the angles to be measured are more than 12 degrees. All angles should be read within 1/2 degree with the tool or protractor held plumb on a clean, flat surface.
4. Driveline angle check with Pinion Angle Level Gauge T68P-4602-A: place the vee magnet of the tool on the bottom of the vehicle frame as shown and calibrate the tool to a 'zero' bubble reading. This gives the 0 degree frame angle. Take and average the readings from both sides to obtain a more accurate reading.



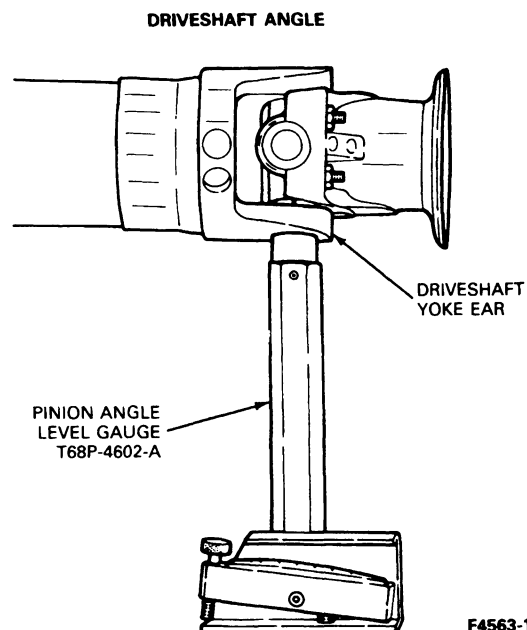
F5028-B

DIAGNOSIS AND TESTING (Continued)

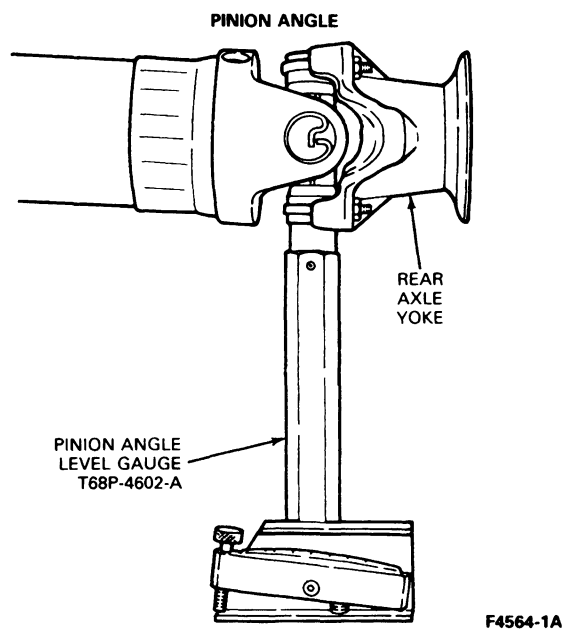
Check the engine angle by rotating the driveshaft until one transmission slip-yoke ear is parallel to the floor. Remove the retaining snap ring, if equipped, from the yoke. Install the Pinion Angle Level Gauge and record the angle reading. If the angle reading differs from the specified angle by 1 degree or more, proceed to Engine Angle Adjustment and neutralize the engine and transmission mounts. With the Engine Angle at specifications, check the Driveshaft and Pinion Angles. Re-install the snap ring.



To check the driveshaft angle, rotate the driveshaft so one driveshaft yoke ear is parallel to the floor. Remove the retaining snap ring, if so equipped, from the yoke. Install the magnetic Pinion Angle Level Gauge on the U-Joint bearing cup and record the angle reading. Reinstall the snap ring. Check the Pinion Angle and if both or either reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.

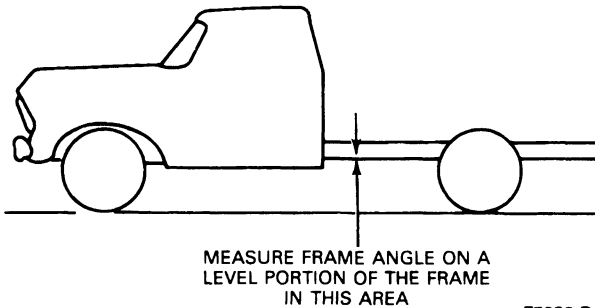


To check the pinion angle, rotate the driveshaft so that one ear of the rear axle yoke is parallel to the floor. Install the Pinion Angle Level Gauge and record the reading. If the reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



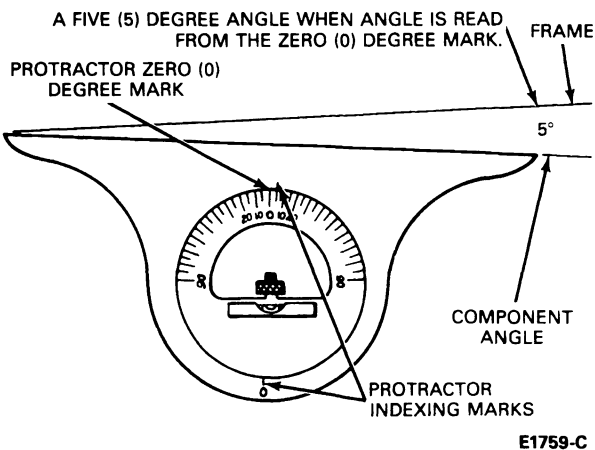
DIAGNOSIS AND TESTING (Continued)

5. Driveline angle check with adjustable bubble (spirit level) protractor: follow Steps 1 and 2 to normalize suspension and measure ride height. Place the protractor on the bottom of the vehicle frame directly below the front driver / passenger seat. This gives the 0 degree frame angle. Take and average the readings from both sides to obtain a more accurate reading.

FRAME REFERENCE POINT

F5028-B

NOTE: When using a bubble (spirit level) protractor, the angles are read from the 0 degree frame angle. The 90 degree mark on the protractor is read as the 0 degree frame angle. For example, when the protractor is placed vertically on the component and the protractor reads 85 degrees, the component angle is actually ± 5 degrees.

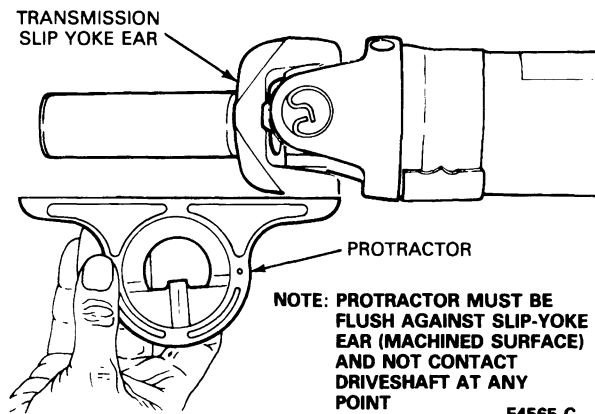


E1759-C

To check the engine angle, rotate the driveshaft until one transmission slip-yoke ear is parallel to the floor. Place the protractor so it is flush against the slip-yoke ear.

NOTE: If slip-yoke ears are not machined, rest protractor against bottom of engine starter motor.

Make sure the protractor is not resting against any portion of the driveshaft assembly. Record the angle reading. If the engine angle reading differs from the specified angle by 1 degree or more, proceed to Engine Angle Adjustment and normalize the engine and transmission mounts. With the engine angle at specifications, check the driveshaft and pinion angles. Refer to angle specifications following this section.

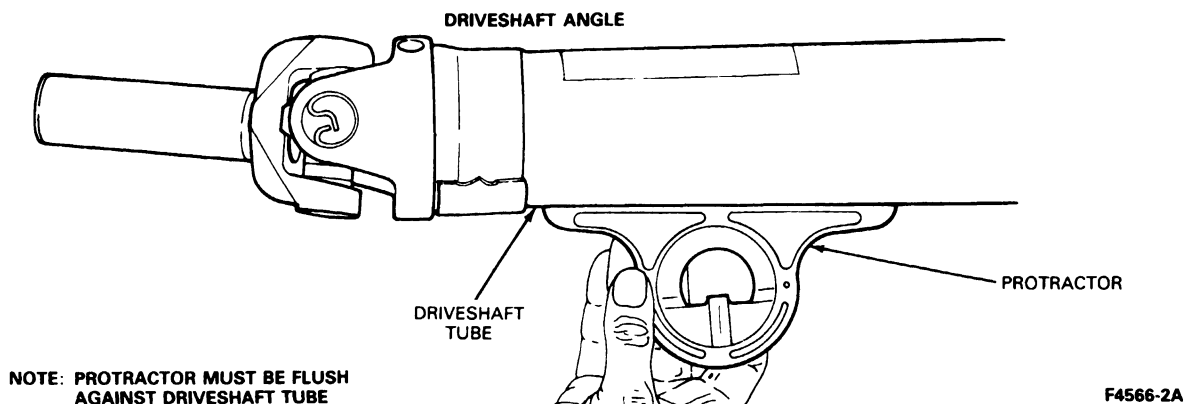
ENGINE ANGLE

F4565-C

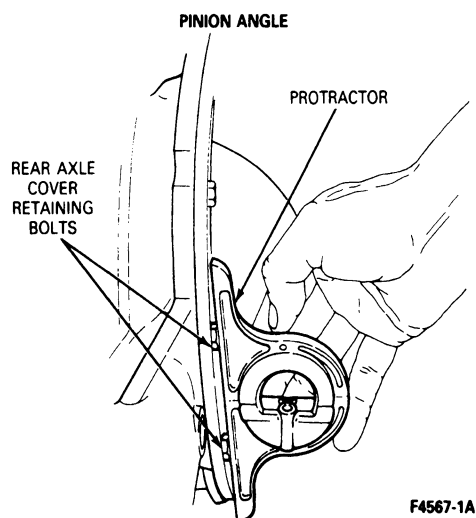
To check the driveshaft angle, place the protractor on any portion of the driveshaft tube so the plane surface of the protractor is flush against the bottom surface of the tube and parallel to the floor.

DIAGNOSIS AND TESTING (Continued)

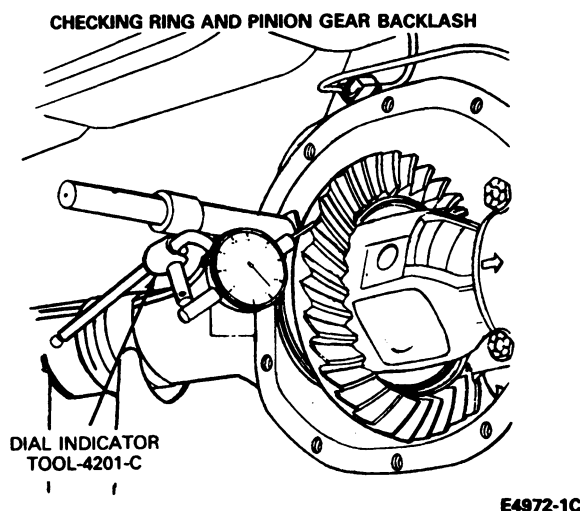
Record the reading. Subtract frame angle to get driveshaft angle. Check the Pinion Angle and if both or either reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



To check the pinion angle, place the protractor in a vertical position so it is flush against two rear axle cover retaining bolts. Rotate the protractor bubble indicator so the 90 degree marks align with the indexing marks. Read the protractor and calculate angle. For example, if the protractor indicates a reading of 85 degrees, the Pinion Angle reading is ± 5 degrees. Record the reading. If the reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



6. Road test to verify resolution of condition. If driveline angle correction and driveline runout / balance procedures (refer to Driveshaft Balancing in this section) do not eliminate the vibration condition, the axle ring gear and pinion gearset should be checked for backlash variation. Remove the axle cover plate as described in the appropriate Rear Axle section. Measure ring gear backlash on thirty consecutive ring gear teeth and note the variation between the high and low readings. If over 0.10mm (0.004 inch) replace the gearset as described in the appropriate rear axle section.



DIAGNOSIS AND TESTING (Continued)

Driveline Angle Correction

Engine Angle Adjustments

The engine angle is adjusted by normalizing the engine mounts. The engine mounts are normalized by loosening the engine mount nuts to frame. Raise the engine up off the frame, then lower the engine and let it settle into place. Service any damaged mounts at this time. Tighten all fasteners to the specified torque. Recheck the engine angle, if the angle is still out of specification, place shims under the transmission to rear crossmember mount until the specified angle is obtained.

Coupling Shaft Angle Adjustment

Check coupling shaft angle (if so equipped) and adjust to specification by shimming the center support bearing. Refer to center support Bearing Shimming in the Two-Piece Driveshaft Service portion of this section.

Driveshaft and Pinion Angle Adjustment

Check the driveshaft angle and adjust to specifications by shimming between the rear springs and the rear axle spring seats.

Adjust the pinion angle by placing tapered shims between the springs and spring seats. On F-150, a 63.5mm (2 1/2 inch) wide shim (Part No. C3TZ-5A313-A or equivalent) is available for a 2 degree change. On E-150 and Bronco, a 63.5mm (2 1/2 inch) wide shim (Part No. C3TZ-5A313-E or equivalent) is available for a 3 degree change. On E-250-350, F-250-350, and F-Super Duty Chassis Cab, a 76.2mm (3 inch) wide shim (Part No. C6TZ-5A313-B or equivalent) is available for a 3 degree change. For F-Super Duty Chassis, a 101.1mm (4 inch) wide shim is required.

Two-Piece Driveshaft Service

The two-piece driveshaft used in longer wheelbase light truck models introduces some special considerations to diagnosis and testing. As compared with a one-piece installation, the two-piece design includes a front, or "coupling" shaft, a rubber-insulated frame-mounted center bearing, a splined slip joint and an intermediate universal joint at the front of the rear driveshaft.

Center Support Bearing Shimming

Drive-away shudder is the predominant symptom associated with driveline angles condition on F-150-250 vehicles with two-piece driveshafts. After eliminating coupling shaft phasing condition as the possible cause, driveline angles should be measured and corrected. Drive-away shudder can usually be serviced by shimming down the center support bearing in 1/4-inch increments using shims E0TZ-4A209-A or equivalent until the drive-away shudder is eliminated. Plate stock must be used to maintain proper preload compression of the rubber insulator.

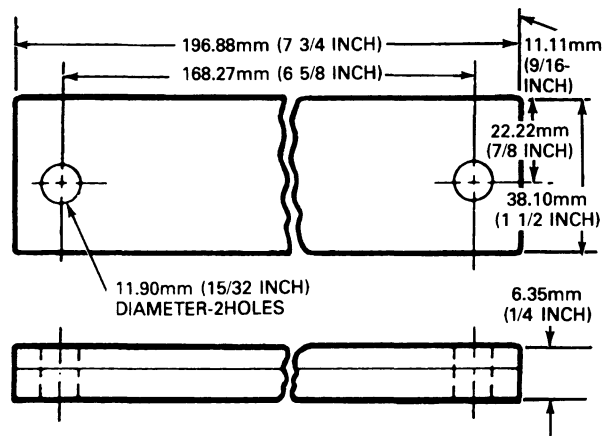
Replace the existing bolts with the appropriate length 7 / 16-14 hex head bolts.

Tighten bolts to 51-73 N-m (37-54 ft-lb).

Road test to verify resolution of condition.

If the drive-away shudder cannot be serviced by shimming down the center support bearing, proceed to the driveline angle checking and service procedure in the following paragraphs.

CENTER SUPPORT SHIM DIMENSIONS



MATERIAL: HOT ROLLED LOW CARBON STEEL

Y1978-D

Coupling Shaft/Center Bearing Alignment

E-150-250-350 and F-150-250-350 and F-Super Duty Chassis Cab Vehicles with Two-Piece Driveshaft

Vehicle noise and vibration can be caused by dislocated and/or failed center bearing rubber insulator, contaminated center bearing or excessive compression of the rubber insulator.

The service for this condition is as follows:

1. Remove the coupling shaft assembly from the vehicle.
2. Perform the following steps:
 - a. Remove the support bracket and retainer.
 - b. Remove the rubber insulator.
 - c. Press center bearing assembly and bearing retainer off the coupling shaft.
 - d. Press the dust slinger off the coupling shaft.
3. Replace with center bearing assembly kit D9TZ-4800-A or equivalent in all cases except E4TZ-4800-A for F-250 HD, F-350 and F-Super Duty Chassis Cab with the ZF transmission.

DIAGNOSIS AND TESTING (Continued)

4. Reassemble the coupling shaft.

NOTE: First install bearing in rubber insulator and press bearing on shaft with the turned-in lip toward the dust slinger (forward). The support bracket must be installed with the deep flange rearward.

5. Reinstall the driveline in the vehicle with the yokes phased properly.
6. Road test to verify resolution of condition.
7. If vibration still exists, insert 1.19mm (1/16-inch) shims between support bracket and support plate (on bolt ends of support bracket) to reduce compression of the rubber insulator as required.

Slip-Yoke Spline**E-150-250-350, F-150-250-350 and F-Super Duty Chassis Cab Vehicles With Two-Piece Driveshaft**

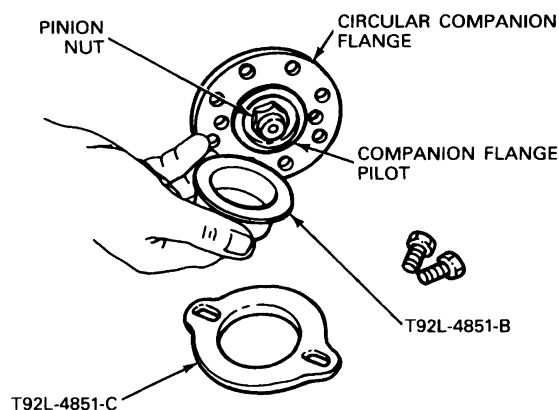
Vehicle noise and vibration can be caused by a seized driveshaft slip-yoke spline resulting in the rubber isolator being pulled out of the center bearing support.

The service resolution to minimize slip-yoke spline contamination and ultimate seizure is as follows:

1. Disconnect the driveshaft from the rear axle yoke and remove it from the truck.
2. Clean the male splines of the coupling shaft using care not to damage the plastic coating. Fine abrasive cloth may be required to dress and polish the male spline. Remove all hardened grease deposits, dirt, or rust. Inspect for worn or galled splines. The plastic coating on the stub spline must not be removed. Replace coupling shaft if necessary.
3. Clean and inspect the female splines of the slip-yoke, removing any hardened grease deposits, dirt or rust. Inspect splines for worn or galled conditions, replace slip yoke if necessary.
4. Apply a coating of Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent to the entire splined stub end of the coupling shaft assembly prior to the assembling of the driveshaft to the coupling shaft.
5. Using a clean long handle (stencil type) brush apply Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent spread evenly on all the female splines of the slip yoke. The spline joint must slide freely by hand.
6. Assemble the driveshaft to the coupling shaft with the yokes phased properly. Attach driveshaft to rear axle yoke.
7. Using a hand type grease gun, lubricate the driveshaft slip yoke through the zerk fitting with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.

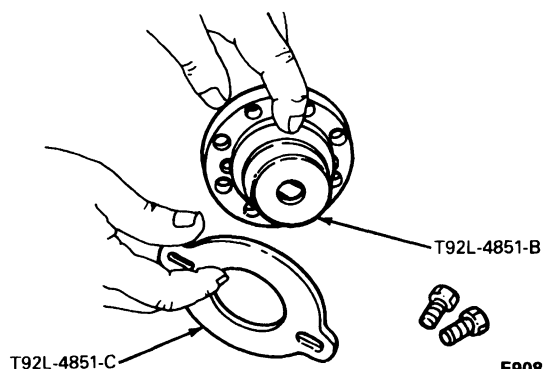
Rear Axle Companion Flange Runout Check

1. Raise the vehicle on a hoist.
2. Remove the driveshaft assembly (Section 05-01A or 05-01B).
3. Check the companion flange for damage.
4. Position Companion Flange Runout Gauge T92L-4851-B on companion flange pilot.



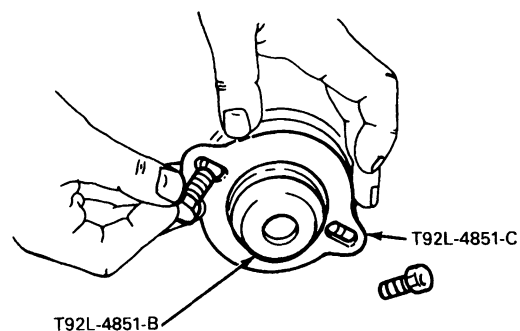
E9086-A

5. Install Clamp Plate T92L-4851C.



E9087-A

6. Align holes in clamp plate with holes in companion flange and install bolts. Snug bolts evenly.

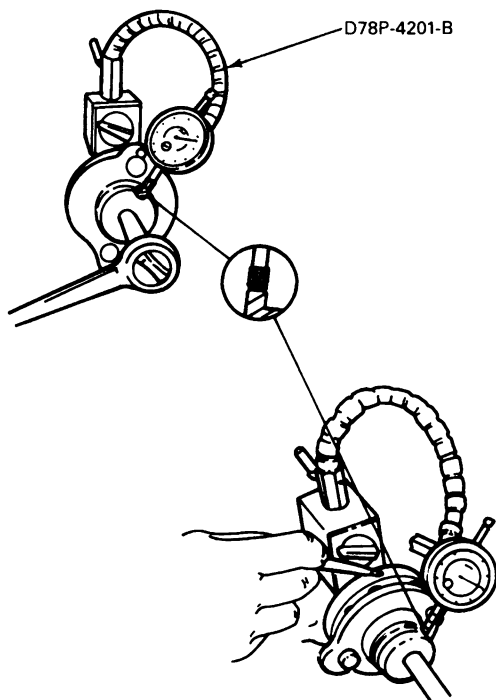


E9088-A

DIAGNOSIS AND TESTING (Continued)

CAUTION: The following operation may disturb the pinion bearing preload. Pinion bearing preload must be preset if the pinion nut is loosened or removed for companion flange reindexing of replacement.

7. Position Dial Indicator D78P-4201-B or equivalent as shown. Turn Companion Flange Runout Gauge as shown to locate and mark high spot on companion flange. If flange runout exceeds .254mm (.010 inch), remove companion flange, reindex 180 degrees on pinion and reinstall. Check runout again. Rotate the flange on the pinion shaft until an acceptable runout is obtained. If flange runout is still greater than .254mm (.010 inch), replace companion.

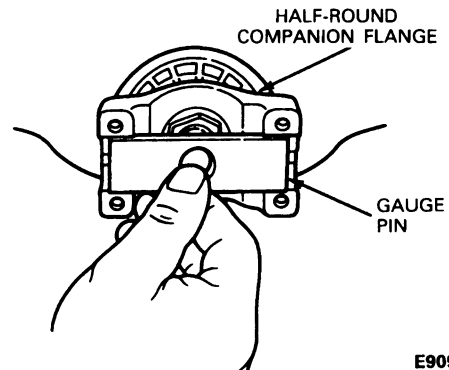


8. If excessive runout is still evident after replacement of the companion flange, it will be necessary to replace the ring and pinion gear set, and repeat the checks described in Step 7 until runout is within specifications (.254mm [.010 in.]). Refer to Section 05-02A for companion flange replacement procedures.

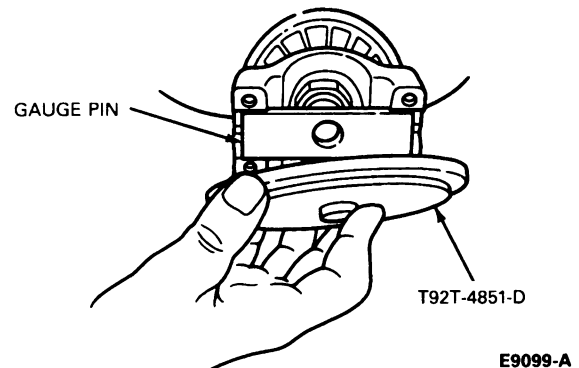
Half Round Companion Flange Runout Check, Rear Axle

1. Raise the vehicle on a hoist.
2. Remove the driveshaft assembly (Section 05-01A or 05-01B).

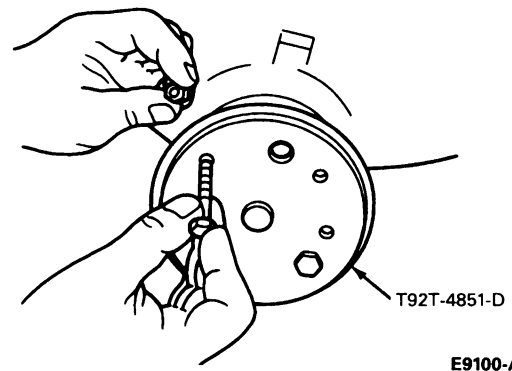
3. Check the companion flange for damage to the universal joint bearing locating lugs. If the lugs are shaved (worn) or damaged, replace the flange.
4. Insert correct size gauge pin, T92T-4851-E, F or G.



5. Position Runout Gauge T92T-4851-D on gauge pin.



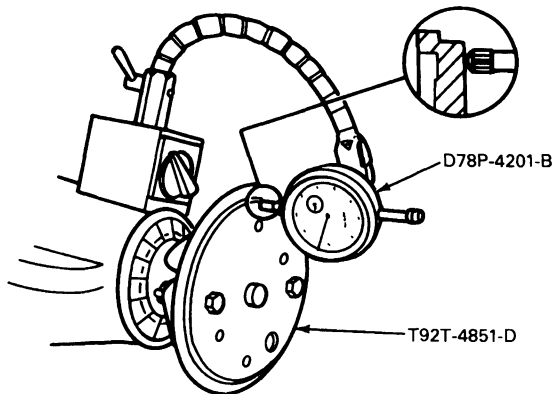
6. Insert two bolts through gauge and companion flange. Install two nuts and hand-tighten.



DIAGNOSIS AND TESTING (Continued)

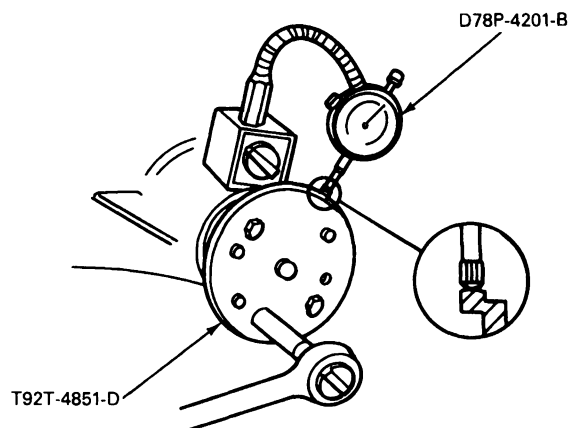
7. Position Dial Indicator D78P-4201-B or equivalent as shown. Adjust and lightly tighten mounting bolts and nuts so gauge runout is .254mm (0.010 in) or less.

NOTE: Accurate tool set-up will result in accurate final readings.



E9101-A

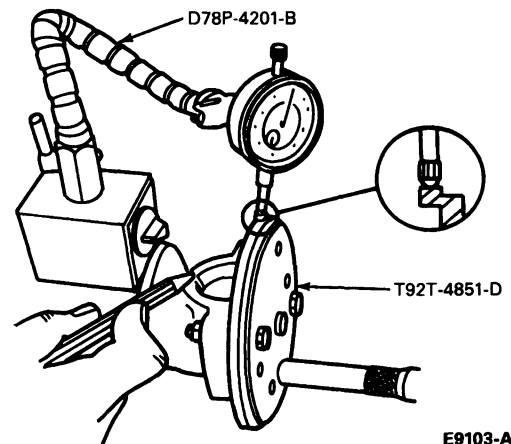
8. Reposition dial indicator on edge of gauge, and turn companion flange / gauge as shown until high spot is located.



E9102-A

CAUTION: The following operation may disturb the pinion bearing preload. Pinion bearing preload must be preset if the pinion nut is loosened or removed for companion flange reindexing or replacement.

9. Turn companion flange runout gauge as shown to locate and mark high spot on companion flange. If flange runout exceeds .254mm (.010 inch), remove companion flange, reindex 180 degrees on pinion and reinstall. Check runout again. Rotate the flange on the pinion shaft until an acceptable runout is obtained. If flange runout is still greater than .254mm (.010 inch), replace companion flange.

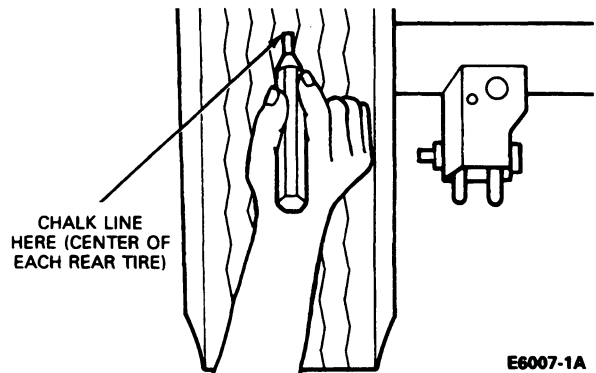


E9103-A

10. If excessive runout is still evident after replacement of the companion flange, it will be necessary to replace the ring and pinion gear set, and repeat the checks described in Step 9 until runout is within specifications (.254mm [.010 in.]). Refer to Section 05-02A for companion flange replacement procedures.
11. Install driveshaft as described in Section 05-01.

Rear Axle Alignment Inspection Procedure

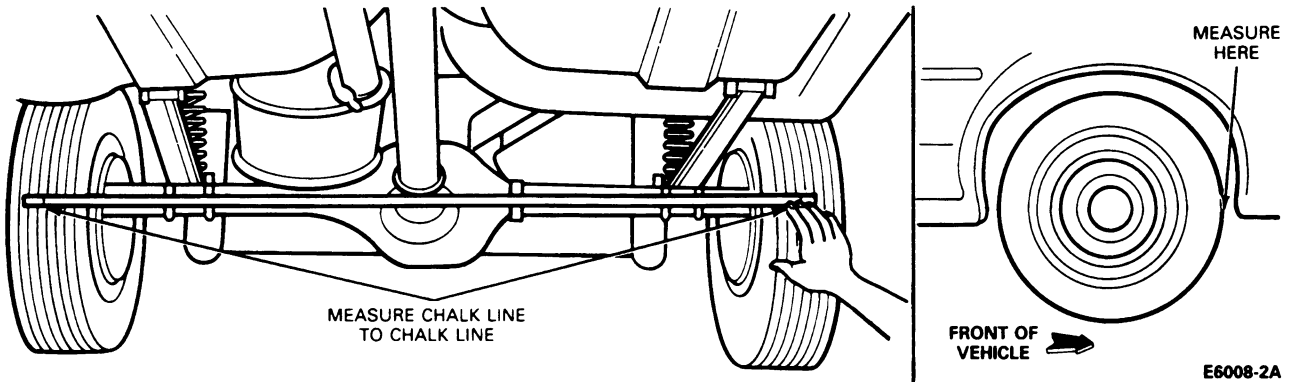
1. Raise the vehicle on a hoist to allow the axle to be freely suspended.
2. Using white chalk or paint, mark a small area at the center of each rear tire and scribe a vertical line on it.



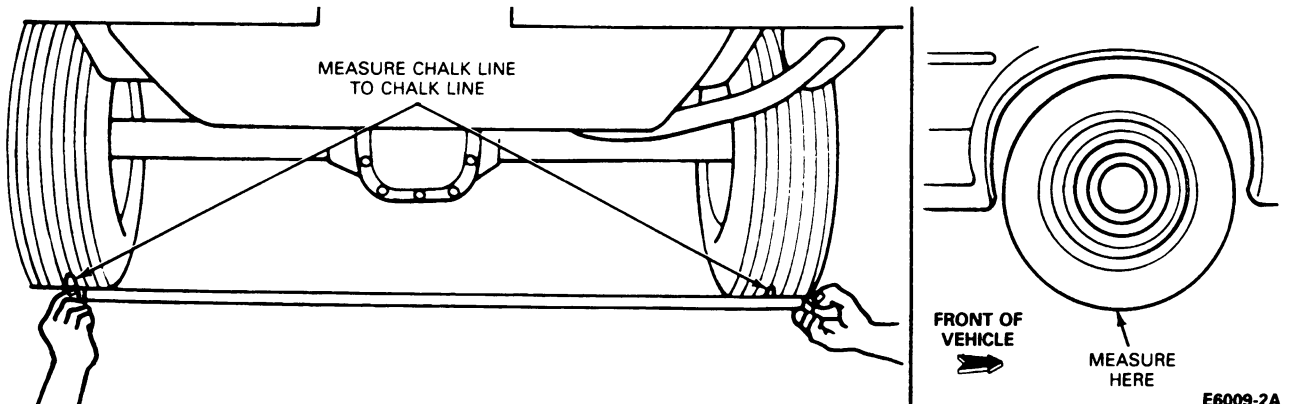
E6007-1A

DIAGNOSIS AND TESTING (Continued)

3. Adjust both wheels so that the markings face the front of the vehicle. Using a tape measure, measure the distance between scribe marks and record this reading (front reading).

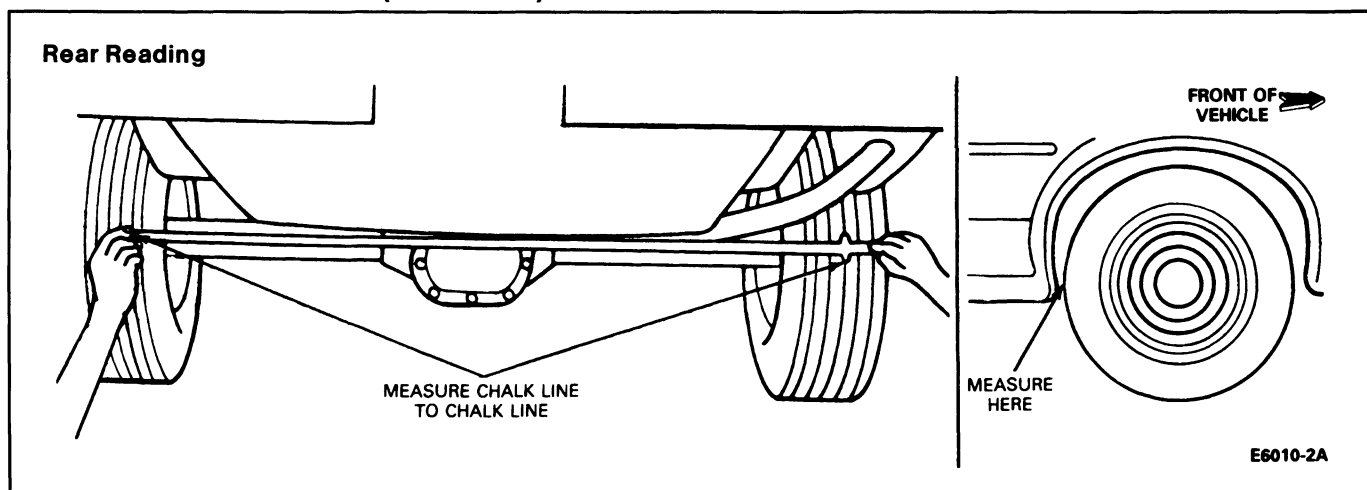


4. Rotate the rear wheels so the markings are directly underneath the vehicle. Measure the distance between the scribe marks and record this reading (bottom reading).

Bottom Reading

5. Rotate the rear wheels so the markings face the rear of the vehicle. Again, measure and record the distance between scribe marks (rear reading).

DIAGNOSIS AND TESTING (Continued)



6. The difference between the front and rear readings is the toe-out or toe-in condition of the housing (Steps 3 and 5).

NOTE: All numbers are for example only.

Front reading: 52-3 / 16 inch

Rear reading: 52-1 / 16 inch

Toe-out: 2 / 16 inch or 1 / 8 inch

Toe-in occurs when the front reading is less than the rear reading.

7. To determine camber, find the average of the front and rear readings (obtained in Steps 3 and 5). Then, subtract the bottom reading from this (obtained in Step 4).

Average of front and rear readings:

52-2 / 16 inch

Bottom reading: 52-2 / 16 inch

Difference or camber: 0 inch

Positive (+) camber is when the bottom reading is less than the average of the front and rear readings. Negative (-) camber is when the bottom reading is greater than the average of the front and rear readings.

8. Results of the measurements taken must conform to the following specifications:

Tape measure specification:

Camber: $0 \pm 5/32$ inch

Toe-in: 0-1 / 16 inch

Toe-out: 0-3 / 16 inch

If the rear axle assembly does not meet this specification, it must be replaced.

9. If the rear axle is replaced, repeat Steps 2 through 7.

DIAGNOSIS AND TESTING (Continued)**Diagnosis Guides, Driveshaft****DRIVELINE COMPLAINTS**

CONDITION	POSSIBLE SOURCE	ACTION
Driveline concerns	<ul style="list-style-type: none"> Rear spring U-bolt loose. U-joint worn or improperly installed. Coupling shaft center support bearing improperly installed. Excessive runout or damaged U-joint. Excessive lateral and radial tire and wheel runout. Excessive driveshaft runout. Driveshaft out-of-balance. Driveline and pinion angles out-of-specification. Binding, damaged or galled splines on slip-yoke. 	<ul style="list-style-type: none"> Retighten U-bolts and driveshaft. Install or replace U-joint. Correctly install bearing and replace if damaged. Rotate flange 180 degrees and install. Recheck, and if not acceptable, replace flanges and/or U-joint and repair as required. Refer to Section 04-04. Replace driveshaft if necessary, or rotate driveshaft 180 degrees and check for out-of-balance condition. Rebalance driveshaft. Adjust to specifications. Check transmission for proper lubricant, and clean and lap splines. Lubricate splines with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B).
Noise on drive or coast.	<ul style="list-style-type: none"> Improper driveline angles or phasing. 	<ul style="list-style-type: none"> Adjust or correct as required.
Loud clunk in the driveline when shifting from reverse to forward.	<ul style="list-style-type: none"> Loose or worn driveshaft components, companion flange attaching nut below specifications. 	<ul style="list-style-type: none"> Inspect, repair, replace as required.
Lubricant leaking from the axle housing pinion seal, axle seals or support arm to housing.	<ul style="list-style-type: none"> Dirt or other debris is blocking vent. Observe end yoke bezel for damage in seal contact area or dust slinger. 	<ul style="list-style-type: none"> Clean vent tube. Replace end yoke and pinion seal if damage is found.

TE6123G

DRIVESHAFT VIBRATES — TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	VERIFY CONDITION		
	<ul style="list-style-type: none"> The following procedure should be used to isolate part or parts causing concern when a vibration condition exists which is thought to be caused by driveline components. Road test vehicle to determine critical vibration points. Note road speed, engine rpm, and shift lever positions at which vibration occurs. Stop vehicle and run engine with clutch depressed (automatic transmission in neutral) through critical speed ranges noted above. 	<p>No</p> <p>Yes</p>	<p>If excessive vibration is present, CORRECT engine or clutch condition causing vibration.</p> <p>GO to A2.</p>
A2	TRANSMISSION CHECK		
	<ul style="list-style-type: none"> With transmission in neutral and clutch engaged (manual transmission), run engine through critical speed ranges and note if any excessive vibration is apparent. 	<p>Yes</p> <p>No</p>	<p>STOP.</p> <p>GO to A3.</p>
A3	TRANSMISSION ALIGNMENT		
	<ul style="list-style-type: none"> Check transmission to clutch housing alignment (ZF transmission only). 	<p>No</p>	<p>ALIGN transmission and clutch housing.</p>

TE8723B

DIAGNOSIS AND TESTING (Continued)

Axle Testing

Certain rear axle and driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. For this reason, be sure that the cause of the trouble is in the rear axle before adjusting, repairing, or replacing any of its parts. See Section 00-04.

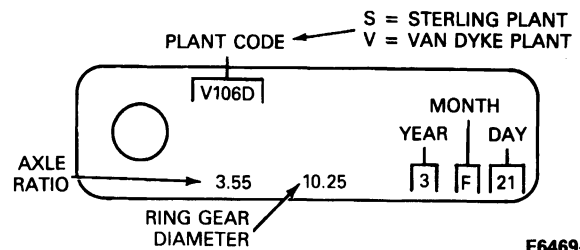
Certain trouble symptoms may be caused by limited-slip differentials. Check the vehicle certification and axle ratio tag to determine the type of differential.

Location of the axle identification code on the rating plate is shown in the illustrations. The first two digits of the axle code (located in the right lower corner of the plate) are rear axle identifiers. The third digit identifies a front axle. Refer to Section 00-01 for a complete listing of the codes.

MFD. BY FORD MOTOR CO. IN U.S.A.					
GVWR: 6600 LB/2994 KG					
DATE: 2/91			FRONT GAWR: 3320 LB		
1506KG			WITH 1816KG		
LT 215/85R 16D			WITH TIRES		
16 x 6K			RIMS		
AT 51 PSI COLD			AT 58 PSI COLD		
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE					
VIN: 1FTBF25H5MLA00000					
TYPE: (a) (b) (c) (d) (e) (f) (g) (h)					
F0083 T0112					
7N 9M					
EXTERIOR PAINT COLORS					
WB	TYPE-GVW	BODY	TRANS	AXLE	TAPE
133	F251	LG4	E	342	B
					SPRING
					2 D 2 9
					(a)(b)(c)(d)
CE4147-J					

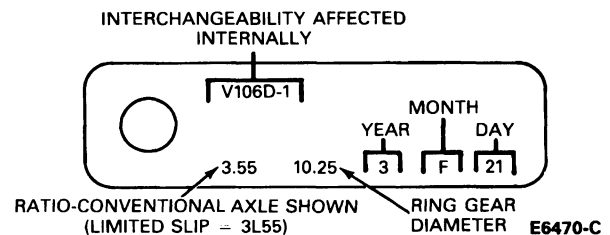
Ford Design Axles

The plant code on the axle identification tag is to be used as the official service identifier.



The Plant Code for an axle denotes a particular design and specific ratio, and if it is a conventional or limited-slip type. In addition, the Plant Code will not change as long as that particular axle assembly never undergoes an external design change. If, however, an internal design change takes place during the production life of the axle and that internal change affects service parts interchangeability, a dash and numerical suffix will be added to the Plant Code.

Note that Plant Codes are identical except the tag below shows a numeric. This means that AS AN ASSEMBLY both axles are interchangeable; however, internally they are different. Therefore, each would require different internal service parts at service time.

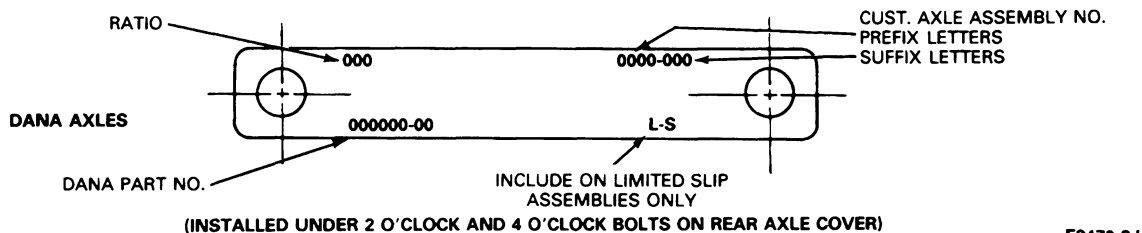


Dana Design Axles

Rear axles have a metal tag secured under adjacent cover bolt heads listing Ford and Dana part numbers and the ratio. Front drive axles have a similar tag.

DIAGNOSIS AND TESTING (Continued)

Dana Axle Identification Tag



Noise Acceptability

A gear-driven unit, especially a truck drive axle, will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions, as on a newly paved blacktop road, for example. The slight noise is in no way detrimental to operation of the rear axle and must be considered normal.

Limited-Slip Differential Operation Check

Refer to Section 05-02F for E-250-350; Section 05-02H, for F-150 and Bronco; and Section 05-02C for F-250-350.

To demonstrate the proper performance of the limited-slip differential:

Place one wheel on good, dry surface and the other wheel on ice, mud or snow.

Gradually open throttle to obtain maximum traction prior to "break-away". The ability to move the vehicle will demonstrate proper performance of a limited-slip axle.

When starting with one wheel on an excessively slippery surface, a slight application of the parking brake may be necessary to help energize the limited-slip feature of the differential. Release the brake when traction is established. Use light throttle on starting to provide maximum traction.

In vehicle operation, it should be noted that:

1. If, with unequal traction, both wheels slip, the limited-slip axle has done all it can possibly do.
2. In extreme cases of differences in traction, the wheel with the least traction may spin after the limited-slip has transferred as much torque as possible to the non-slipping wheel.

WARNING: A VEHICLE EQUIPPED WITH A LIMITED-SLIP DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. DRIVING THE AXLE WITH THE ENGINE AND ONLY ONE WHEEL RAISED OFF THE GROUND IS NOT A RECOMMENDED PRACTICE WITH EITHER THE LIMITED-SLIP OR CONVENTIONAL AXLE DUE TO THE DANGER OF THE VEHICLE DRIVING OFF THE STAND OR JACK.

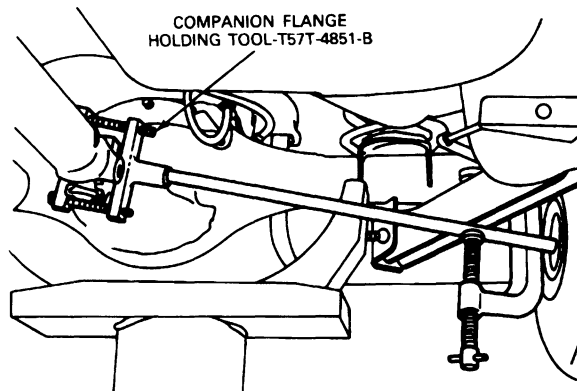
Total Axle Backlash Check

Ford Axles

Raise vehicle on hoist. Use a rigid bar or pipe of suitable length and clamp one end to the axle companion flange using Companion Flange Holding Tool T57T-4851-B, for half-round flange on F-250-350 applications, and T78P-4851-A for F-150 and E-Series (circular flange), and the other end to the frame or body member in order to prevent movement of the companion flange.

NOTE: Remove driveshaft when performing this procedure on circular flange application.

Lock Axle for Total Backlash Check, Ford F-250-350 Axles

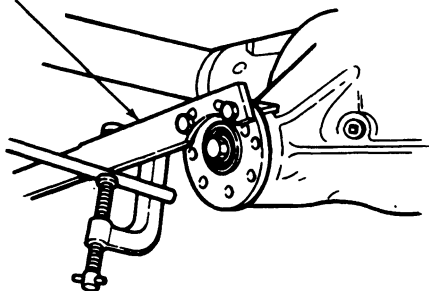


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DIAGNOSIS AND TESTING (Continued)

Lock Axle for Total Backlash Check, Ford E-150 and F-B-150 Axles

COMPANION
FLANGE HOLDER
T78P-4851-A



E7668-1A

Lower the vehicle so that one rear wheel is resting on a wheel chock to prevent it from turning. The other rear wheel will then be used to measure total axle backlash.

Rotate the free wheel slowly, by hand, until a feel of driving the axle is encountered. Position a crayon or chalk firmly on the side of the tire 305mm (12 inches) from the center of the wheel. Rotate the wheel slowly in the opposite direction until the feel of driving the axle is encountered again.

Measure the length of the crayon or chalk mark on the tire. If the length of the mark is 25.4mm (1 inch) or less, the axle backlash is within allowable limits.

If the chalk mark is greater than 25.4mm (1 inch), check for these conditions:

1. Elongation of the differential pinion shaft holes in the differential case.
2. Missing differential, pinion, or side gear thrust washers.
3. Galling of the differential pinion shaft and bore.
4. Excessive gear set backlash. Follow procedure for type of axle, to check backlash.

Dana Rear Axles

Apply parking brake to keep both rear wheels from turning. Mount a Dial Indicator D78P-4201-B or equivalent on the carrier housing with the indicator point positioned to contact the pinion yoke 38.1mm (1-1/2 inch) from the center line of the pinion shaft.

With the transmission in neutral and engine not running, check the total rotational movement of the pinion yoke. If the total reading on the dial indicator is 1.9mm (0.075 inch) or less, the axle backlash is within allowable limits.

Diagnosis Guides, Driving Axle

CONDITION	POSSIBLE SOURCE	ACTION
Excessive rear axle noise.	<ul style="list-style-type: none"> • N.V.H. problem. (Noise, vibration and harshness.) • Worn or damaged wheel bearing. 	<ul style="list-style-type: none"> • Perform the N.V.H. tests to determine whether the noise is a N.V.H. caused by an axle problem. Refer to Section 00-04. • Perform wheel bearing noise test. Refer to Section 00-04. Replace bearings if required.
Loud "clunk" in the driveline when shifting from reverse to forward.	<ul style="list-style-type: none"> • High idle speed. • Loose engine mounts. • Loose or worn driveshaft components, companion flange attaching nut below specs. • Inoperative shock absorbers and/or loose rear springs or suspension arms. • Excessive backlash in axle, or transmission. • Insufficient lubrication. 	<ul style="list-style-type: none"> • Adjust idle speed. • Inspect, repair as required. • Inspect, repair or replace as required. • Inspect, repair or replace as required. • Perform total backlash check of axle. Repair or replace as necessary. • Add lubricant as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
Driveline "clunk" as vehicle starts to move following a brake stop (two-piece driveshaft).	<ul style="list-style-type: none"> Loose rear spring U-bolts. Worn or galled output shaft splines. Worn or galled slip-yoke splines. Damaged slip-yoke seal. Insufficient lubrication in slip-yoke. 	<ul style="list-style-type: none"> Tighten U-bolts to specification. Remove the driveshaft from the vehicle. Clean the male splines and inspect for worn or galled splines. Replace if necessary. Clean and inspect the female splines of the slip-yoke for worn or galled condition. Replace if necessary. Replace seal. Using a long handle (stencil type) brush, apply long life lube evenly on all the splines of the slip-yoke. Reinstall driveshaft and using a hand grease gun lubricate the slip-yoke through the zerk fitting with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. <p>NOTE: Install the slip-yoke making sure that the coupling shaft and driveshaft are in phase.</p>
On turns, Dana Limited-Slip axle has a high pitched chattering noise.	<ul style="list-style-type: none"> Improper lubricant. Dana axles use different lube than Ford axles. Refer to Maintenance Schedule in Section 00-03 for complete information. 	<ul style="list-style-type: none"> If axle chatters, siphon or drain lubricant from axle and refill with specified rear axle lubricant, and dosage of friction modifier additive.
Dana Limited-Slip axle does not work in snow, mud or ice.	<ul style="list-style-type: none"> Worn or damaged axle unit. 	<ul style="list-style-type: none"> Starting with one wheel on a slippery surface, slightly apply the parking brake. Gradually open throttle. If the vehicle moves, the axle is operating satisfactorily. If no movement, refer to Section 05-02F.
Driveline concerns.	<ul style="list-style-type: none"> Rear spring U-bolt loose. U-joint worn or improperly installed. Coupling shaft center support bearing improperly installed. Excessive runout in companion flange and damaged U-joint. Excessive lateral and radial tire and wheel runout. Excessive driveshaft runout. Driveshaft out-of-balance. Driveline and pinion angles out-of-specification. Binding, damaged or galled splines on slip-yoke. 	<ul style="list-style-type: none"> Retighten U-bolts and driveshaft. Reinstall or replace U-joint. Correctly install bearing and replace if damaged. Rotate flange 180 degrees and reinstall. Recheck and if not acceptable, replace flanges and/or U-joint and repair as required. Refer to Section 04-04. Replace driveshaft or rotate driveshaft 180 degrees and check for out-of-balance condition. Rebalance driveshaft. Adjust to specifications. Check transmission for proper lubricant, and clean and lap splines. Lubricate splines with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.

TE8784B

DIAGNOSIS AND TESTING (Continued)**REAR AXLE DIAGNOSIS GUIDE — FORD AXLES**

CONDITION	POSSIBLE SOURCE	ACTION
Excessive rear axle noise.	<ul style="list-style-type: none"> Differential carrier. 	<ul style="list-style-type: none"> Road test vehicle to assure problem is rear axle noise rather than other system noise. Refer to General Diagnostic Procedure. Repair and replace parts as required.
Loud "clunk" in the driveshaft when shifting from reverse to forward.	<ul style="list-style-type: none"> Driveshaft. Rear axle shafts or carrier. 	<ul style="list-style-type: none"> Raise vehicle, rotate driveshaft by hand to isolate problem as driveshaft or rear axle problem. Repair or replace as required. Remove and inspect. Repair as necessary.
Limited-slip axle does not work in snow, mud or on ice.	<ul style="list-style-type: none"> Differential. 	<ul style="list-style-type: none"> Perform Differential Operation Check in this section. Repair as required per Section 05-02F.
On turns, the rear axle has a high pitched chattering noise (limited-slip axles only).	<ul style="list-style-type: none"> Lubricant. Differential. 	<ul style="list-style-type: none"> Road test vehicle — drive truck in tight circles, 5 clockwise and 5 counterclockwise. If chatter is still evident, flush and replace lubricant. (See Lubricant Specifications at the end of this section.) Remove differential, repair as required.
Noise is the same on drive or coast.	<ul style="list-style-type: none"> Road noise. Tire noise. Front wheel bearing noise. 	<ul style="list-style-type: none"> Normal condition. Rebalance or replace tire. Adjust or replace wheel bearings.
Noise tone lowers as vehicle speed is lowered.	<ul style="list-style-type: none"> Tire noise. 	<ul style="list-style-type: none"> Rebalance or replace tire.
Similar noise is produced with vehicle standing and driving.	<ul style="list-style-type: none"> Engine noise. Transmission noise. 	<ul style="list-style-type: none"> Refer to Section 03-00. Refer to appropriate transmission section.
Vibration.	<ul style="list-style-type: none"> Refer to Section 00-04. 	<ul style="list-style-type: none"> Refer to Section 00-04.
Noise most pronounced on turns.	<ul style="list-style-type: none"> Differential side gears and pinion gears. 	<ul style="list-style-type: none"> Replace gears.
Drive noise, coast noise or float noise.	<ul style="list-style-type: none"> Wheel bearings or differential side bearings. Ring and pinion gear. 	<ul style="list-style-type: none"> Adjust or replace wheel or differential side bearings. Check ring and pinion gear. Adjust or replace.

TE8785B

CHATTERS ON TURNS WITH LIMITED-SLIP DIFFERENTIAL — TEST B

TEST STEP		RESULT	ACTION TO TAKE
B1	DRIVE VEHICLE		
	<ul style="list-style-type: none"> Drive vehicle in fairly tight figure 8's — ten times total (five clockwise and five counterclockwise). 	No chatter Chatter still present.	STOP. GO to B2 .
B2	CHANGE LUBRICANT		
	<ul style="list-style-type: none"> Siphon or drain lubricant from axle and refill with specified rear axle lubricant. <p>NOTE: F-150, Bronco, E-150 with Ford 8.8 Limited-slip, add 4 oz. of Additive Friction Modifier (EST-M2C 118-A) C8AZ-19B546-A or equivalent. E-250-350 with Dana Limited-Slip or F-250-350 with Ford 10.25 Limited-Slip, add 8 oz. of Additive Friction Modifier (EST-M2C 118-A) C8AZ-19B546-A or equivalent.</p> <ul style="list-style-type: none"> Drive vehicle in fairly tight figure 8's — ten times total (five clockwise and five counterclockwise). 	No chatter Chatter still present	STOP. GO to B3 .

DIAGNOSIS AND TESTING (Continued)**CHATTERS ON TURNS WITH LIMITED-SLIP DIFFERENTIAL — TEST B (Continued)**

TEST STEP		RESULT	ACTION TO TAKE
B3	DRIVE VEHICLE		
	<ul style="list-style-type: none"> Drive vehicle 40-80 km (25-50 miles) in addition to figure 8's. 	No chatter Chatter still present	STOP. REMOVE the differential and REPAIR as required.

TE4767K

LIMITED-SLIP DIFFERENTIAL DOES NOT OPERATE IN MUD OR SNOW OR ON ICE — TEST C

TEST STEP		RESULT	ACTION TO TAKE
C1	ALL FORD AND DANA MODEL 60 AND 70		
	<ul style="list-style-type: none"> Starting with one wheel on an excessively slippery surface, slightly apply the parking brake. Gradually open throttle. If the vehicle moves, the axle is operating properly. 	Vehicle moves Vehicle doesn't move	Unit OK. STOP. REPAIR unit as required.

TE4768E

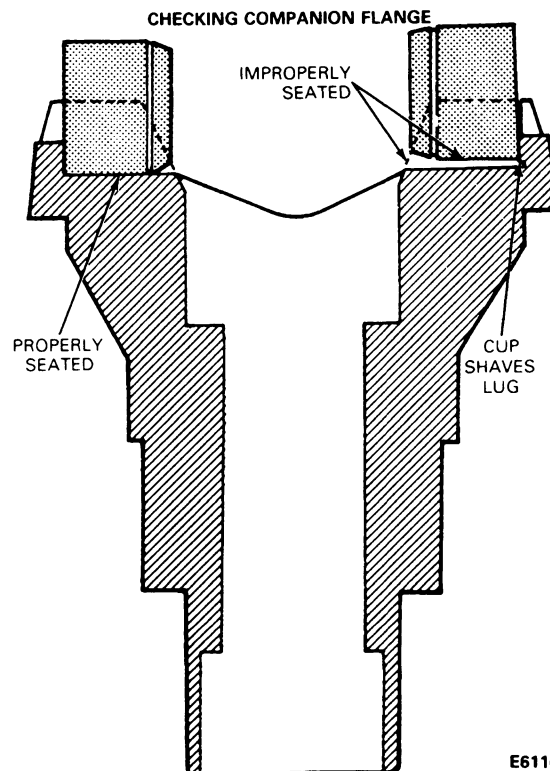
ADJUSTMENTS**Driveshaft Balancing**

Vibration or shudder which is noticeable either on fast acceleration, when coasting, or when using the engine for braking, may be caused by the rear axle housing being loose on the rear suspension, improper tire balance, improper driveline installation, or driveline balance.

If driveshaft components are replaced and shaft vibration is encountered after installation, disconnect the shaft and remove the slip yoke. Rotate the slip-yoke 180 degrees; then, reconnect the shaft to the slip-yoke and reinstall in vehicle. If the vibration persists, disconnect the shaft at the rear axle companion flange. Rotate the companion flange 180 degrees and reconnect the shaft to the flange. Driveshafts connected to circular flanges on 8.8-inch axles can be indexed in 45-degree increments to fine tune the balance of the driveline system.

If rotating the driveshaft 180 degrees does not eliminate vibration, the driveshaft may be balanced, using the following procedure:

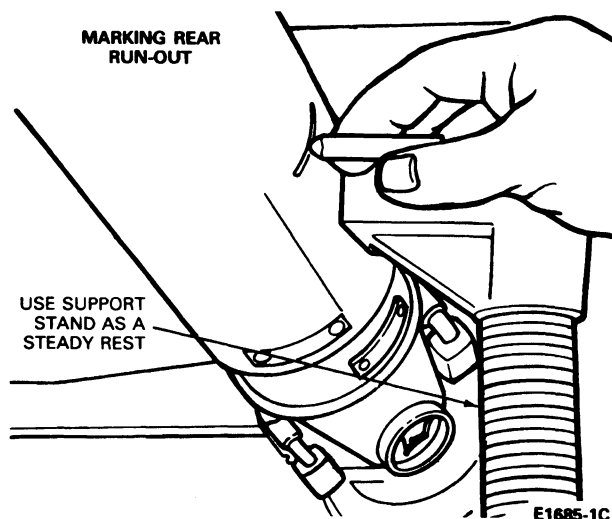
1. Raise the vehicle on a twin-post hoist so that both the front and rear axles are safely supported with all wheels free to rotate.
2. Remove the rear wheels and tires. Reinstall lugnuts to retain brake drums or rotors.
3. With the transmission in gear, increase the vehicle speed to the maximum vibration level. Note and record the speed of this vibration period as a baseline speed.
4. Check the attachment of all U-joint bearing caps of the driveshaft to the transmission yoke for improper installation or damaged U-joint bearing cap locating lugs. All yokes with worn, shaved, or damaged locating lugs must be replaced.



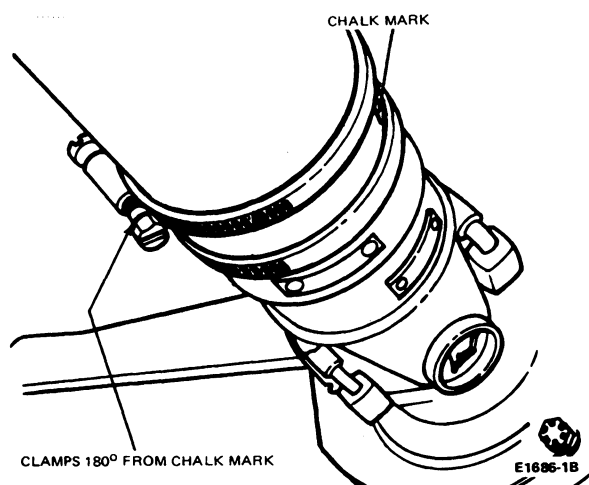
E6116-1A

ADJUSTMENTS (Continued)

5. With the transmission in gear, run the vehicle with the driveshaft rotating at a speedometer speed of 64-80 km (40-50 miles); have an assistant carefully bring a crayon, piece of chalk, or colored pencil up until it just barely contacts the rear end, center and front end of the driveshaft. The chalk marks will indicate the heavy side of the driveshaft. Use caution when checking the driveshaft near the balance weights to prevent injury to the hands.



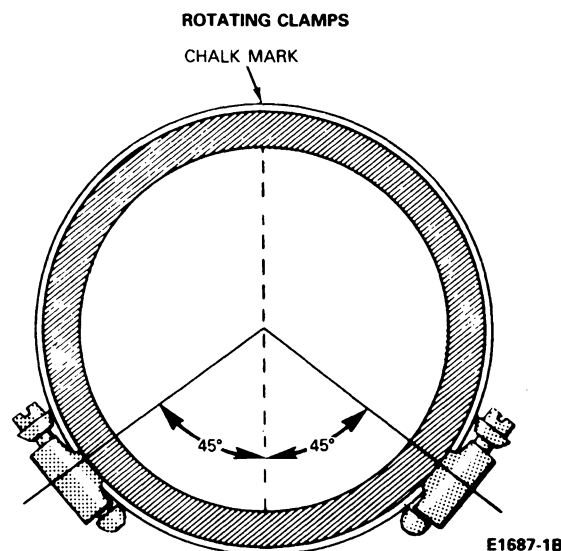
6. Install two screw-type hose clamps on the driveshaft so that their heads are located 180 degrees from the chalk mark, starting at the pinion yoke end of the driveshaft. Tighten the clamps.



7. Run the vehicle up to the baseline speed. If vibration is still evidenced, rotate the clamps approximately 45 degrees away from each other and test for correction of vibration.

CAUTION: To prevent overheating, do not run the vehicle on the hoist for an extended period.

8. If necessary, continue to rotate the clamps apart in smaller increments until the vibration is eliminated or begins to be reduced.
9. If the vibration is not completely eliminated, repeat the foregoing procedure and balance the front end of the driveshaft, checking for elimination or reduction in the vibration level.
10. Reinstall wheels and tires.
11. Remove the vehicle from the hoist and road test.



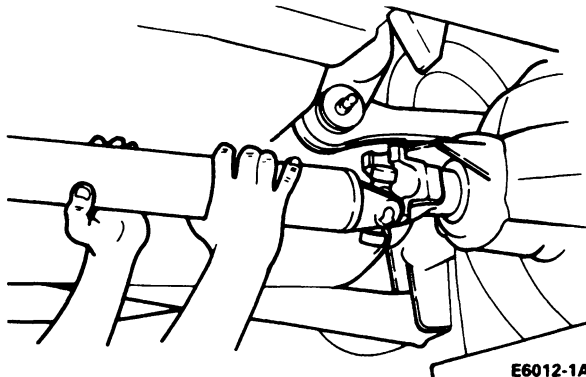
Alternate In-Vehicle Driveshaft Balancing Procedure

Rotunda Dynamic Wheel Balancer (Model 006-01400 or Equivalent Equipment)

1. Road Test—Evaluate and record road speed at which vibration occurs.
2. Raise vehicle on a frame contact hoist. Remove the wheels and tires. Reinstall lugnuts to retain brake drums. Re-evaluate by starting the engine, engaging the transmission and accelerating to the indicated speeds at which the vibration was most severe during the road test. Suspending the rear axle makes the driveline more sensitive to vibration.

ADJUSTMENTS (Continued)

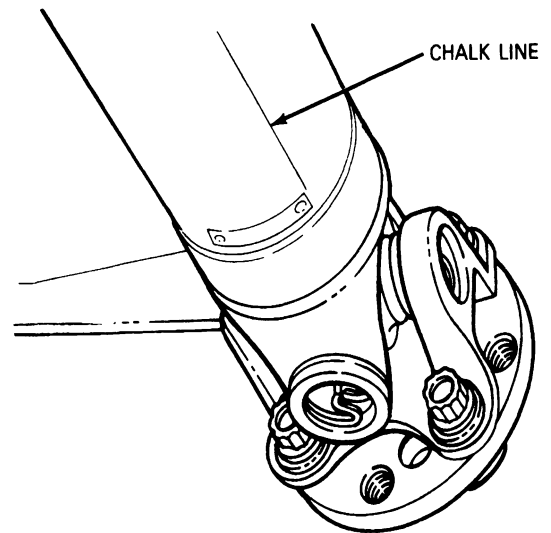
3. Disconnect the driveshaft from the companion flange. Rotate the driveshaft 180 degrees from its original position and re-install. Repeat evaluation per Step 2 above.



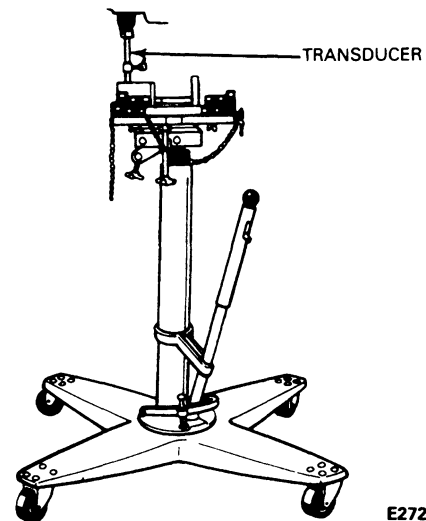
NOTE: In some cases, rotating the driveshaft 180 degrees may decrease the vibration to an acceptable level. However, if the vibration level is increased, install the driveshaft in its original position and proceed to Step 4. Driveshafts connected to circular flanges on 8.8-inch axles can be indexed in 45-degree increments to fine tune the balance of the driveline system.

4. A vehicle is more sensitive to excessive imbalance and / or runout at the rearward end of the driveshaft; therefore, locate the heavy side of the driveshaft by the use of the strobe light and transducer, as follows:

Scribe an axial chalk line (at any radial location) approximately 101.6mm (4 inches) long at the rear of the driveshaft. Locate the transducer on the bottom side of the carrier, and secure it in place. Run the engine and driveline at the worst vibration speed noted and visually note the position of the chalk line by use of the strobe light. This provides a starting point for the initial location of the clamps.



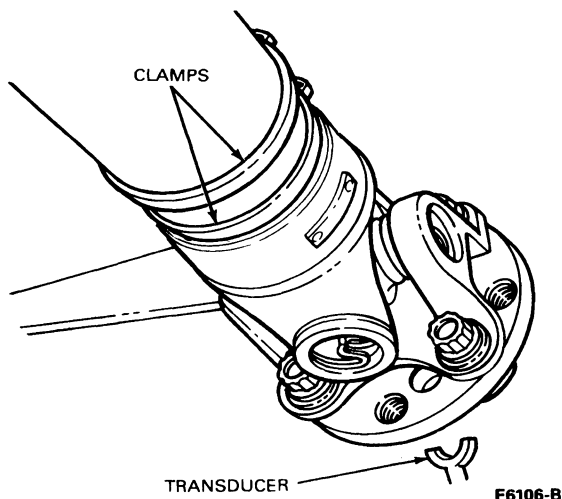
LOCATING TRANSDUCER



5. Stop the engine and rotate the driveshaft so that the chalk line is in the same location as it was noted under the strobe light.

ADJUSTMENTS (Continued)

6. Install two (stainless steel) hose clamps on the driveshaft. Position the clamp heads 180 degrees from the transducer and tighten the clamps.



7. Run the engine and driveline through the speed range. If no vibration is felt, remove the lugnuts, install the wheels and tires and reinstall the lugnuts in the correct position and proceed to Step 9. However, if any vibration still exists, the combined weight of the two hose clamp heads may be in excess. To reduce this excess weight, rotate the clamp heads away from each other approximately 15 degrees (one each way from the original position). Run the engine and driveline and note if the vibration has been reduced.

CAUTION: Do not run the engine with the transmission engaged on the hoist for extended periods due to the danger of overheating the engine and/or transmission.

8. Continue to rotate the clamp heads apart in smaller angular increments until the vehicle feel of balance (vibration) is best. At this point, install the wheels and tires per Step 7 and road test the vehicle to determine the actual degree of improvement. If satisfactory improvement has been obtained, proceed with Step 9. If no improvement has been obtained, the clamps must be removed and diagnosis should be re-directed to other areas, such as wheels, tires, driveline angle, and companion flange runout. For additional information refer to Diagnosis and Testing in this section.

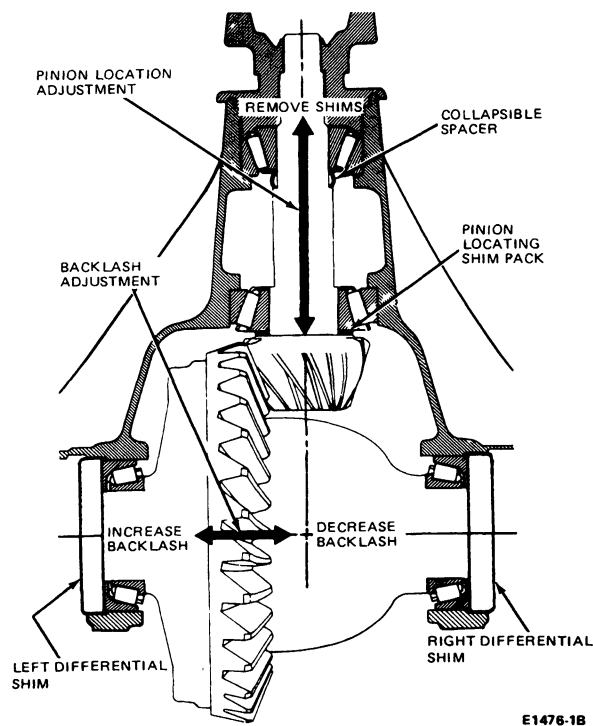
9. When the vehicle has been corrected to a satisfactory level, as determined by a road test evaluation, tighten the clamps securely. Clean thoroughly with lacquer thinner, and spray the clamps with a commercially available black paint for a finished appearance.

Axle Adjustments

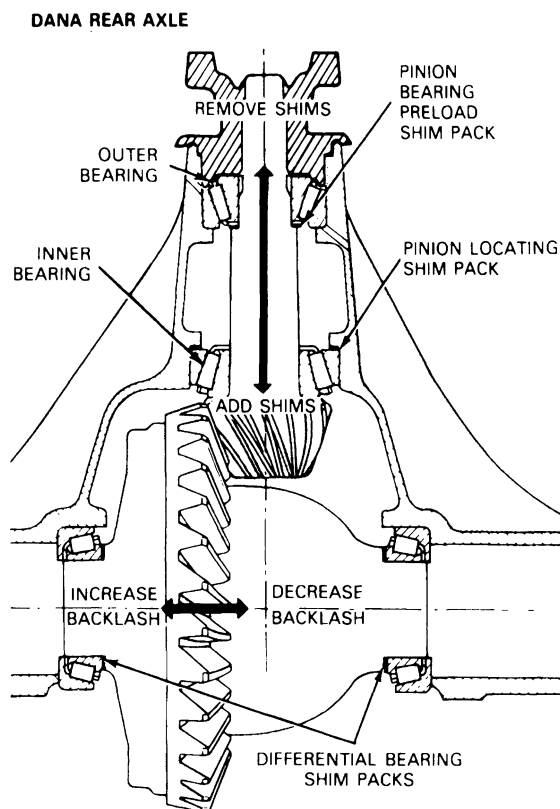
Certain rear axle and driveline concern symptoms are also common to the engine, transmission, wheel bearing, tires, and other parts of the vehicle. For this reason, be sure that the cause of the concern is in the rear axle before adjusting, repairing or replacing any of the parts. See Section 00-04.

Pinion and Ring Gear Adjustments

Two adjustments affect drive pinion and ring gear tooth contact. They are drive pinion depth and drive pinion and ring gear backlash.



ADJUSTMENTS (Continued)



E6406-D

The pinion depth adjusting shims are installed between the drive pinion head and rear pinion bearing, therefore, adding shims moves the drive pinion toward the ring gear, and removing shims moves the drive pinion away from the ring gear.

On Ford integral axles, drive pinion and ring gear backlash is adjusted by adding or removing shims between the differential case side bearings and carrier housing. On DANA axles, backlash is adjusted by adding or removing shims between the differential case and differential bearings.

Shim Selection

Individual differences in matching the differential housing and the (rear) pinion bearing require the use of a shim(s) to locate the pinion for correct contact with the ring gear.

Ring Gear Replacement Dana Axles

New ring gear bolts should be used to attach a new ring gear to the differential case. Grade 9 bolts with increased torque requirements are now required. Refer to Section 05-02D.

Place the new ring gear on the differential case and insert the bolts through the ring gear and into the case and tighten the ring gear bolts to specifications at the end of this section.

Axle Lubrication

The ability of any axle to deliver quiet, trouble-free operation over a period of years is largely dependent upon the use of good quality gear lubricants. To make sure gears and bearings will last as long as possible, use only specified hypoid gear lubricants.

Dana and Ford rear axles use different lubricants as follows:

- Ford requires ESP-M2C 154-A (E0AZ-19580-AA)
- Dana requires ESW-M2C 105-A (C6AZ-19580-E)

It is recommended that the lube be replaced in all rear axles at 100,000 mile intervals, or if the axle has been submerged in water, or more often under certain extreme conditions. High Performance Rear Axle Lubricant F 1TZ-19580-B is available for repairs and refills in situations that fall into the severe or extreme use categories. Refer to maintenance schedules.

Dana front drive axles have different lubrication requirements for different applications.

- F-150-250 requires WSL-M2C 191 (F 1TZ-19580-A or equivalent)
- F-350 requires ESW-M2C 105A (C6AZ-19580-E or equivalent)

Draining

Dana Axles

Dana axles do not have a drain plug. The cover should be loosened and removed from the housing to allow drainage. The RTV Sealer must be removed from the cover and axle housing. Reseal with Silicone Rubber, E7TZ-19562-A (ESL-M4G273-A) or equivalent.

NOTE: A suction pump may also be used for draining lube from the housing.

Filling

Ford Axle

The filler hole is in the carrier casting. Fill F-150 and E-150 axles 1/4 to 9/16 inch below bottom of the hole.

To check F-250-350 axles for proper lubricant level, the filler plug should be backed out slowly. If seepage occurs around the threads of the plug, immediately turn the plug back in to avoid any drainage. This condition indicates that the specified factory fill amount of lubricant is in the axle. Service fill is level with bottom of filler hole.

ADJUSTMENTS (Continued)

Dana Front and Rear Axles

The lubricant level in these axles may vary depending on internal casting variations, spring orientation, or flatness of the floor or hoist involved, as well as the amount of fill. During manufacture, axles are filled by volume, not to a specific level. Dealer inspection of rear axle lubricant level is not an authorized element of vehicle preparation. The only times a dealer should check lubricant levels are: 1) when a leak is suspected or observed, or 2) when an axle repair requires draining and refilling.

These Dana rear axles have a proper lubricant fill level of 0.01-0.03mm (0.25-0.75 inch) below the bottom of the fill hole in the rear cover. Dealers should avoid overfilling the axles above this range because overfilling can cause foaming and raise the temperature of the lubricant, leading to lubricant oxidation and eventual gear or bearing failure in extreme cases. The extra lubricant may also be expelled through the axle vent hose.

Rear Wheel Bearing and Seal Removal and Installation

Two types of rear wheel bearing assemblies are used in truck axles. Straight roller bearings are used in semi-floating axles, which are used in all light trucks under 8551 GVW. The bearing rides on the axle shaft. Opposed pairs of tapered roller bearings are used on all full-float axles, which are used on vehicles over 8550 GVW. The bearings ride on the axle housing outside the shaft. For removal and installation procedures, refer to Section 05-02D, Section 05-02F, Section 05-02G, or Section 05-02A.

Light trucks under 8551 pounds GVW have semi-floating axles which are equipped with straight roller bearings. The oil seal is outboard of the bearings. Full service procedures for these bearings and seals are provided in Section 05-02D, Section 05-02F, Section 05-02G, or Section 05-02A.

CLEANING AND INSPECTION

Inspection Before Carrier Disassembly

The differential case assembly and drive pinion should be inspected before they are removed from the carrier casting. These inspections can help find the cause of the concern and determine the correction needed.

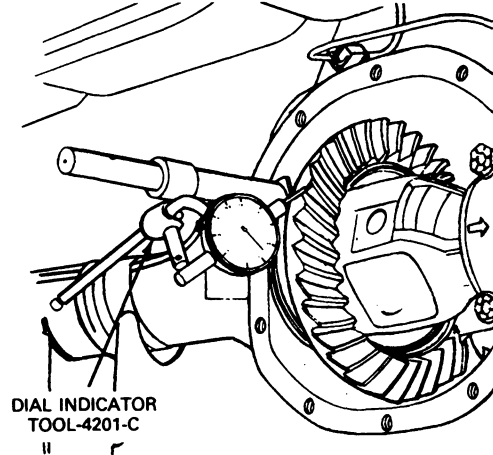
1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to see if there is any roughness which would indicate worn or damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.

4. Set up a dial indicator, and check ring gear backlash and ring gear backface runout.

NOTE: On F-Series, Econoline and Bronco vehicles equipped with Rear Anti-lock Brakes (RABS), mount Dial Indicator with Bracketry TOOL-4201-C on the carrier so the tip of the dial indicator contacts the backface of the ring gear. There is a space provided between the excitor ring and the ring gear for measuring ring gear backface runout.

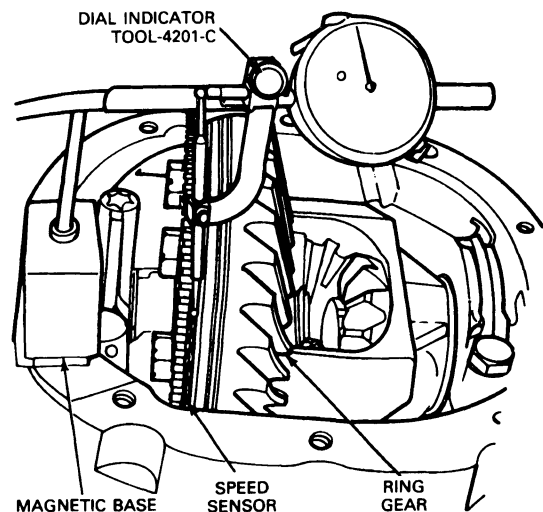
5. Proper gear set assembly must be checked using the Pinion Depth Gauge T79P-4020-A which shows correct pinion shim required to assure acceptable running condition.

CHECKING RING AND PINION GEAR BACKLASH



E4972-1C

RING GEAR BACKFACE RUNOUT
REAR ANTI-LOCK BRAKE VEHICLES



E7162-C

CLEANING AND INSPECTION (Continued)**Inspection After Carrier Disassembly****All Axles**

Thoroughly clean all parts. Pinion seal is synthetic rubber and must not be cleaned, soaked or washed in cleaning solvents. Always use clean solvent when cleaning bearings. Oil the bearings immediately after cleaning, to prevent rusting. Inspect the parts for wear or damage. If rust is present, remove with a wire brush mounted on a power drill or equivalent. Rinse clean with metal-prep solvent on sponge or rag to remove all particles. With a clean sponge, coat tube interior with Dupont 3012-5 Red Oxide Preparakote or equivalent. Allow to dry for a minimum of one hour.

When a scored gear set is replaced, the axle housing should be washed thoroughly. Inspect individual parts as outlined below.

Gears

Examine the pinion and ring gear teeth for scoring or excessive wear. Worn gears cannot be rebuilt to correct a noisy condition. Gear scoring is the result of excessive shock loading, vehicle loading, or the use of an incorrect lubricant all of which contribute to the loss of lubricating film between the two gears. Scored gears cannot be reused. Examine the teeth and thrust surfaces of the differential gears. Wear on the hub of the differential side gear can cause a chucking noise known as chuckle when the vehicle is driven at low speeds. Wear of splines, thrust surfaces, or thrust washers, can contribute to excessive driveline backlash.

Sensor

Inspect the Anti-lock Brake System sensor pole piece for loose metal particles, and clean if required. Note any indication of axle lubricant leakage through core of sensor or around perimeter. Replace as required.

Speed Sensor Ring

Examine the Anti-lock Brake System speed sensor ring to see that it is firmly pressed on to the differential case and check it for damaged (dented, chipped or missing) teeth that could result in erratic RABS performance. If damage is found, remove and replace speed sensor ring.

Bearing Cups and Cone and Roller Assemblies

Check bearing cups for rings, scores, galling, or excessive wear. Pinion bearing cups must be solidly seated in the housing bores. Check for seating by attempting to insert a 0.04mm (0.0015-inch) feeler gauge between these cups and the bottoms of their bores.

When operated in the bearing cups, cone and roller assemblies must turn without roughness. Examine the large roller ends for wear. If the original blend radius has worn to a sharp edge, the bearing should be replaced.

If inspection reveals either a worn bearing cup or a worn cone and roller assembly, both parts should be replaced to avoid damage.

Pinion Flange

Be sure that the surfaces of the pinion flange have not been damaged in removing the driveshaft or in removing the flange from the axle. The end of the pinion flange that contacts the front pinion bearing inner race or slinger washer, as well as the flat surface of the pinion nut counterbore, must be smooth. Polish these surfaces if necessary. Note also the barrel of the pinion flange (circular or half round) for any damage which could permit the pinion seal to leak. Roughness aggravates backlash noises and causes wear of the flange and pinion nut, with a resultant loss in pinion bearing preload.

Carrier Housing

Make sure that the differential bearing bores are smooth (if applicable). Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

NOTE: Care should be taken to prevent damage to the RABS speed sensor ring while handling and servicing the differential case.

Limited-Slip Differential Parts

Inspect the clutch plates for uneven or extreme wear. The dog-eared clutch plates must be free from burrs, nicks or scratches which could cause excessive or erratic wear to the internally splined clutch plates. The internally splined clutch plates should be inspected for condition of the material, and wear. Replace the plates if their thickness is less than 1.5mm (0.058-inch) or if the material is scored or badly worn. Inspect the plate internal teeth for wear. Replace them, if excessive wear is evident.

Plates should be replaced as a set only. Examine all thrust surfaces and hubs for wear. Abnormal wear on these surfaces can contribute to a noisy axle.

SPECIFICATIONS**Torque Specifications****FORD RING GEAR BOLTS**

Description	N·m	Lb·Ft
8.8 inch	95-115	70-85
10.25 inch	136-163	100-120

SPECIFICATIONS (Continued)

DANA GRADE 8 RING GEAR BOLTS

Description	N-m	Lb-Ft
Models 44 and 50	81	59
Models 60 and 70	156	115
Model 80	Not Available	Not Available

DANA GRADE 9 RING GEAR BOLTS

Description	N-m	Lb-Ft
Models 44 and 50	115	84
Models 60 and 70	156	115
Model 80	298	219

NOTE: Grade 9 screws are identified by seven radial lines on head. Grade 8 screws are no longer recommended for service.

COUPLING SHAFT ANGLES TO HORIZONTAL AT CURB LOAD EMPTY — E-350

Model	Wheelbase		Engine	Axle Ratio	Transmission	Angle
	mm	Inch				
E-350	4013	158	4.9L	4.10	C6	3-1/2°
			5.8L	3.54/4.10		
			7.3L	3.54/4.10	E40D	3-1/4°
			7.5L	3.07/3.54/4.10		
E-350	4470	176	7.3L	3.54/4.10	C6	3-1/2°
			7.5L		E40D	3-1/4°

CE5836-D

REAR AXLE PINION ANGLES TO HORIZONTAL — E-150, E-250, E-350

Model	Wheelbase		Spring Capacity at Pad		Spring Part No. (5580)	Curb Load Empty	
	mm	Inch	Lbs.	(Kg)		Ratio	Angle
E-150	3505	138	1250	566	F2UA-AB	3.55	5°
			1685	764	F2UA-CA	3.55	6°
E-250	3505	138	1825	828	F2UA-DD	3.54/3.73	5 1/2°
			2365	1072	F2UA-FD	3.07/3.54/4.10	5 1/4°
E-350	3505	138	2450	1111	F2UA-GD	3.07/3.54/4.10	6°
			2770	1256	F2UA-HD	3.07/3.54/4.10	6 1/2°
			3300	1496	F2UA-JD	3.07/3.54/4.10	5 1/2°
			3460	1569	F2UA-KD	3.07/3.54/4.10	5 1/4°
E-350	4013	158	3460	1569	F2UA-KD	3.07/3.54/4.10	5 1/4°
E-350	4470	176	3460	1569	F2UA-KD	3.54/4.10	5 1/4°

CE6462-C

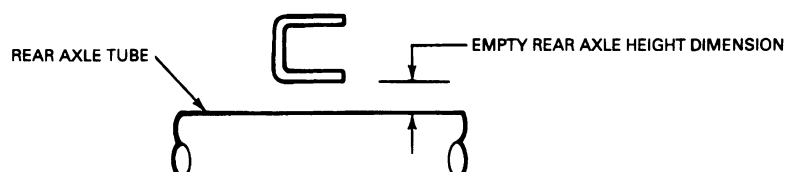
SPECIFICATIONS (Continued)

DRIVESHAFT ANGLES TO HORIZONTAL AT CURB LOAD EMPTY — E150, E250, E350

Model	Wheelbase		Engine	Rear Axle	Transmission	Spring Rating at Pad (Lbs)	Curb Load Empty Angle	Empty Rear Ride Height (Axle to Frame) ①	
	mm	Inch						Inch	mm
E-150	3505	138	4.9L	All Ford 8/8	AOD C6/E4OD	1250	4 1/2°	5.08	129
			5.0L			1685	4 3/4°	5.51	140
E250	3505	138	4.9L	5400 Dana	C6/E4OD	1830	5°	6.02	153
			5.8L			2353	5 1/4°	6.18	157
E-350	3505	138	All	6340 Dana	C6/E4OD	2452	6°	6.02	153
						2777	6 1/2°	6.57	167
						3461	6°	5.98	152
E-350	3505	138	All	7800 Dana	C6/E4OD	3461	6°	5.98	152
						3307	6 1/2°	6.57	167
E-350	4013	158	All	6340 Dana	C6/E4OD	3461	5 1/2° ②	5.98	152
E-350	4013	158	All	7800 Dana	C6/E4OD	3461	5 1/2°	5.98	152
E-350	4470	176	All	7800 Dana	C6/E4OD	3461	4° ②	5.98	152

① Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration below.

② Two-piece drivelines.



CE6461-D

ENGINE ANGLE TO HORIZONTAL

E-150 — E-250 — E-350

Model	Wheelbase	Engine	Transmission	Angle
All	All	All	All	4°

CE3923-2B

FRONT DRIVESHAFT F-150-250-350 4x4

Model	Wheelbase	Engine (L)	Transmission	Front Axle		Engine Angle (Degrees)	Front Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
				Type	GVW Capacity			
Bronco and F150 (4x4)	All	All	C6	Twin	3800#	5.5	0.03	4.39
			T-18	I-Beam		5.5	0.01	4.39
			ZF-HD	W/Coil		5.5	-0.04	4.39
			AOD	Spring		5.5	-0.14	4.39
			ZF-LD/R2			5.5	-0.46	4.39
			E4OD			5.5	-0.09	4.39
F-250 (4x4)	All	All	C6	Twin	4600#	5.5	2.79	6.73
			T-18	I-Beam		5.5	2.77	6.73
			ZF-HD	w/Leaf		5.5	2.69	6.73
			AOD	Spring		5.5	2.54	6.73
			ZF-LD/R2			5.5	2.06	6.73
			E4OD			5.6	2.45	6.73
F-350 (4x4)	All	All	All	Mono-Beam	5000#	5.5	2.50	4.50

CE8817-A

SPECIFICATIONS (Continued)

REAR DRIVELINE ANGLES, BRONCO (4x4)

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Degrees)	Coupling Shaft Angle (Degrees)	Rear Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
					Ring Gear	GVW. Capacity					
Bronco (4x4)	2660	4.9/5.0	M5OD	E3TA-AN	8.8	3800	155.65	5.5	—	11.9	10.8
	2660	4.9	M5OD-HD	E3TA-AN	8.8	3800	155.65	5.5	—	11.9	10.8
	2660	4.9/5.0/5.8	E4OD	E3TA-AN	8.8	3800	155.65	5.5	—	12.5	10.8
	2660	5.0	AOD	E3TA-AN	8.8	3800	155.65	5.5	—	11.4	10.8
	2660	5.0	C6	E3TA-AN	8.8	3800	155.65	5.5	—	11.2	10.8
	2660	4.9/5.0	T-18	E3TA-AN	8.8	3800	155.65	5.5	—	11.2	10.8

CE8818-A

REAR DRIVELINE ANGLES, F-150 (4x4)

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Degrees)	Coupling Shaft Angle (Degrees)	Rear Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
					Ring Gear	GVW. Capacity					
F-150 (4x4)	2967	4.9/5.0	M5OD	E3TA-KA	8.8	3800	186.08	5.5	—	13.3	4.9
	2967	4.9/5.0/5.8	E4OD	E3TA-KA	8.8	3800	186.08	5.5	—	13.9	4.9
	2967	4.9	M5HD	E3TA-KA	8.8	3800	186.08	5.5	—	13.6	4.9
	2967	5.0	AOD	E3TA-KA	8.8	3800	186.08	5.5	—	13.2	4.9
	2967	4.9/5.0	T-18	E4TA-EA	8.8	3800	186.08	5.5	—	13.1	4.9
	3378	4.9/5.0	M5OD	E3TA-KA	8.8	3800	186.08	5.5	—	9.3	4.9
	3378	4.9	M5HD	E3TA-KA	8.8	3800	186.08	5.5	—	9.3	4.9
	3378	5.0	AOD	E3TA-KA	8.8	3800	186.08	5.5	—	9.2	4.9
	3378	4.9/5.0	T-18	E3TA-KA	8.8	3800	186.08	5.5	—	9.2	4.9
	3378	4.9/5.0/5.8	E4OD	E3TA-KA	8.8	3800	186.08	5.5	—	9.5	4.9
	3378	4.9/5.0	M5OD	FOTA-LA	8.8	3800	181.52	5.5	—	9.1	4.9
	3378	4.9	M5HD	FOTA-LA	8.8	3800	181.52	5.5	—	9.1	4.9
	3378	5.0	AOD	FOTA-LA	8.8	3800	181.52	5.5	—	9.0	4.9
	3378	4.9/5.0	T-18	FOTA-LA	8.8	3800	181.52	5.5	—	9.0	4.9
	3378	4.9/5.0/5.8	E4OD	FOTA-LA	8.8	3800	181.52	5.5	—	9.3	4.9
	3526	4.9/5.0	M5OD	FOTA-LA	8.8	3800	181.52	5.5	—	8.2	4.9
	3526	5.0	AOD	FOTA-LA	8.8	3800	181.52	5.5	—	8.1	4.9
	3526	5.0/5.8	E4OD	FOTA-LA	8.8	3800	181.52	5.5	—	8.3	4.9
	3526	4.9/5.0	T-18	FOTA-LA	8.8	3800	181.52	5.5	—	8.1	4.9
	3937	4.9/5.0	M5OD	FOTA-LA	8.8	3800	181.52	5.5	4.7	7.9	4.9
	3937	5.0	AOD	FOTA-LA	8.8	3800	181.52	5.5	4.8	7.9	4.9
	3937	5.0/5.8	E4OD	FOTA-LA	8.8	3800	181.52	5.5	4.6	7.9	4.9
	3937	4.9/5.0	T-18	FOTA-LA	8.8	3800	181.52	5.5	4.8	7.9	4.9

CE8819-B

SPECIFICATIONS (Continued)

REAR DRIVELINE ANGLES, F-250 (4x4)

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Degrees)	Coupling Shaft Angle (Degrees)	Rear Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
					Ring Gear	GVW. Capacity					
F-250 (4x4)	3378	4.9	M5HD	E4TA-EA	10.25	5300	190.7	5.5	—	10.2	7.3
	3378	5.0	M5OD	E4TA-EA	10.25	5300	190.7	5.5	—	10.2	7.3
	3378	5.0	AOD	E4TA-EA	10.25	5300	190.7	5.5	—	10.0	7.3
	3378	5.8	E4OD	E4TA-EA	10.25	5300	190.7	5.5	—	10.5	7.3
	3378	4.9/5.0	T-18	E4TA-EA	10.25	5300	190.7	5.5	—	10.0	7.3
	3937	5.8/7.3/7.5	E4OD	E7TA-FA	10.25	6250	188.55	5.5	7.9	11.6	6.4
	3937	5.8/7.5	M5HD ①	E7TA-FA	10.25	6250	188.55	5.5	7.7	11.7	6.4
	3937	7.3	M5HD ②	E7TA-FA	10.25	6250	188.55	5.5	7.5	11.7	6.4
	3937	5.8/7.3/7.5	C6	E7TA-FA	10.25	6250	188.55	5.5	7.4	11.5	6.4
	3378	5.8/7.5	M5HD ①	E7TA-FA	10.25	6250	188.55	5.5	—	14.0	6.4
	3378	5.0/7.3/7.5	E4OD	E7TA-FA	10.25	6250	188.55	5.5	—	14.4	6.4
	3378	5.8/7.5	C6	E7TA-FA	10.25	6250	188.55	5.5	—	13.4	6.4
	3378	7.3	M5HD ②	E7TA-FA	10.25	6250	188.55	5.5	—	13.7	6.4

① Wide Ratio/Close Ratio

② Close Ratio

CE8820-B

REAR DRIVELINE ANGLES, F-350 (4x4)

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Degrees)	Coupling Shaft Angle (Degrees)	Rear Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
					Ring Gear	GVW. Capacity					
F-350 (4x4)	3378	5.8/7.3/7.5	E4OD	E4TA-SA	10.25	6250	183.92	5.5	—	11.2	5.9
	3378	5.8/7.5	C6	E4TA-SA	10.25	6250	183.92	5.5	—	10.5	5.9
	3378	5.8/7.5	M5HD ①	E4TA-SA	10.25	6250	183.92	5.5	—	10.9	5.9
	3378	7.3	M5HD ②	E4TA-SA	10.25	6250	183.92	5.5	—	10.7	5.9

① Wide Ratio/Close Ratio

② Close Ratio

CE8821-B

SPECIFICATIONS (Continued)

REAR DRIVELINE ANGLES, F-150 (4x2)

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Degrees)	Coupling Shaft Angle (Degrees)	Rear Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
					Ring Gear	GVW. Capacity					
F-150 (4x2) REG. CAB	2967	4.9/5.0	M5OD	E7TA-RA	8.8	3800	185.8	5.5	—	8.4	6.0
	2967	4.9/5.8	E4OD	E7TA-RA	8.8	3800	185.8	5.5	—	8.9	6.0
	2967	5.0	AOD	E7TA-RA	8.8	3800	185.8	5.5	—	8.4	6.0
	2967	4.9/5.0	T-18	E7TA-RA	8.8	3800	185.8	5.5	—	8.4	6.0
	3378	4.9/5.0	M5OD	E7TA-RA	8.8	3800	185.8	5.5	—	6.4	6.0
	3378	4.9/5.0	M5OD	E7TA-RA	8.8	3800	185.8	5.5	—	6.4	6.0
	3378	4.9	M5HD	E7TA-RA	8.8	3800	185.8	5.5	5.1	7.6	6.0
	3378	4.9/5.0/5.8	E4OD	E7TA-RA	8.8	3800	185.8	5.5	—	6.5	6.0
	3378	4.9/5.0	T-18	E7TA-RA	8.8	3800	185.8	5.5	—	6.4	6.0
	3378	5.0	AOD	E7TA-RA	8.8	3800	185.8	5.5	—	6.4	6.0
	3378	5.0/5.8	C6	E7TA-RA	8.8	3800	185.8	5.5	—	6.5	6.0
	3378	4.9/5.0	M5OD	E7TA-NA	8.8	3800	192.1	5.5	—	6.6	6.1
	3378	4.9/5.0	M5OD	E7TA-NA	8.8	3800	192.1	5.5	5.0	7.9	6.1
	3378	4.9	M5HD	E7TA-NA	8.8	3800	192.1	5.5	5.1	7.9	6.1
	3378	4.9/5.0/5.8	E4OD	E7TA-NA	8.8	3800	192.1	5.5	—	6.7	6.1
	3378	4.9/5.0	T-18	E7TA-NA	8.8	3800	192.1	5.5	—	6.6	6.1
	3378	5.0	AOD	E7TA-NA	8.8	3800	192.1	5.5	—	6.6	6.1
	3378	5.0/5.8	C6	E7TA-NA	8.8	3800	192.1	5.5	—	6.7	6.1
F-150 (4x2) SUPERCAB	3526	4.9/5.0	M5OD	E7TA-NA	8.8	3800	192.1	5.5	4.6	7.6	6.1
	3526	4.9/5.0/5.8	E4OD	E7TA-NA	8.8	3800	192.1	5.5	4.3	7.7	6.1
	3526	5.0	AOD	E7TA-NA	8.8	3800	192.1	5.5	4.6	7.6	6.1
	3526	4.9/5.0	T-18	E7TA-NA	8.8	3800	192.1	5.5	4.6	7.6	6.1
	3937	4.9/5.0	M5OD	E7TA-NA	8.8	3800	192.1	5.5	3.8	6.7	6.1
	3937	4.9/5.0/5.8	E4OD	E7TA-NA	8.8	3800	192.1	5.5	3.5	6.8	6.1
	3937	5.0	AOD	E7TA-NA	8.8	3800	192.1	5.5	3.8	6.7	6.1
	3937	4.9/5.0	T-18	E7TA-NA	8.8	3800	192.1	5.5	3.8	6.7	6.1

CE8822-B

REAR DRIVELINE ANGLES, F-250 (4x2)

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Degrees)	Coupling Shaft Angle (Degrees)	Rear Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
					Ring Gear	GVW. Capacity					
F-250 (4x2) REG. CAB	3378	4.9/5.0	M5OD	E4TA-EA	10.25	5300	190.64	5.5	—	7.1	7.2
	3378	4.9/5.0	M5OD	E4TA-EA	10.25	5300	190.64	5.5	5.3	8.6	7.2
	3378	4.9	M5HD ①	E4TA-EA	10.25	5300	190.64	5.5	5.4	8.6	7.2
	3378	4.9/5.8	E4OD	E4TA-EA	10.25	5300	190.64	5.5	—	7.3	7.2
	3378	5.0	AOD	E4TA-EA	10.25	5300	190.64	5.5	—	7.1	7.2
	3378	4.9/5.0	T-18	E4TA-EA	10.25	5300	190.64	5.5	—	7.1	7.2
	3378	4.9	C6	E4TA-EA	10.25	5300	190.64	5.5	—	7.2	7.2
	3378	4.9/5.8/7.5	M5HD ①	E7TA-FA	10.25	6250	199.07	5.5	5.4	10.4	6.3
F-250 HD (4x2) REG. CAB	3378	7.3	M5HD ②	E7TA-FA	10.25	6250	199.07	5.5	5.4	10.4	6.3
	3378	5.0/7.3/7.5	E4OD	E7TA-FA	10.25	6250	199.07	5.5	—	8.4	6.3
	3378	4.9/5.8	C6	E7TA-FA	10.25	6250	199.07	5.5	—	8.2	6.3
	3378	5.8/7.5	M5HD ①	E4TA-SA	10.25	6250	173.35	5.5	5.4	9.7	5.9
	3378	7.3	M5HD ②	E4TA-SA	10.25	6250	173.35	5.5	5.4	9.7	5.9
	3937	5.8/7.3/7.5	E4OD	E7TA-FA	10.25	6250	199.07	5.5	4.4	8.4	6.3
F-250 (4x2) SUPER CAB	3937	4.9/5.8	C6	E7TA-FA	10.25	6250	199.07	5.5	4.5	8.3	6.3
	3937	5.8/7.5	M5HD ①	E7TA-FA	10.25	6250	199.07	5.5	4.6	8.3	6.3
	3937	7.3	M5HD ②	E7TA-FA	10.25	6250	199.07	5.5	4.7	8.3	6.3
	3937	5.8/7.5	M5HD ①	E4TA-SA	10.25	6250	173.35	5.5	4.6	7.6	5.9
	3937	7.3	M5HD ②	E4TA-SA	10.25	6250	173.35	5.5	4.7	7.6	5.9

① Wide Ratio/Close Ratio

② Close Ratio

CE8823-B

SPECIFICATIONS (Continued)

REAR DRIVELINE ANGLES, F-350 (4x2)

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Degrees)	Coupling Shaft Angle (Degrees)	Rear Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
					Ring Gear	GVW. Capacity					
F-350 4x2 REGULAR CAB	3378	5.8/7.3/7.5	E4OD	E4TA-SA	10.25	7400	173.35	5.5	—	8.0	5.9
	3378	5.8/7.5	C6	E4TA-SA	10.25	7400	173.35	5.5	—	7.9	5.9
	3378	5.8/7.5	M5HD ①	E4TA-SA	10.25	7400	173.35	5.5	5.4	9.8	5.9
	3378	7.3	M5HD ②	E4TA-SA	10.25	7400	173.35	5.5	5.4	9.8	5.9
F-350 4x2 CREW CAB	4278	5.8/7.3/7.5	E4OD	E7TA-FA	10.25	6250	199.07	5.5	4.4	6.1	6.3
	4278	4.9/5.8	C6	E7TA-FA	10.25	6250	199.07	5.5	4.5	6.1	6.3
	4278	5.8/7.3/7.5	M5HD	E7TA-FA	10.25	6250	199.07	5.5	4.6	6.0	6.3
F-350 4x2 CHASSIS CAB	3475	4.9/5.8/7.3/7.5	M5HD ①	E7TA-YA	10.25	8250	156.74	5.5	5.2	7.7	4.6
	3475	4.9/5.8	C6	E7TA-YA	10.25	8250	156.74	5.5	5.1	7.7	4.6
	3475	5.8/7.3/7.5	E4OD	E7TA-YA	10.25	8250	156.74	5.5	5.0	7.8	4.6
	3475	7.3	M5HD ②	E7TA-YA	10.25	8250	156.74	5.5	5.3	7.7	4.6
	4085	4.9/5.0/7.3/7.5	M5HD ①	E7TA-YA	11.25	8250	156.74	5.5	4.4	5.7	4.6
	4085	4.9/5.8	C6	E7TA-YA	11.25	8250	156.74	5.5	4.1	5.8	4.6
	4085	5.8/7.3/7.5	E4OD	E7TA-YA	11.25	8250	156.74	5.5	4.0	5.8	4.6
	4085	7.3	M5HD ②	E7TA-YA	11.25	8250	156.74	5.5	4.4	5.7	4.6
F-350 4x2 SUPER CAB	3937	7.3/7.5	E4OD	E7TA-FA	10.25	7400	199.07	5.5	4.4	8.7	6.3
	3937	7.3	M5HD ②	E7TA-FA	10.25	7400	199.07	5.5	4.6	8.6	6.3
	3937	7.3/7.5	M5HD ①	E7TA-FA	10.25	7400	199.07	5.5	4.7	8.6	6.3
	3937	7.3/7.5	C6	E7TA-FA	10.25	7400	199.07	5.5	4.5	8.7	6.3

① Wide Ratio

② Close Ratio

CE8824-B

REAR DRIVELINE ANGLES, F-SUPER DUTY

Model	Wheel Base	Engine (L)	Transmission	Rear Spring	Rear Axle		Blocked Ride Height (mm)	Engine Angle (Degrees)	Coupling Shaft Angle (Degrees)	Rear Driveshaft Angle (Degrees)	Pinion Angle (Degrees)
					Ring Gear	GVW. Capacity					
F-SUPER DUTY	3475	7.3	M5HD	E7TA-YA	11.25	11000	156.74	5.5	7.0	5.9	4.6
	3475	7.3/7.5	E4OD	E7TA-YA	11.25	11000	156.74	5.5	7.5	5.8	4.6
	4085	7.3	M5HD	E7TA-YA	11.25	11000	156.74	5.5	5.4	3.8	4.6
	4085	7.3/7.5	E4OD	E7TA-YA	11.25	11000	156.74	5.5	5.4	3.8	4.6
	3475	7.5	M5HD ②	E7TA-YA	11.25	11000	156.74	5.5	7.0	5.9	4.6
	4085	7.5	M5HD ①	E7TA-YA	11.25	11000	156.74	5.5	5.4	3.8	4.6

① Wide Ratio/Close Ratio

② Close Ratio

CE8825-B

ENGINE ANGLE TO HORIZONTAL — F-SUPER DUTY MOTORHOME CHASSIS

Wheelbase		Engine	Transmission	Angle
mm	Inch			
All	All	7.5L	E4OD	5-1/2°

CE8252-B

SPECIFICATIONS (Continued)

DRIVESHAFT — TORQUE LIMITS

Description	Bolt Size	Torque Limits	
		(Ft-Lb)	N-m
Bolt Yoke to Coupling Shaft	5/8-18	148-165 ①	201-222 ①
	3/4-16	175-240	238-325
	7/8-14	250-300	339-406
	1-2	160	216
Nut — U-Joints — U-Bolt	5/16-18	8-15	11-20
	3/8-18	17-26	24-35
	7/16-20	30-40	41-54
Coupling Shaft Center Bearing Bracket-to-Support	7/16-20	37-54	51-73
Bolt — Drive Shaft U-Joint to Rear Yoke	1/2-20	90-110	123-149
Bolt and Nut — U-Joint Adapter to Rear Axle	1/2-20	60-70	82-94
Circular Flange Bolts	—	61-87	83-118
Double Cardan Driveshaft-to-Transfer Case Bolts	5/16-24	20-28	28-33
Driveshaft-to-Front and Rear Axle U-Bolt Nuts	5/16-18	8-15	11-20
Bolt — Strap ②	5/16-24	25-40	34-54

NOTES:

① Dana Axle

② F-250 H.D. and F-350 with M5HD Transmission and F-Super Duty.

CE7160-C

FRONT AND REAR AXLE LUBRICANT CAPACITIES

Axle Model	Vehicle	Approximate Capacity		
		U.S. Pints	Imperial Pints	Liters
Ford Axle — 8.8 Inch Ring Gear ③	F-150/Bronco	5.5	4.6	2.6
	E-150	5.5	4.6	2.6
Ford Axle 10.25 Inch Ring Gear ③	F-250-350 (4x2) — Dual Rear Wheels	7.5 ④	6.3	3.5
	F-250-350 (4x4)			
Dana 44 IFS — Front ①	F-150 (4x4), Bronco	3.6	3.0	1.7
Dana 44 IFS-HD — Front ①	F-250 (4x4)	3.6	3.0	1.7
Dana 50-IFS — Front ①	F-250 (4x4) HD	3.8	3.2	1.8
Dana 60 — Front	F-350 (4x4)	5.9	4.9	2.8
Dana 60-IU — Rear ②	E-250 — 350 SRW	6.25	5.2	3.0
Dana 70-2U — Rear ②	E-350 Dual Rear Wheel	6.6	5.5	3.1
Dana 70-HD — Rear ②	E-350 Dual Rear Wheel	7.4	6.1	3.5
Dana 80 — Rear	F-Super Duty Chassis Cab, Commercial Stripped Chassis and Motor Home Chassis	8.25	6.9	3.9

① Add 2 U.S. ounces of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Dana Front Drive Axle with limited slip differential.

② Add 8 U.S. ounces of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Dana rear axles with limited slip differentials.

③ Add 4 U.S. ounces of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Ford 8.8 inch limited slip rear axles.




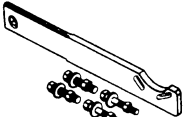
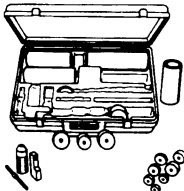

④ 7.5 pints is the factory fill. In vehicle fill is 6.5 pints. Ford 10.25 inch Axles with Limited Slip differentials.

⑤ Add 8 oz. of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Ford 10.25 inch ring gear Limited-Slip Axles.


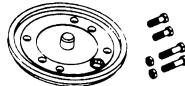



NOTE: Replace axle lube at 100,000 mile intervals. Refer to maintenance schedules.

CE5089-K

SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number/ Description	Illustration
T68P-4602-A Pinion Angle Level Gauge	 T68P-4602-A
TOOL-4201-C Dial Indicator with Bracketry	 TOOL-4201-C
T57T-4851-B Companion Flange Holding Tool	 T57T-4851-B
T78P-4851-A Companion Flange Holding Tool	 T78P-4851-A
T79P-4020-A Pinion Depth Gauge	 T79P-4020-A
T92L-4851-B Companion Flange Runout Gauge	 T92L-4851-B

(Continued)

Tool Number/ Description	Illustration
T92L-4851-C Clamp Plate	 T92L-4851-C
T92L-4851-D Companion Flange Runout Gauge	 T92L-4851-D
T92L-4851-E Gauge Pin	 T92L-4851-E
T92L-4851-F Gauge Pin	 T92L-4851-F
T92L-4851-G Gauge Pin	 T92L-4851-G

Tool Number	Description
D78P-4201-B	Dial Indicator

ROTUNDA EQUIPMENT

Tool Number	Description
006-01400	Strobe Balancer

SECTION 05-01 Driveshaft

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION	
Adjustable Driveline Support Plate	05-01-18	Driveshaft (One-Piece Models).....	05-01-7
Driveshaft Alignment	05-01-17	Driveshaft (Two- or Three-Piece), F-Super Duty	
Driveshaft Runout and Balance	05-01-17	Commercial Chassis and Motorhome	
DESCRIPTION AND OPERATION		Chassis Vehicles	05-01-8
Double Cardan-Type U-Joint Driveshaft.....	05-01-5	Driveshaft, Double Cardan-Type U-Joint.....	05-01-10
Front Axle Driveshaft	05-01-6	Driveshaft/Coupling Shaft (Two-Piece),	
Single Cardan-Type U-Joint Driveshaft.....	05-01-2	Except F-Super Duty, Commercial Chassis	
Universal Joints	05-01-3	and Motorhome Chassis	05-01-6
DIAGNOSIS AND TESTING	05-01-6	Front Driveshaft	05-01-11
DISASSEMBLY AND ASSEMBLY		SPECIAL SERVICE TOOLS	05-01-20
Double Cardan-Type U-Joints	05-01-13	SPECIFICATIONS	05-01-20
Slip Between Center Driveshaft	05-01-15	VEHICLE APPLICATION	05-01-1
Single Cardan-Type U-Joint	05-01-11		

VEHICLE APPLICATION

E-150-250-350, F-150-250-350 4x2, 4x4, F-Super
Duty Chassis Cab, Commercial and Motorhome
Chassis and Bronco Vehicles

DESCRIPTION AND OPERATION

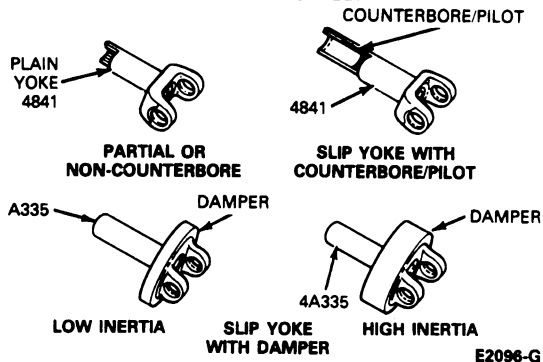
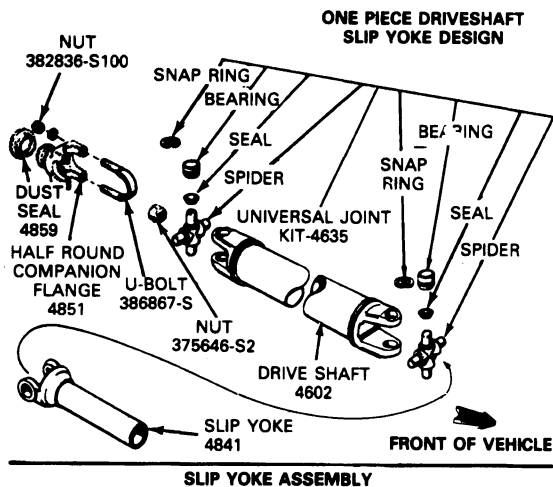
The driveshaft is a tubular shaft which is used to transfer torque from the engine, through the transmission output shaft, to the differential in the axle, which in turn transmits torque to the wheels. Driveshafts differ in length, diameter, and type of slip and axle attachment, to accommodate various wheelbase and powertrain combinations.

DESCRIPTION AND OPERATION (Continued)

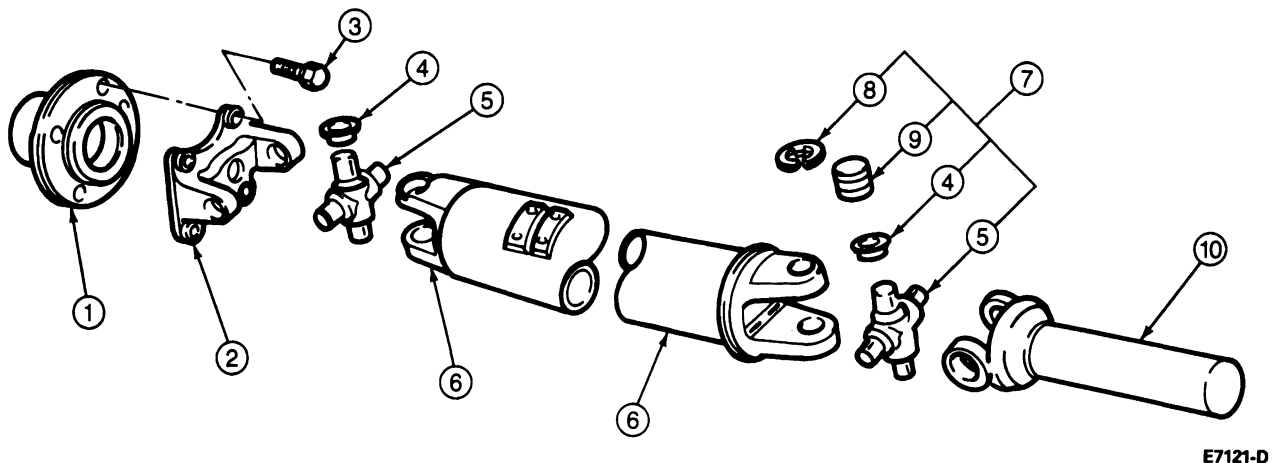
Single Cardan-Type U-Joint Driveshaft

The driveshaft or coupling shaft used on E-150-250-350, F-150-250-350, F-Super Duty Chassis Cab, Commercial Chassis, Motorhome Chassis and Bronco vehicles, is composed of the universal joints (U-joints), connecting shafts, attaching flanges, and slip-yokes. The number of shafts and U-joints used depends on the vehicle application.

Some vehicles use a one-piece slip-yoke type driveshaft. A universal joint and splined slip-yoke are located at the transmission end of the shaft, where they are held in alignment by a bushing in the transmission rear extension. The splined slip-yoke and transmission output shaft permits fore and aft movement of the driveshaft as the rear axle moves up and down. This provides smooth performance during vehicle operation. An oil seal at the transmission prevents leakage and protects the slip-yoke from dust, dirt and other harmful material. A second universal joint mates with the companion flange at the rear axle.



Driveshaft, Disassembled View



E7121-D

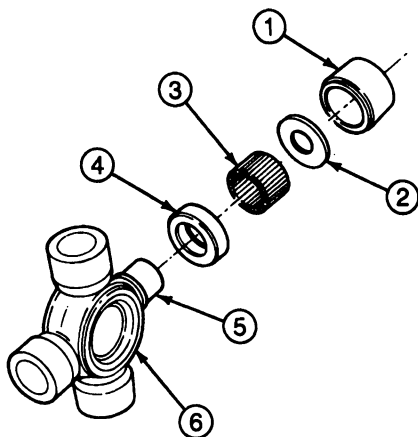
DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	4851	Axle (Circular) Companion Flange
2	4A378	Rear Flange
3	N800594-S100	Bolt
4	—	Seal

(Continued)

Item	Part Number	Description
5	—	Spider
6	4602	Driveshaft Assembly
7	4635	U-Joint Kit
8	—	Snap Ring
9	—	Bearing
10	4841	Slip-Yoke

Others use a coupling shaft in conjunction with a driveshaft. Care must be taken to align the shafts as shown in the illustrations. The two-piece driveline system incorporates a "necked down" coupling shaft stub with a blindspline feature which assures positive phasing action. The "blindspline" feature is not used on the F-Super Duty Commercial and Motorhome Chassis.



E8739-B

Item	Description
1	Bearing Cup
2	Thrust Washer (Ford Design Only)
3	Needle Rollers
4	Grease Seal
5	Trunnion

(Continued)

Item	Description
6	Spider

Two different attaching systems are incorporated to attach the driveshaft to the drive axle. Depending on application, either a driveshaft rear flange is bolted to the (circular) companion flange, or a universal joint is attached to the axle (half-round) companion flange by means of U-bolts, or bolts with straps.

Universal Joints

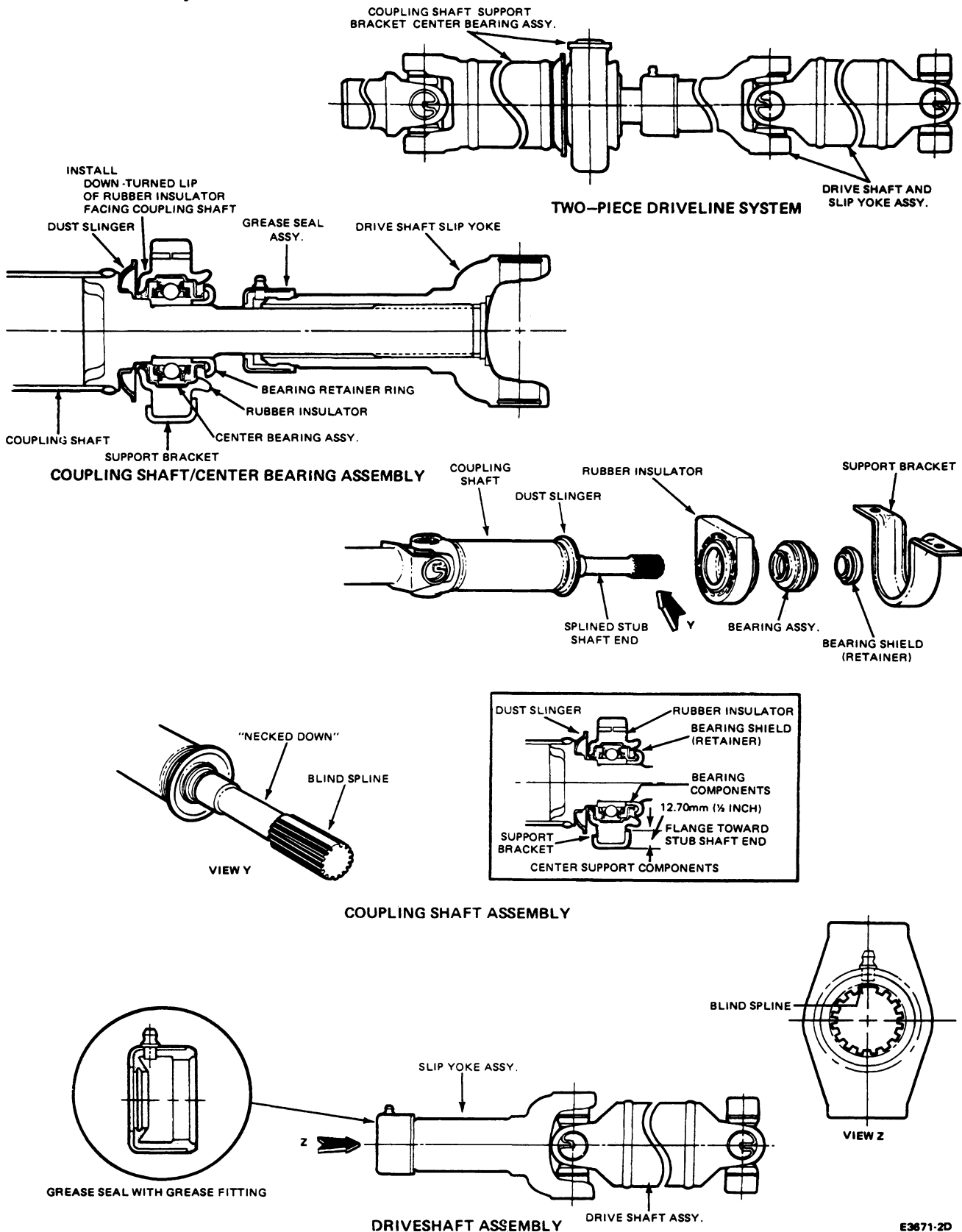
The universal joints are of a lubed-for-life design except on commercial and motorhome chassis vehicles. Two types of universal joints are used on Ford light trucks: Dana design and Ford design. The designs are similar except the Ford design universal joints are equipped with a nylon thrust washer at the base of the bearing cup. This thrust washer controls end play, positions the needle bearings and improves grease movement. Parts are not interchangeable between Dana and Ford design universal joints.

NOTE: Other type universal joints should not be used in place of the Ford design. Driveshaft imbalance and vibration may result.

CAUTION: Universal joint components from different manufacturers or new and used universal joints should never to be mixed. Universal joint kits are to be installed as complete assemblies only.

DESCRIPTION AND OPERATION (Continued)

Driveshaft Assembly

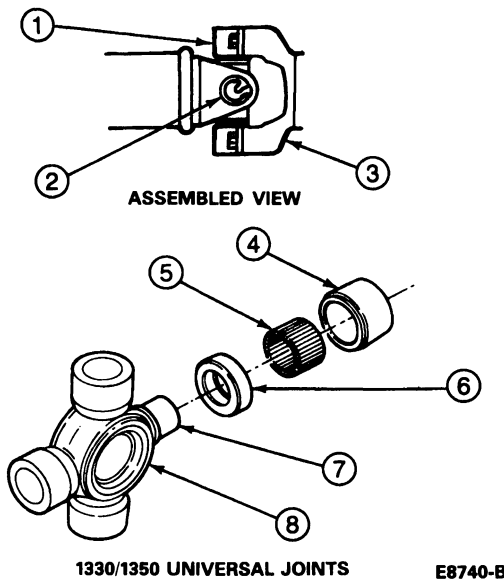


DESCRIPTION AND OPERATION (Continued)

All two- and three-piece driveshaft vehicles are equipped with center support bearings that are prelubricated and sealed for the bearing life.

U-joints equipped with grease fittings should be lubricated at the specified intervals. Driveshaft to coupling shaft slip-yokes, however, require periodic lubrication. The U-joint bearings are retained on the U-joints spiders by snap rings and U-bolts or straps on some applications.

Driveshafts and coupling shafts are balanced; therefore, if the vehicle is being undercoated, the shafts and all open spline areas must be covered to prevent undercoating material from getting on the shafts.



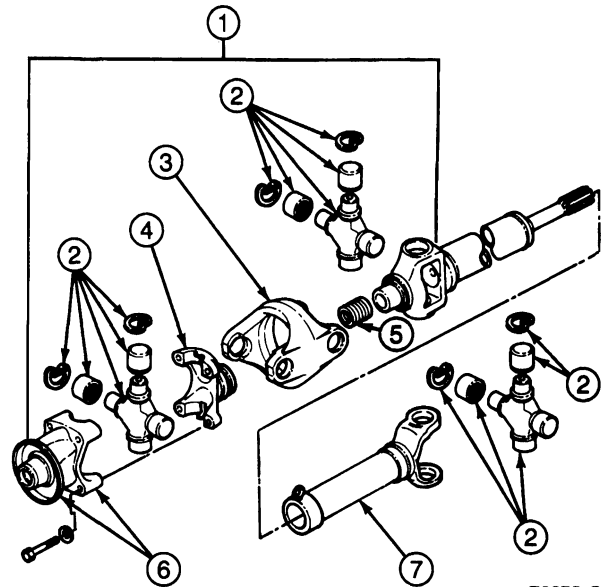
Item	Description
1	Bearing Strap Type
2	Snap Ring Type
3	Rear Driveshaft
4	Bearing Cup
5	Needle Rollers
6	Grease Seal
7	Trunnion
8	Spider

Double Cardan-Type U-Joint Driveshaft

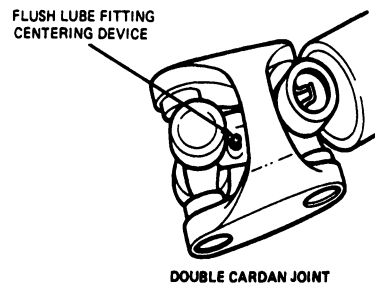
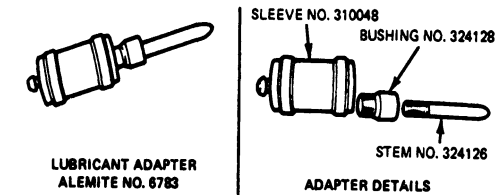
The driveshaft assembly, applicable to Bronco rear driveshaft and F-350 4x4 front driveshaft vehicles, is of the double Cardan-type which incorporates two U-joints, a centering socket yoke, and a center yoke at the transfer case end of each shaft. A single U-joint is used at the axle end of the shafts. All U-joints are lubed for life, and do not require scheduled maintenance.

NOTE: Double Cardan center yokes require lubrication.

All driveshafts are balanced. Therefore, if the vehicle is to be undercoated, cover the driveshaft to prevent undercoating material from getting on the shaft.



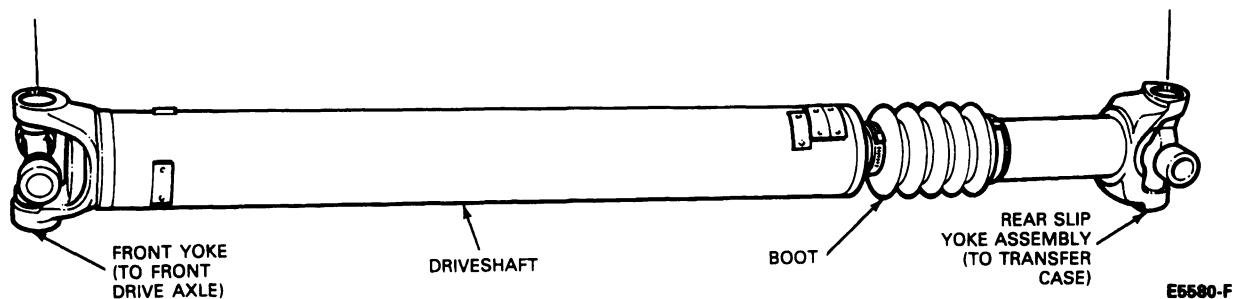
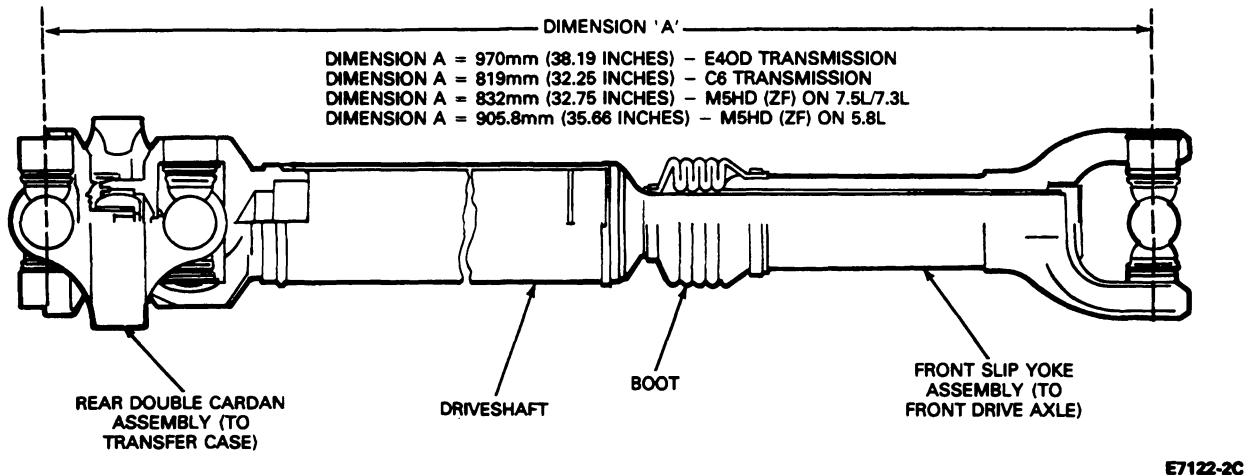
Item	Description
1	Double Cardan Assembly
2	U-Joint Assembly
3	Center Yoke
4	Socket Yoke
5	Centering Spring
6	Companion Flange
7	Slip-Yoke



DESCRIPTION AND OPERATION (Continued)**Front Axle Driveshaft**

The front axle driveshaft used on F-150-250-350 4x4 and Bronco vehicles connects the power flow from the transfer case to the front drive axle. It incorporates two single Cardan universal joint (U-joint) assemblies, one double Cardan on F-350, a driveshaft with a splined stub shaft end, and a boot with two clamps, one large and one small.

NOTE: Whenever the vehicle is raised on a hoist, inspect the rubber boot for rips or tears. Replace if required.

Front Driveshaft, F-150-250 4x4 and Bronco 4x4**Front Driveshaft, F-350 4x4****DIAGNOSIS AND TESTING**

Refer to Section 05-00 for driveshaft diagnostic and testing procedures.

REMOVAL AND INSTALLATION**Driveshaft / Coupling Shaft (Two-Piece), Except F-Super Duty, Commercial Chassis and Motorhome Chassis**

To maintain driveline balance, mark the relationship of the rear driveshaft yoke and the rear axle companion flange before disassembly.

REMOVAL AND INSTALLATION (Continued)**Removal**

1. Disconnect the driveshaft from the rear axle companion flange and disconnect the driveshaft slip-yoke from the coupling shaft yoke. Wrap tape around the loose bearing caps to prevent the bearings from falling off the universal joint spiders.
2. Remove the two center bearing support (coupling shaft)-to frame crossmember attaching bolts noting exact location of the support. Remove the coupling shaft assembly. Wrap tape around the loose bearing caps. Install the appropriate tool in the transmission housing to prevent leaking.
3. Clean the male splines of the coupling shaft and driveshaft with a wire brush and a suitable solvent. Remove all hardened grease deposits, dirt or rust. Do not remove the blue plastic coating from male splines. Inspect for worn or galled splines. Remove any nicks, gouges or burrs from the driveshaft using a file or emery cloth.
4. Using a suitable cleaning fluid, clean all dirt from the slip-yoke internal splines and the slip-yoke assembly. Carefully inspect the slip-yoke splines for wear or evidence of twisting. Check the operation of the slip-yoke.
5. Wash all parts except the sealed center bearing and rubber insulator in suitable cleaning fluid. Do not immerse the sealed bearing in the cleaning fluid. Wipe the bearing and rubber insulator clean with a cloth dampened in cleaning fluid.

NOTE: Inspect the slip-yoke seal for cuts, tears or deformation. Replace if necessary.
6. Check the center support bearing for wear or rough action by rotating the inner race while holding the outer race. If any wear or roughness is evident, replace the bearing.
7. Examine the rubber insulator for evidence of hardening, cracking, or deterioration. Replace if damaged in any way.

Installation

1. Using a brush, coat all surfaces of the coupling shaft front slip-yoke splines with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Remove the tool preventing leakage from the transmission housing (slip-yoke applications only). Install the front yoke of the coupling shaft assembly on the transmission output shaft. Do not allow the slip-yoke assembly to bottom on the output shaft with excessive force.
2. Secure the center bearing support bracket to the frame crossmember with the center support attaching bolts and spacers (if any were removed). Tighten the bolts to 40-64 N·m (30-47 ft-lb).
3. Apply a coating of Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent to entire splined stub shaft end of the coupling shaft assembly prior to the assembling of the driveshaft and the slip-yoke.

4. Using a clean long handle (stencil type) brush apply Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent, spread evenly on all the female splines of the slip-yoke.
5. Assemble the driveshaft slip-yoke to the coupling shaft.

NOTE: When installing a new service driveshaft assembly, align the factory-made yellow paint mark at the rear of the driveshaft tube with the factory-made yellow paint mark on the outside diameter of the axle companion flange. If paint marks are not visible and a vibration exists after installation, refer to Section 00-04.

6. Connect the rear U-joint of the driveshaft to the rear axle companion flange and tighten the U-bolt nuts or strap bolts to specification. Refer to Specifications at the end of this section.
7. Using a hand type grease gun, lubricate the driveshaft slip-yoke through the zerk fitting with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.

NOTE: To make sure complete lubrication of the slip-yoke splines, temporarily plug the vent hole in the "welch" type plug located at the yoke-end of the slip-yoke while applying grease through the zerk fitting.

Driveshaft (One-Piece Models)**Removal**

1. To maintain driveline balance, if the yellow alignment marks are not visible, mark the relationship of the rear driveshaft flange and the axle companion flange so they may be re-installed in their original positions.
2. Circular axle companion flange:

Remove the bolts retaining the driveshaft rear flange to the axle companion flange and disconnect the driveshaft from the axle. Lower the driveshaft and slide the driveshaft rearward off the transmission output shaft. Install an appropriate plug in the transmission extension housing to prevent fluid loss.

Half-round axle companion flange:

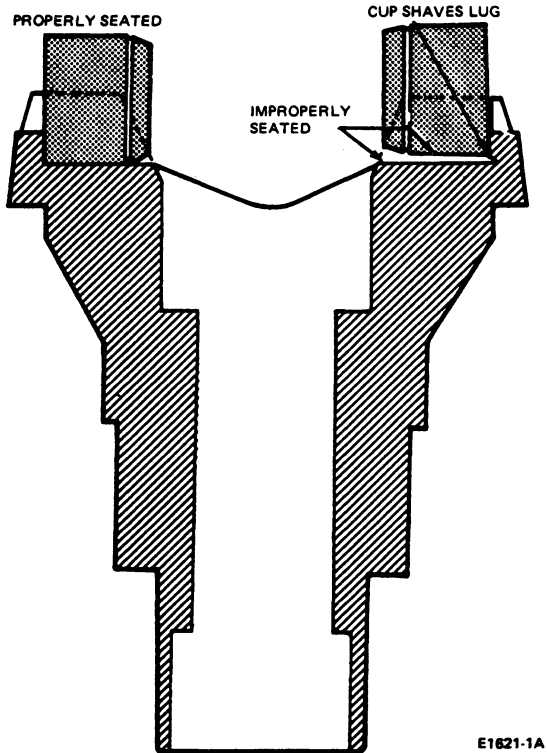
Remove the nuts retaining the U-bolts to the axle companion flange or bolts and straps. Disconnect the U-joint from the axle companion flange, being careful not to drop the U-joint bearing cups. Wrap tape around the U-joint to retain the bearing cups. Slide the driveshaft rearward off the transmission output shaft. Install an appropriate plug in the transmission extension housing to prevent fluid loss.

NOTE: On four-wheel drive vehicles equipped with a slip between center driveshafts, disconnect the driveshaft at the transfer case during removal.

REMOVAL AND INSTALLATION (Continued)

Installation

1. If the lugs on the half-round axle companion flange are shaved or distorted so the bearings slide, replace the flange.



2. Lubricate the slip-yoke spline with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Remove the tool from the extension housing. Install the slip-yoke on the transmission output shaft. Do not allow the yoke assembly to bottom on the output shaft with excessive force.

Install the driveshaft so that the index marks made before removal are aligned or the yellow mark (if visible) on the driveshaft tube (light side) is in line with the yellow mark on the companion flange. This prevents vibration which occurs when the balance of the shaft and runout of the axle pinion flange become additive instead of neutralizing. If a vibration exists, the driveshaft should be disconnected from the axle, rotated 180 degrees and re-installed.

NOTE: When installing a new driveshaft assembly, align the factory-made yellow paint mark at the rear of the driveshaft tube with the factory-made yellow paint mark on the outside diameter of the axle companion flange. If paint marks are not visible and vibration exists after installation, refer to Driveshaft Indexing in Section 05-00.

3. On half-round axle companion flange applications, install the U-bolts and nuts that attach the U-joint to the companion flange. If equipped with straps and bolts, install and tighten bolts to specifications. Refer to Specifications at the end of this section. On circular axle companion flange applications, install the bolts retaining the axle flange yoke to the circular companion flange. Tighten to 95-129 N·m (70-95 ft-lb).

Driveshaft (Two- or Three-Piece), F-Super Duty Commercial Chassis and Motorhome Chassis Vehicles

Removal

1. Disconnect the driveshaft from the yoke at the rear axle.
2. Slide the driveshaft off the coupling shaft splines.
3. Working from the center support nearest to the rear of the vehicle, remove the two attaching bolts and support the bearing.
4. Remove the forward joint from its mating yoke.
5. Repeat Steps 3 and 4 until last shaft has been removed.
6. Thoroughly clean old grease and dirt from the driveshaft splines and then check the splines for wear, warpage and cracks. If the shaft is worn, warped, or cracked, replace it.

Using a suitable cleaning fluid, clean all dirt from the slip-yoke, slip-yoke splines, and shaft splines.

Do not clean the plastic coating on the male splines with a wire brush. Do not remove the plastic coating from the male splines.

Carefully inspect the slip-yoke splines for wear or evidence of twisting. Check the clearance between the slip-yoke splines and the shaft splines.

Wash all parts except the sealed ball bearing and rubber cushion in suitable cleaning fluid. **Do not immerse the sealed bearing in cleaning fluid.** Wipe the bearing and cushion clean with a cloth dampened with cleaning fluid.

Check the bearing for wear or rough action by rotating the inner race while holding the outer race. If wear or roughness is evident, replace the bearing.

Examine the rubber cushion for evidence of hardening, cracking, or deterioration. Replace it if it is damaged in any way.

Grease retainers and slingers are serviced only as part of the bearing assembly.

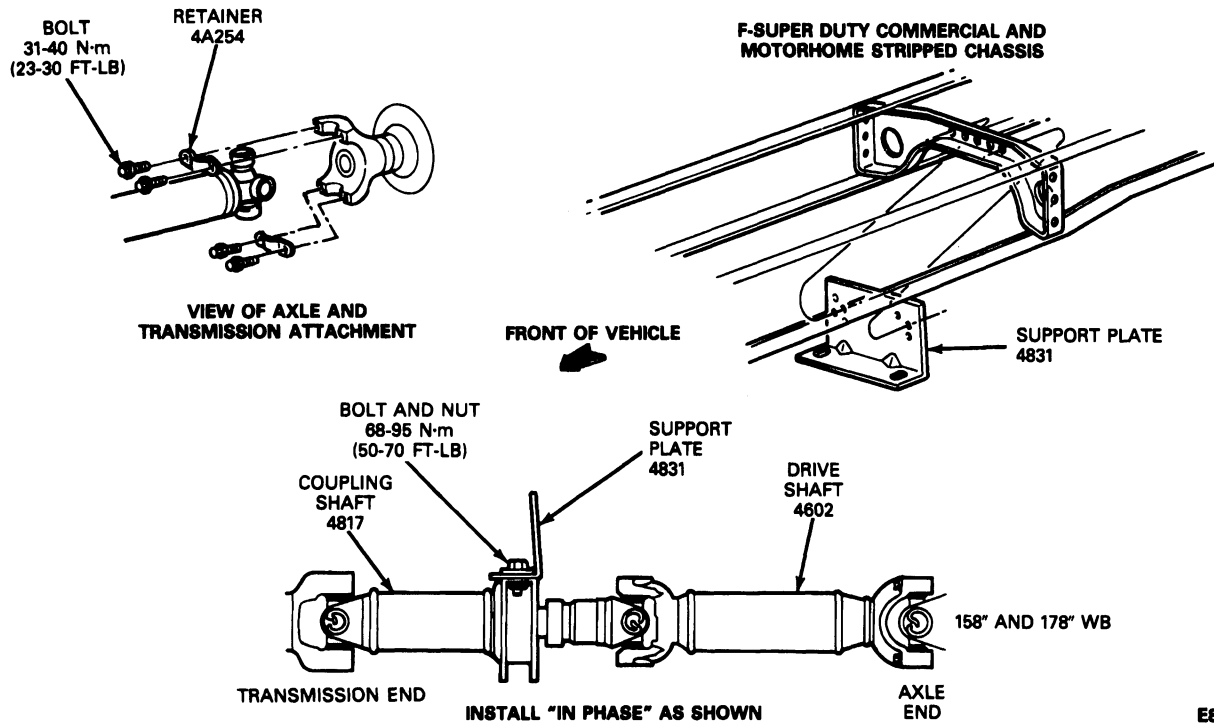
Installation

1. Connect the front joint of the coupling shaft to the yoke on the transmission. Tighten the bolts to specification found at the end of this section.

REMOVAL AND INSTALLATION (Continued)

2. Secure the center to the frame bracket with the center support and attaching bolts. Tighten the bolts to 40-64 N·m (30-47 ft-lb). Make sure that the center bearing is not twisted in the support plate.
3. If working on a vehicle with more than one coupling shaft, connect the rear shaft to the forward one, then install the remaining center support. All splines should be lubricated with High Temperature Grease E43Z-19590-A (ESP-M1C207-A) or equivalent.
4. Connect the rear U-joints to the rear axle flange and tighten the bolts to specification found at the end of this section. Make sure all driveshaft and coupling shaft yokes are properly in phase.

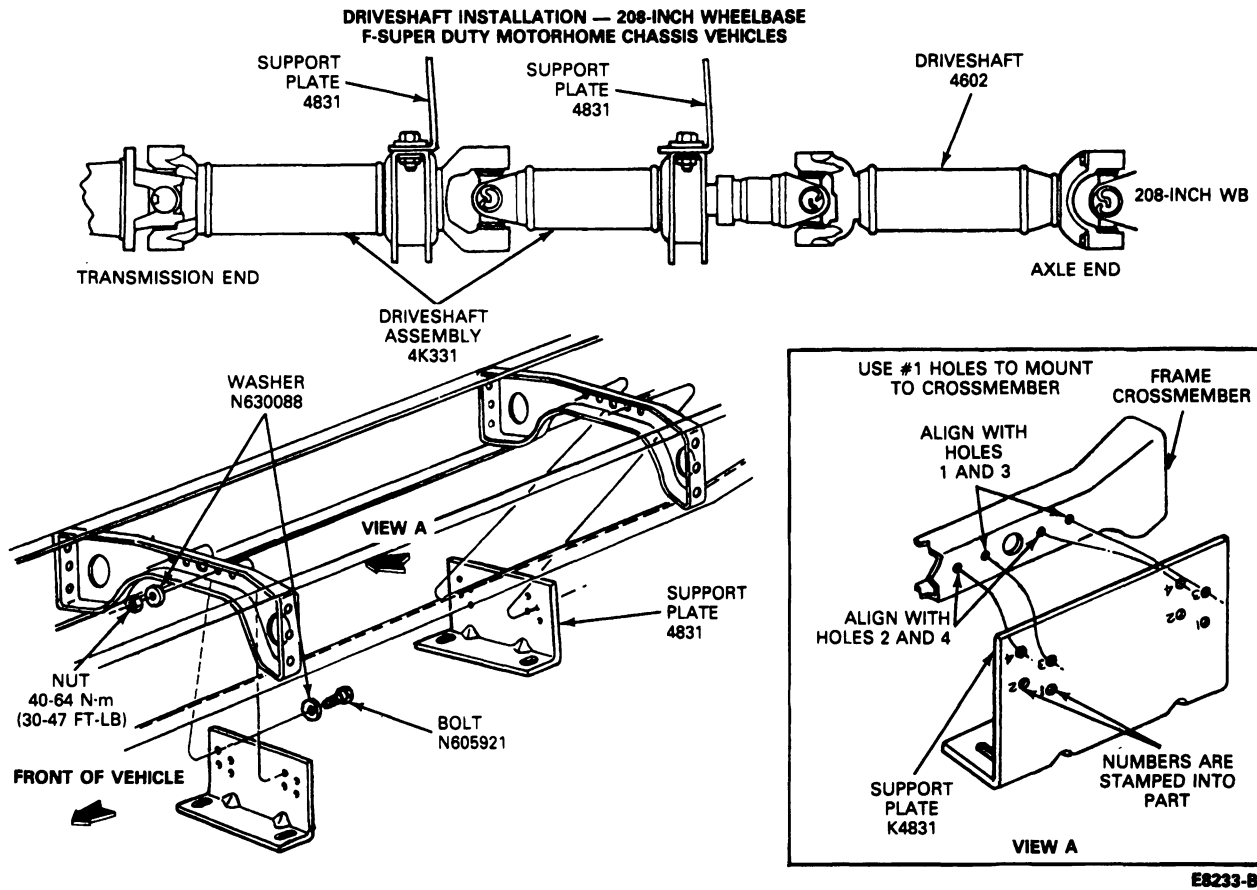
Driveshaft Installation, Two-Piece



E8061-D

REMOVAL AND INSTALLATION (Continued)

Driveshaft Installation, Three-Piece



Driveshaft, Double Cardan-Type U-Joint

Removal

1. To remove the rear driveshaft on Bronco, index mark the driveshaft in relation to the transfer case and rear axle companion flange. Disconnect the double Cardan U-joint from the flange at the transfer case and the single U-joint from the flange at the rear axle. Tape loose bearing caps and remove the driveshaft.
2. To remove the front driveshaft on F-350, index mark the driveshaft in relation to the transfer case and front axle companion flange. Disconnect the double Cardan joint from the flange at the transfer case and the single U-joint from the flange at the front axle. Remove the driveshaft.

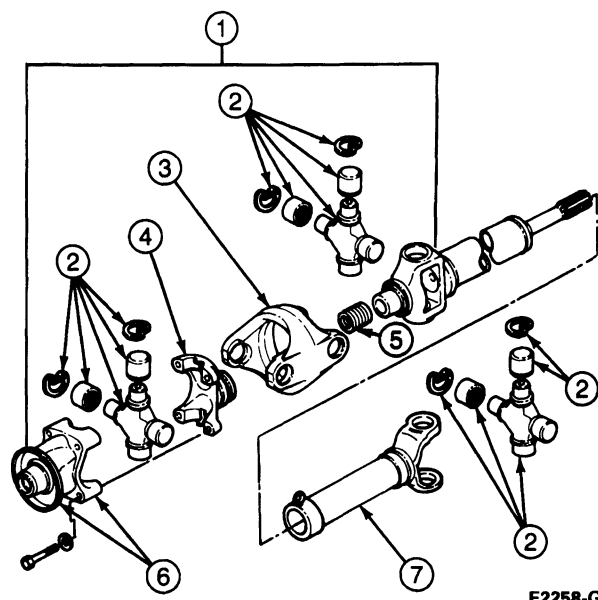
Installation

1. To install the front driveshaft on F-350, align index marks and position the single U-joint end of the driveshaft to the front axle and install the U-bolts and nuts.
2. Position the U-joint to the transfer case with index marks aligned and install the four bolts and lockwashers.
3. Tighten the bolts at the transfer case to 28-33 N·m (20-25 ft-lb), and the nuts at the front axle to 11-20 N·m (8-15 ft-lb).
4. To install the rear driveshaft on Bronco, position the single U-joint end of the driveshaft to the rear axle with index marks aligned and install the U-bolts and nuts.

NOTE: When installing a new rear driveshaft assembly, align the factory-made yellow paint mark at the rear of the driveshaft tube with the factory-made yellow paint mark on the outside diameter of the axle companion flange. If the paint marks are not visible, and a vibration is present after driveshaft installation refer to driveshaft indexing in Section 05-00.

5. Position the double Cardan joint to the transfer case with index marks aligned and install the four bolts and lockwashers.
6. Tighten the bolts at the transfer case to 28-33 N·m (20-25 ft-lb) and the nuts at the rear axle to 11-20 N·m (8-15 ft-lb).

REMOVAL AND INSTALLATION (Continued)



E2258-G

Item	Description
1	Double Cardan Assembly
2	U-Joint Assembly
3	Center Yoke
4	Socket Yoke
5	Centering Spring
6	Companion Flange
7	Slip-Yoke

Front Driveshaft

Removal

1. To maintain driveshaft balance, mark the rear slip-yoke in relation to the transfer case yoke for correct positioning during installation.
2. Remove the nuts and U-bolts (bolts for F-350 at transfer case) that connect the rear slip-yoke to the transfer case and the front yoke to the front drive axle.
3. Remove the driveshaft from the vehicle. Wrap tape around the loose bearing caps to prevent the bearings from falling out of the U-joint spiders.

Installation

NOTE: If the slip-yoke and rubber boot have been separated from the splined stub shaft on the driveshaft, refer to Front Driveshaft, Disassembly and Assembly in this section.

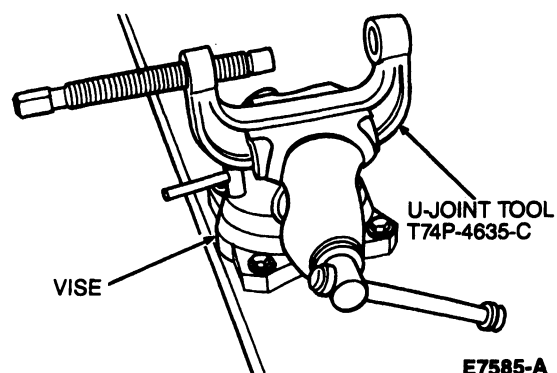
1. Install the driveshaft so the marks on the slip-yoke and transfer case yoke are in alignment.
2. Install the nuts and U-bolts that retain the slip-yoke to the transfer case yoke. Tighten nuts to 11-20 N·m (8-15 ft-lb). On F-350 tighten bolts to 28-33 N·m (20-28 ft-lb).
3. Install the nuts and U-bolts that retain the front driveshaft yoke to the front drive axle yoke. Tighten nuts to 11-20 N·m (8-15 ft-lb).

DISASSEMBLY AND ASSEMBLY

Single Cardan-Type U-Joint

Disassembly

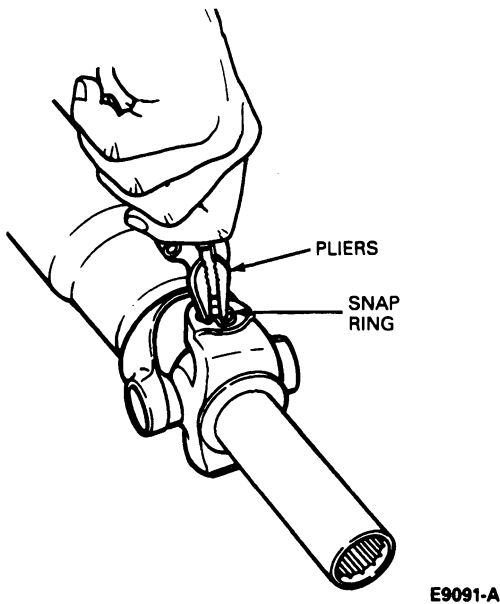
1. Place the driveshaft on a suitable workbench, being careful not to damage the tube.
CAUTION: Under no circumstances is the driveshaft assembly to be clamped in the jaws of a vice or similar holding fixture. Denting or localized fracture of the tube may result, which may cause driveshaft failure during vehicle operation.
2. Prior to disassembly, mark the positions of the driveshaft components relative to the driveshaft tube. All components must be reassembled in the same relationship to maintain proper balance.
NOTE: If components are not marked and therefore installed incorrectly, driveline imbalance may occur.
3. Clamp U-Joint Tool T74P-4635-C in vise.



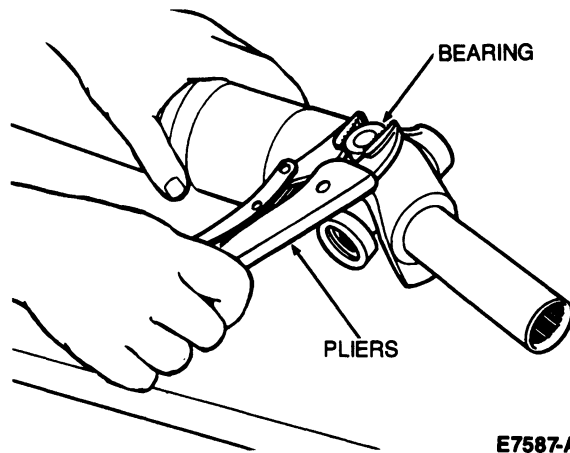
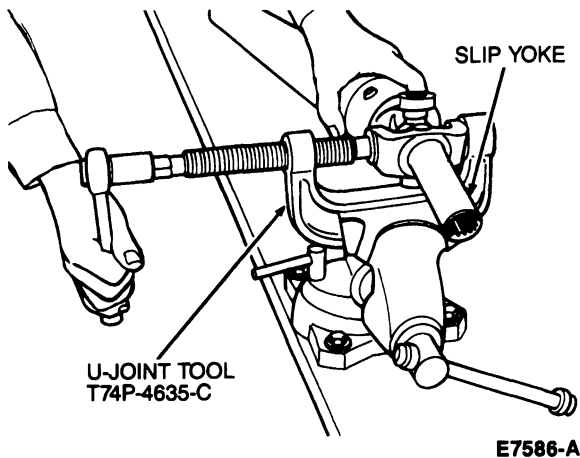
E7585-A

DISASSEMBLY AND ASSEMBLY (Continued)

4. Remove the snap rings that retain the bearing cups.



5. Position the slip-yoke in U-Joint Tool T74P-4635-C and press out bearing. If bearing cup cannot be pressed all the way out of the slip-yoke, remove it with vise grip or channel lock pliers.

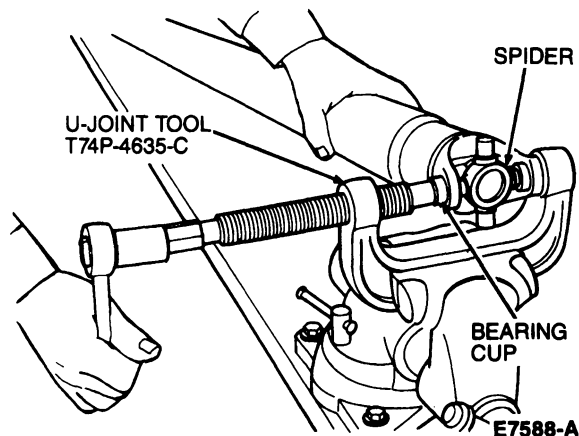


6. Reposition the slip-yoke in U-Joint Tool T74P-4635-C 180 degrees to press on the spider and remove the remaining bearing cup from the opposite side.
7. Remove slip-yoke from the spider.
8. Remove the remaining bearing cups, spiders and rear flange (if equipped) from the driveshaft in the same manner.
9. Clean all foreign matter from the yoke area at each end of the driveshaft.

Assembly

NOTE: Universal Joint Service Kits are to be installed as complete assemblies only. Do not mix components from other universal joints.

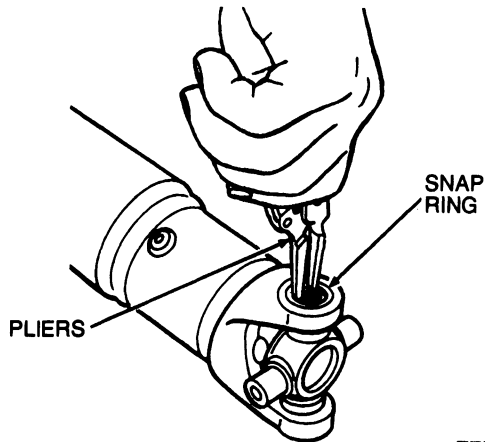
1. Start a new bearing cup into the yoke of the driveshaft.
2. Position the new spider in the driveshaft yoke and press the bearing cup 6.3mm (1/4 inch) below the yoke surface using U-Joint Tool T74P-4635-C.



3. Remove driveshaft from U-Joint Tool T74P-4635-C and install a new snap ring.
4. Start a new bearing cup into the opposite side of the yoke. Check needles for proper position.

DISASSEMBLY AND ASSEMBLY (Continued)

5. Position driveshaft in U-Joint Tool T74P-4635-C and press on the bearing cup until the opposite bearing cup contacts the snap ring.
6. Remove the driveshaft from tool and install a new snap ring. Check snap ring for proper seating.

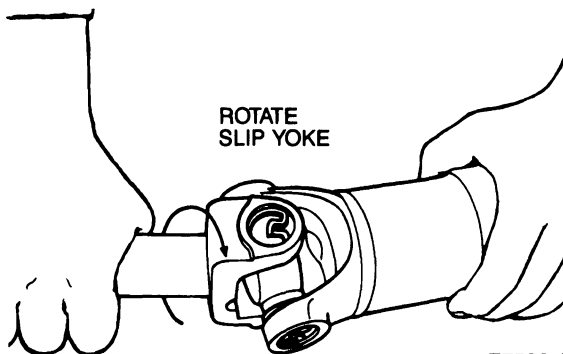


E7589-A

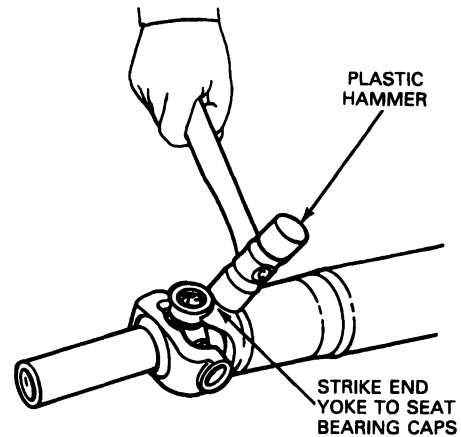
7. Install the remaining new bearing cups, spider, slip-yoke, rear flange (if equipped) and snap rings in the same manner.

NOTE: Assemble universal joint using the yellow snap rings supplied in the kit. If difficulty is encountered with yellow snap rings, install the black snap rings supplied in the kit.

8. Check U-joints for freedom of movement. If binding has resulted from misalignment during assembly, a sharp rap on the yokes with a brass or plastic hammer will seat bearing needles. Take care to support the shaft end and **do not strike the bearings during this procedure**. Make sure U-joints are free to rotate easily without binding before installing driveshaft.



E7590-A



E9104-A

9. Lubricate the universal joint assemblies (if equipped with grease fittings) with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent grease.

NOTE: The effort required for U-joint movement should not exceed 4 N·m (35 in-lb) when measured with a spring scale.

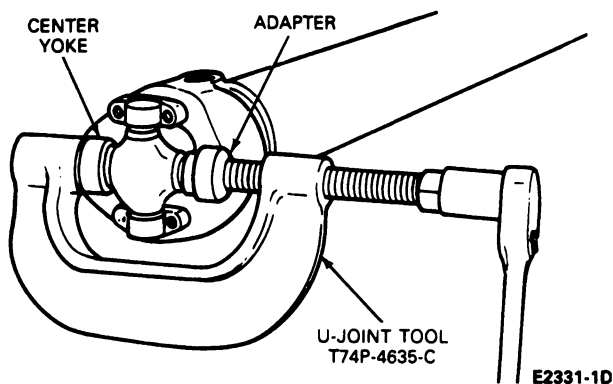
Double Cardan-Type U-Joints

Disassembly

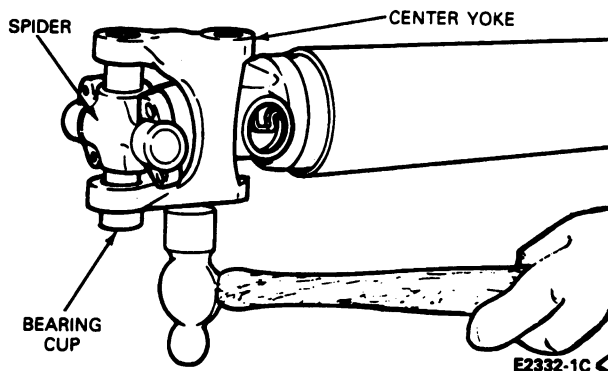
1. Place the driveshaft on a suitable workbench being careful not to damage the tube.
CAUTION: Under no circumstances is the driveshaft assembly to be clamped in the jaws of a vice or similar holding fixture. Denting or localized fracture of the tube may result, which may cause driveshaft failure during vehicle operation.
2. Mark the positions of the spiders, the center yoke, and the centering socket yoke as related to the stud yoke which is welded to the front of the driveshaft tube.
3. Remove the snap rings that secure the bearings in the front of the center yoke.

DISASSEMBLY AND ASSEMBLY (Continued)

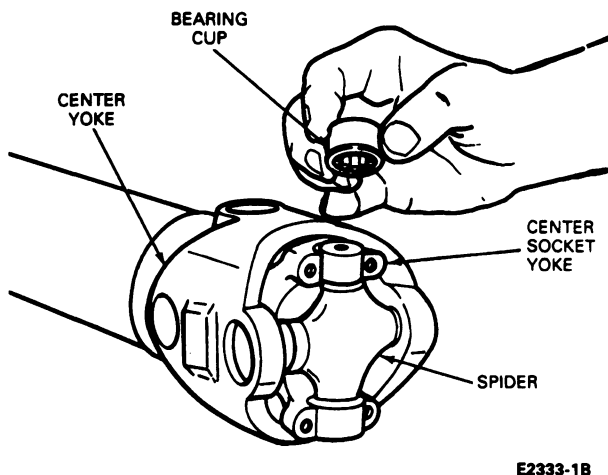
4. Position the U-Joint Tool T74P-4635-C as shown. Tighten the tool clockwise until the bearing protrudes approximately 9.525mm (3/8 inch) out of the yoke.



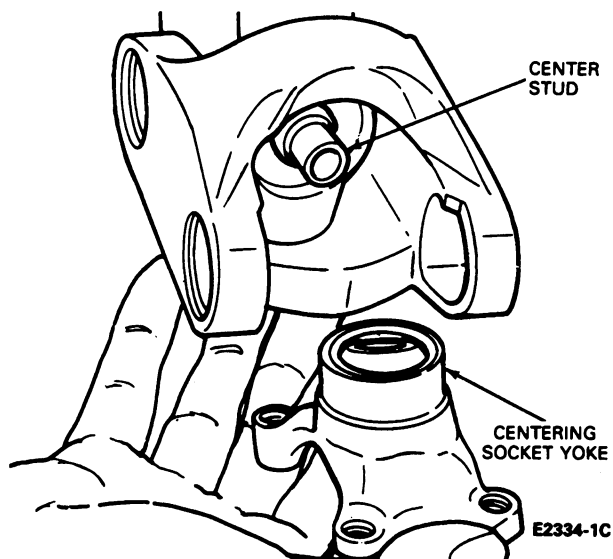
5. Clamp the bearing in a vise and tap on the center yoke to free it from the bearing.



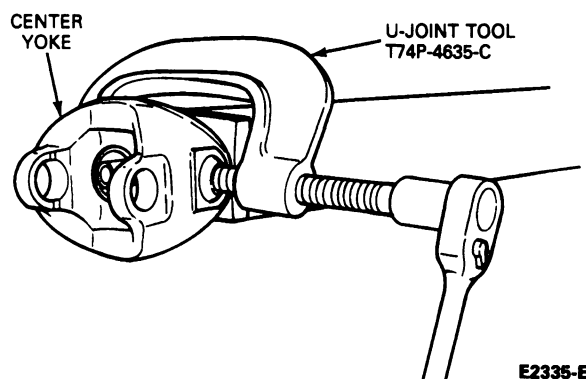
6. Lift the two bearing cups from the spider.



7. Re-position the tool on the yoke and move the remaining bearing in the opposite direction so that it protrudes approximately 9.525mm (3/8 inch) out of the yoke.
8. Clamp the bearing in a vise. Tap on the center yoke to free it from the bearing.
9. Remove the spider from the center yoke.
10. Pull the centering socket yoke off the center stud. Remove the rubber seal from the centering ball stud.

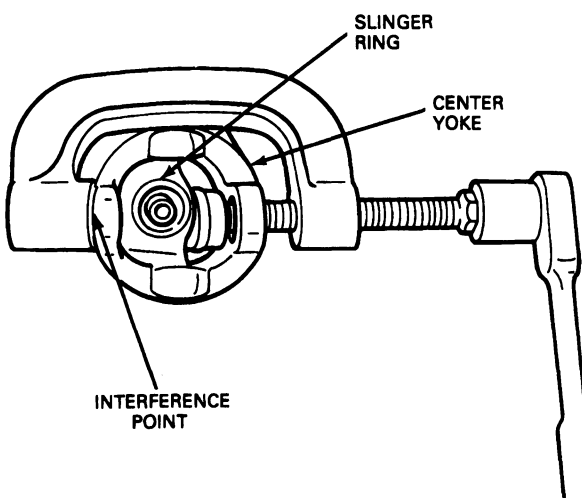


11. Remove the snap rings from the center yoke and from the driveshaft yoke.
12. Position the U-Joint Tool T74P-4635-C on the driveshaft yoke and press the bearing outward until the inside of the center yoke almost contacts the slinger ring at the front of the driveshaft yoke.



DISASSEMBLY AND ASSEMBLY (Continued)

Pressing beyond this point can distort the slinger ring. The arrow illustrates the interference point.



13. Clamp the exposed end of the bearing in a vise and drive on the center yoke with a soft-faced hammer to free it from the bearing.
14. Re-position the tool and press on the spider to remove the opposite bearing.
15. Remove the center yoke from the spider.
16. Remove the spider from the driveshaft yoke in the same manner.

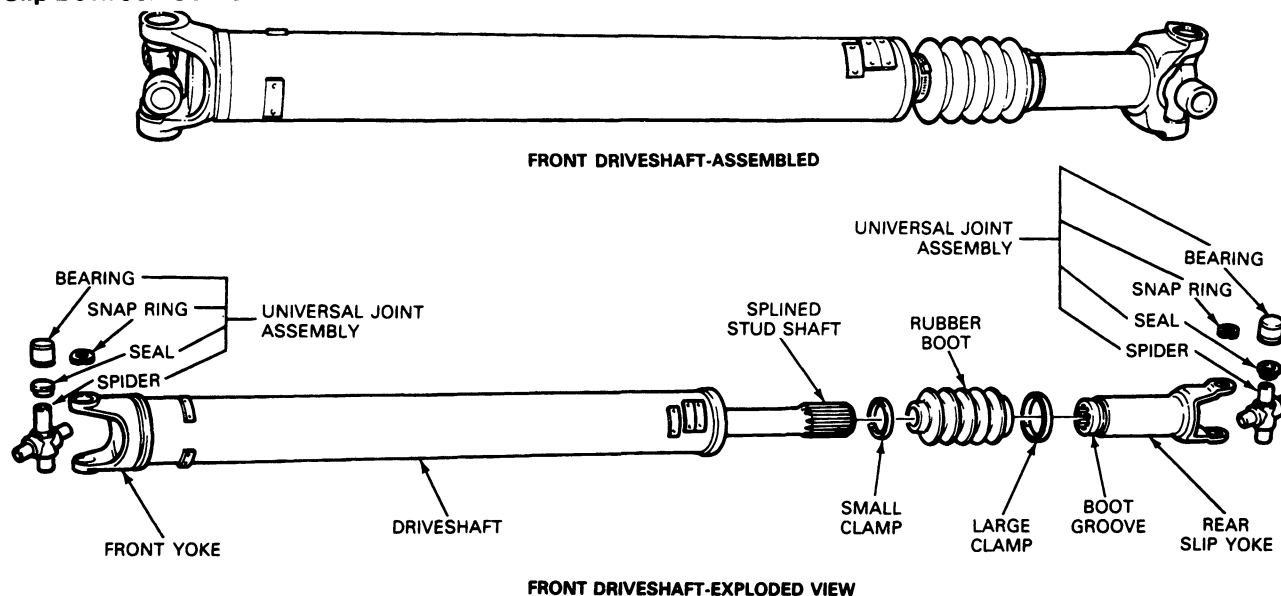
17. Clean all serviceable parts in cleaning solvent. If using a repair kit, install all of the parts supplied in the kit. If the driveshaft is damaged, replace the complete shaft to be assured of a balanced assembly.

Assembly

NOTE: Universal joints are to be installed as complete assemblies only. Do not mix any components from other universal joints.

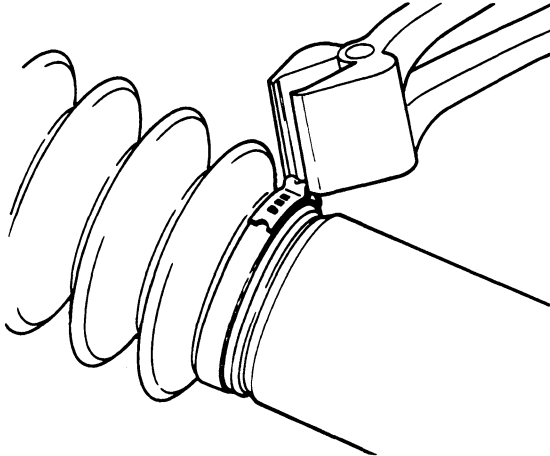
1. To assemble the double Cardan joints, position the spider in the driveshaft yoke. Make sure the spider bosses (or lubrication plugs on kits) will be in the same position as originally installed. Press in the bearing using U-Joint Tool T74P-4635-C. Install the snap rings.
2. Pack the socket relief and the ball with the Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent, then position the center yoke over the spider ends and press in the bearing. Install the snap rings.
3. Install a new seal on the centering ball stud. Position the centering socket yoke on the stud.
4. Place the front spider in the center yoke. Make sure the spider bosses are properly positioned.
5. With the spider loosely positioned on center stop, proceed to seat the first pair of bearings into the centering socket yoke, then press the second pair into the centering yoke. Install the snap rings.
6. Apply pressure on the centering socket yoke and install the remaining bearing cup.
7. Lubricate the universal joint assemblies (if equipped with grease fittings) with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent grease.

Slip Between Center Driveshaft



DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

1. With the front driveshaft assembly on a bench, cut the boot clamps with sidecutters. Remove and discard the clamps.

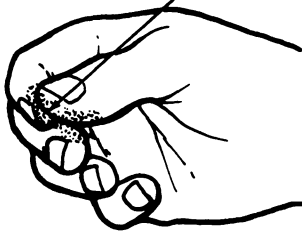


E5582-1A

2. Separate the slip-yoke from the splined stub shaft on the driveshaft.
3. Remove the rubber boot. Inspect the boot for rips or tears and replace if required.

If during inspection, the driveshaft boot is found to be cracked or split, the grease should be checked for contamination. If driveshaft was operating satisfactorily and the grease does not appear to be contaminated, add grease as described in the assembly portion of this procedure and replace the boot. If the grease appears contaminated, disassemble the driveshaft and inspect the stub shaft and slip-yoke for wear.

CHECK THE LUBRICANT FOR CONTAMINATION BY RUBBING BETWEEN TWO FINGERS. ANY GRITTY FEELING INDICATES A CONTAMINATED SLIP YOKE AND STUB SHAFT.

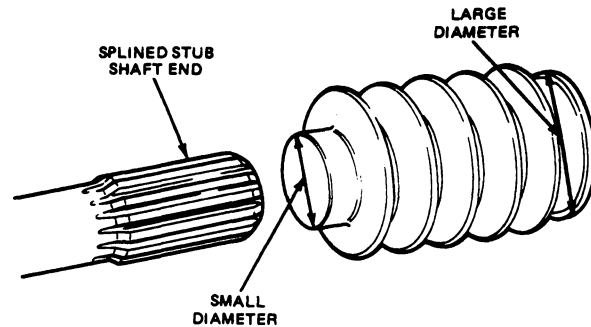


E5583-1A

4. If required, remove and install the U-joints as described in this section.

Assembly

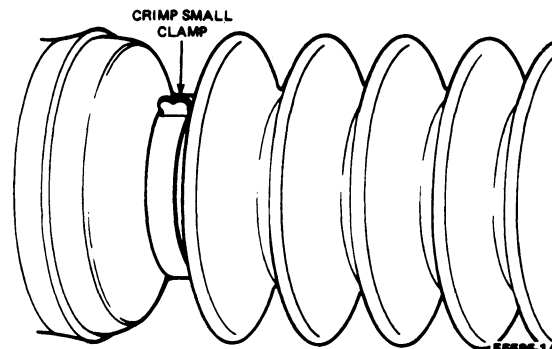
1. Install the rubber boot with the small diameter side facing the splined stub shaft on the stub shaft. Push the boot as far as it will travel on the stub shaft.



E5584-1A

2. Install a new small clamp and crimp the clamp using Clamp Pliers T63P-9171-A.

NOTE: Use ORIGINAL EQUIPMENT CLAMPS when installing boots. Use of other clamps may cause the driveshaft to become out of balance.

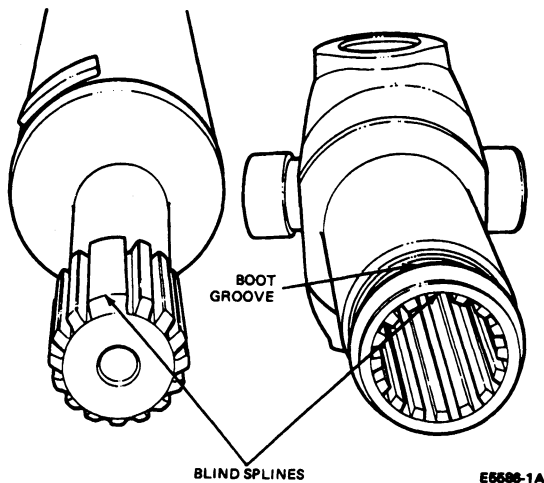


E5585-1A

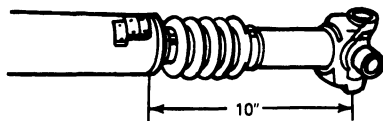
3. Pull the boot towards the driveshaft and coat the stub shaft splines with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.
4. Fill the boot with approximately 10 grams of Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.
5. Slide the large clamp onto the barrel of the slip-yoke.

DISASSEMBLY AND ASSEMBLY (Continued)

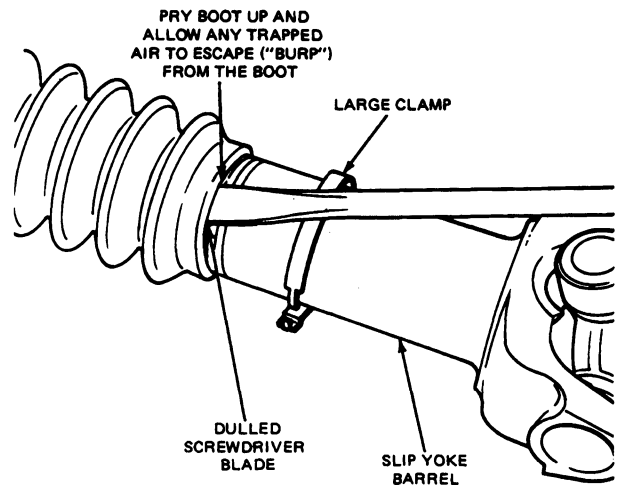
6. Align the blind splines on the splined stub shaft and in the slip-yoke. Push the slip-yoke onto the stub shaft.



7. Remove all excess grease from the boot and slip-yoke surfaces. Position the boot over the slip-yoke boot groove.
8. Move the slip-yoke in or out in order to obtain the distance of 10 inches between stud shaft weld to the centerline of the slip-yoke U-joint.



9. Before installing the new large clamp, make sure that any air pressure which may have built up in the boot is relieved. Insert a dulled screwdriver between the boot and the slip-yoke and allow the trapped air to escape ("burp") from the boot. **THE AIR MUST BE RELEASED ONLY AFTER THE DRIVESHAFT IS SET AT THE SPECIFIED LENGTH.**



10. Position the new large clamp over the boot and groove in the slip-yoke. Crimp the clamp with Clamp Pliers T63P-917 1-A.

ADJUSTMENTS

For adjustment procedures, refer to Section 05-00.

Driveshaft Runout and Balance

Refer to Section 05-00.

Driveshaft Alignment

Before adjusting components for correct driveshaft alignment, be sure to check the following.

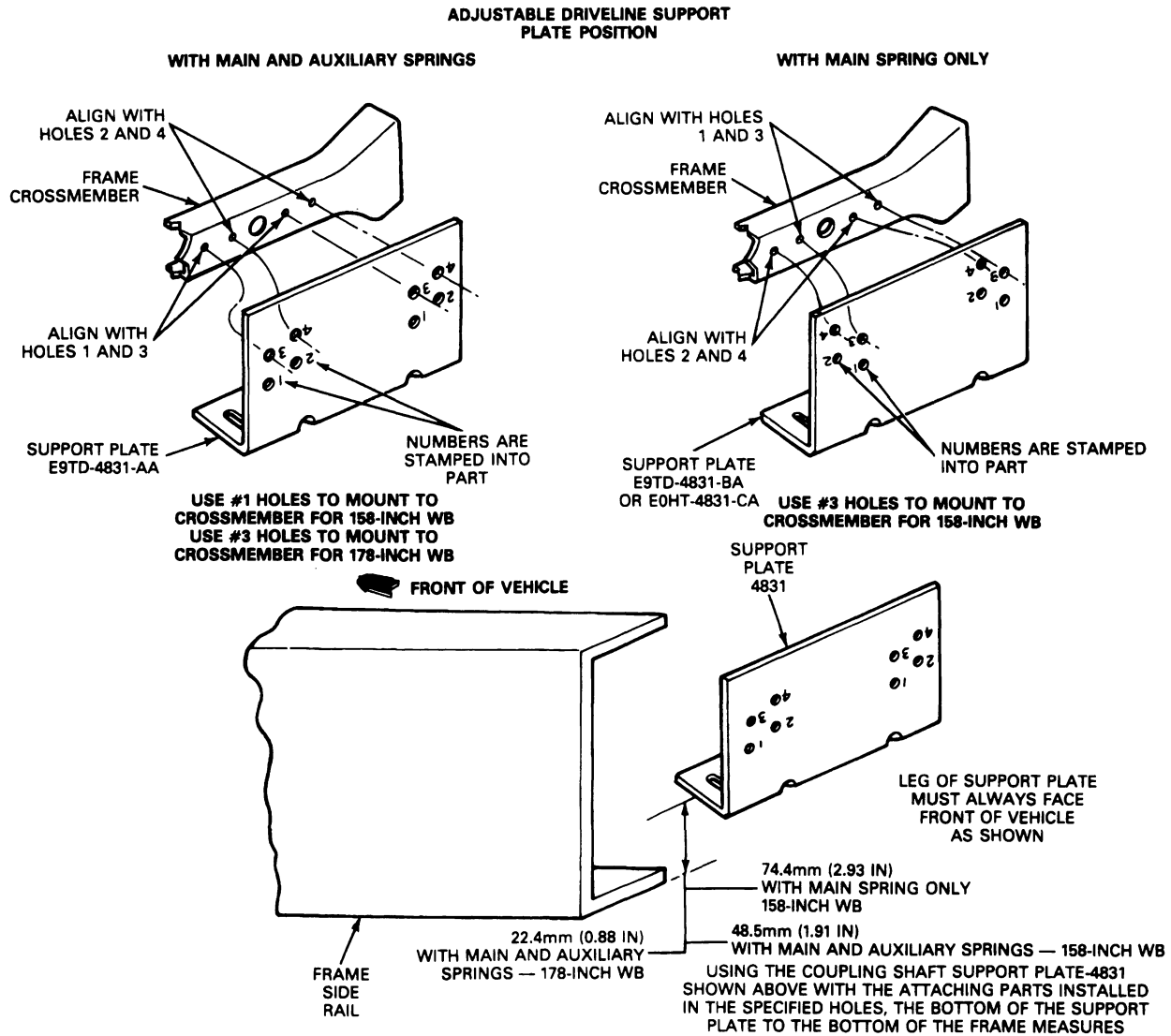
1. Alignment of drivelines must be accomplished with the empty vehicle sitting on a hard level surface.
2. All angle measurements must be made on a surface or the component which is either parallel to or perpendicular to the center line of the component being measured.
3. Angle measurements must be made with either a spirit level or an inclinometer. Angle values given in Section 05-00 are nominal values with a tolerance of $\pm 1/4$ degree.

ADJUSTMENTS (Continued)

Adjustable Driveline Support Plate

F-Super Duty Commercial Chassis

An adjustable driveline support plate is used. Although it can be mounted in any one of several positions, only one position is correct for a specific application. The correct position can be determined from the following illustration.



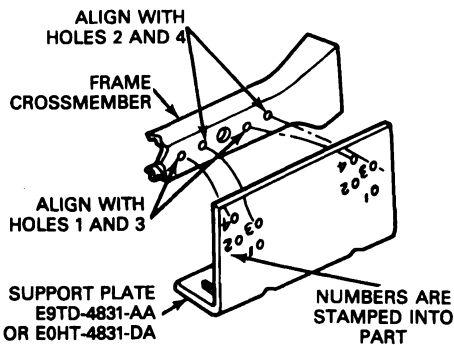
E8093-B

F-Super Duty Motorhome Chassis

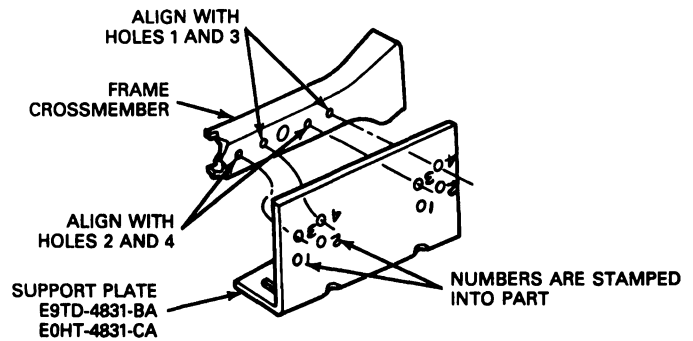
An adjustable driveline support plate is used. Although it can be mounted in any one of several positions, only one position is correct for a specific application. The correct position can be determined from the following illustration.

ADJUSTMENTS (Continued)

Adjustable Driveline Support Plate Position



USE #3 HOLES TO MOUNT FORWARD SUPPORT 208-INCH WB

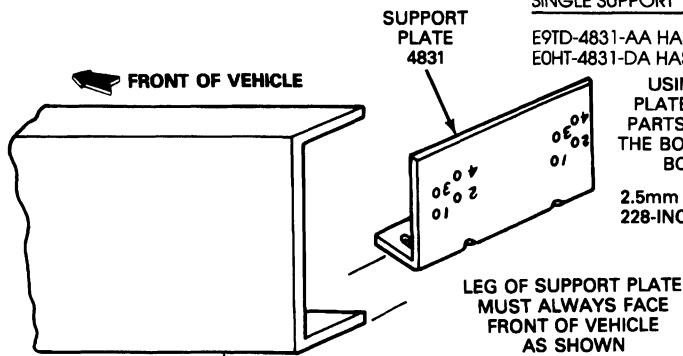


FORWARD SUPPORT	208-INCH	WB USE	#3	HOLES TO MOUNT
FORWARD SUPPORT	228-INCH	WB USE	#1	HOLES TO MOUNT
REARWARD SUPPORT	208-INCH	WB USE	#4	HOLES TO MOUNT
REARWARD SUPPORT	228-INCH	WB USE	#5	HOLES TO MOUNT *
SINGLE SUPPORT	178-INCH	WB USE	#2	HOLES TO MOUNT
SINGLE SUPPORT	190-INCH	WB USE	#2	HOLES TO MOUNT

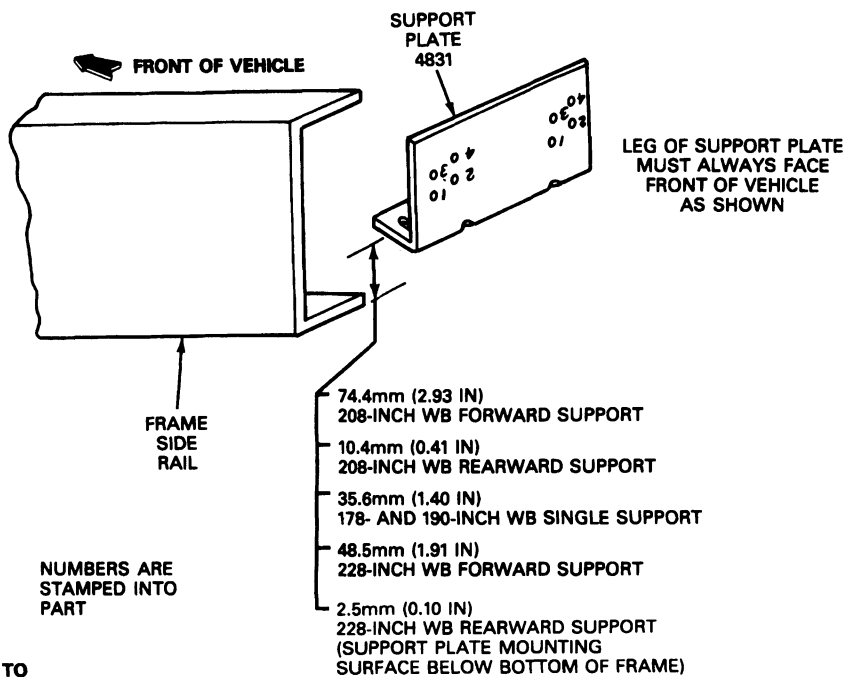
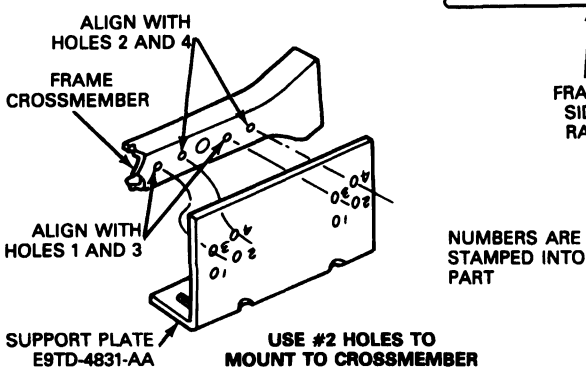
E9TD-4831-AA HAS 4 HOLE SETS
E0HT-4831-DA HAS 5 HOLE SETS *

USING THE COUPLING SHAFT SUPPORT PLATE-4831 SHOWN WITH THE ATTACHING PARTS INSTALLED IN THE SPECIFIED HOLES, THE BOTTOM OF THE SUPPORT PLATE TO THE BOTTOM OF THE FRAME MEASURES

2.5mm (0.10 IN)
228-INCH WB REARWARD SUPPORT



SINGLE SUPPORT 178-INCH WB AND 190-INCH WB





E8742-C

SPECIFICATIONS

DRIVESHAFT, TORQUE LIMITS

Description	N-m	Lb-Ft
Bolt Yoke to Coupling Shaft 5/8-18	201-222 (Dana)	148-164 (Dana)
Bolt Yoke to Coupling Shaft 3/4-16	238-325	175-240
Bolt Yoke to Coupling Shaft 7/8-14	339-406	250-300
Bolt Yoke to Coupling Shaft 1-20	216	160
Nut-U-Joints — U-Bolt 5/16-18	11-20	8-15
Nut-U-Joints — U-Bolt 3/4-18	24-35	17-26
Nut-U-Joints — U-Bolt 7/16-20	41-54	30-40
Coupling Shaft Center Bearing Bracket-to-Support 7/16-20	51-73	37-54
Bolt — Driveshaft U-Joint to Rear Yoke 1/2-20	123-149	90-110
Bolt and Nut — U-Joint Adapter to Rear Axle 1/2-20	82-94	60-70
Bolt — Circular Flange to Pinion Flange M12-1.25 x 27	83-117	61-87
Double Cardan Driveshaft-to-Transfer Case Bolts 5/16-24	28-38	20-28
Driveshaft-to-Front and Rear Axle U-Bolt Nuts 5/16-18	11-20	8-15
Center Support Bracket-to-Crossmember	40-64	30-47

SPECIAL SERVICE TOOLS

Tool Number/ Description	Illustration
T74P-4635-C U-Joint Bearing Removal-Installation Tool	 T74P-4635-C
T63P-9171-A Clamp Pliers	 T63P-9171-A

SECTION 05-02A Axle, Ford, 10.25-Inch Ring Gear

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		REMOVAL AND INSTALLATION (Cont'd.)	
Bearing Cups.....	05-02A-29	Axle Shaft, Semi-Floating Axle.....	05-02A-6
Inspection After Disassembly	05-02A-28	Differential Case and Drive Pinion.....	05-02A-10
Inspection Before Disassembly	05-02A-27	Differential Runout Check.....	05-02A-13
DESCRIPTION AND OPERATION		Drive Pinion Shim Selection	05-02A-15
Description	05-02A-1	Front and Rear Pinion Bearing Cups.....	05-02A-15
Operation.....	05-02A-2	Oil Seal and Wheel Bearing, Semi-Floating	
Rear Anti-lock Brakes	05-02A-1	Axle	05-02A-9
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Differential Case	05-02A-27	SPECIAL SERVICE TOOLS	05-02A-30
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Axle Housing	05-02A-24	VEHICLE APPLICATION	05-02A-1

VEHICLE APPLICATION

F-250 Light Duty (Semi-Float), F-250 HD, and F-350 (Full Float) Vehicles

DESCRIPTION AND OPERATION

Description

The Ford Truck Integral Carrier rear axle assembly is an integral type housing, hypoid gear design with the centerline of the pinion set below the centerline of the ring gear.

The hypoid gear set consists of a 10.25-inch diameter ring gear and an overhung drive pinion. The pinion is positioned by a selected shim and supported by two opposed tapered roller bearings. Pinion bearing preload is adjusted by the pinion nut and a collapsible spacer.

The housing assembly consists of a cast center section with two steel tube assemblies and a stamped rear cover. The cover uses a silicone sealant as a gasket.

The differential case is a one-piece design with two openings to allow for assembly of the internal components and lubricant flow. The differential pinion shaft is retained with a threaded bolt. The differential case assembly is mounted in the carrier between two opposed tapered roller bearings and is positioned by selected shims. The bearings are retained in the carrier by removable bearing caps.

For full floating hub service procedures, refer to Section 05-02B. Wheel end service procedures for the semi-floating axle are included in this section.

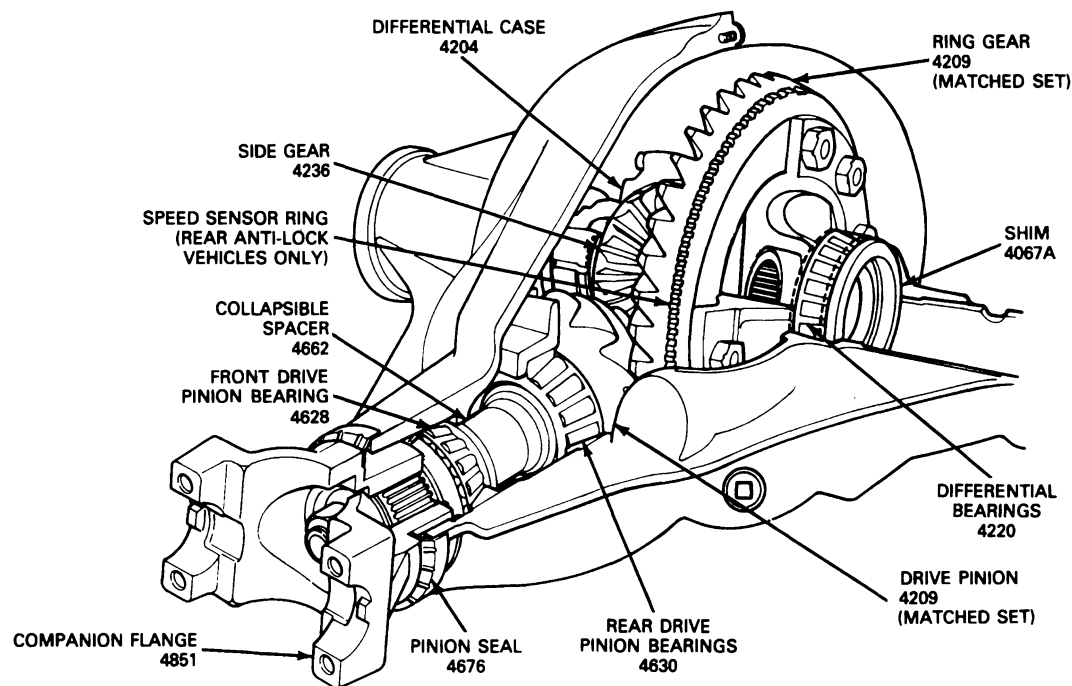
Rear Anti-lock Brakes

F-250-350 vehicles use the Rear Anti-lock Braking System. The system is designed to automatically reduce brake pressure when brake lock-up is detected during braking. The system features a multi-tooth speed sensor ring that is pressed on the differential case behind the ring gear. If the speed sensor ring is removed, it must be discarded and replaced with a new one. The sensor ring works in conjunction with an electromagnetic speed sensor. This sensor is retained in a bore at the top of the carrier housing and fastened by one bolt. There is a space provided between the ring gear and sensor ring for measuring the ring gear backface runout. For more information on the Rear Anti-lock Brake System, refer to Section 06-09.

DESCRIPTION AND OPERATION (Continued)**Operation**

The rear axle drive pinion receives its power from the engine through the transmission and driveshaft. The pinion gear rotates the differential case through engagement with the ring gear, which is bolted to the case outer flange.

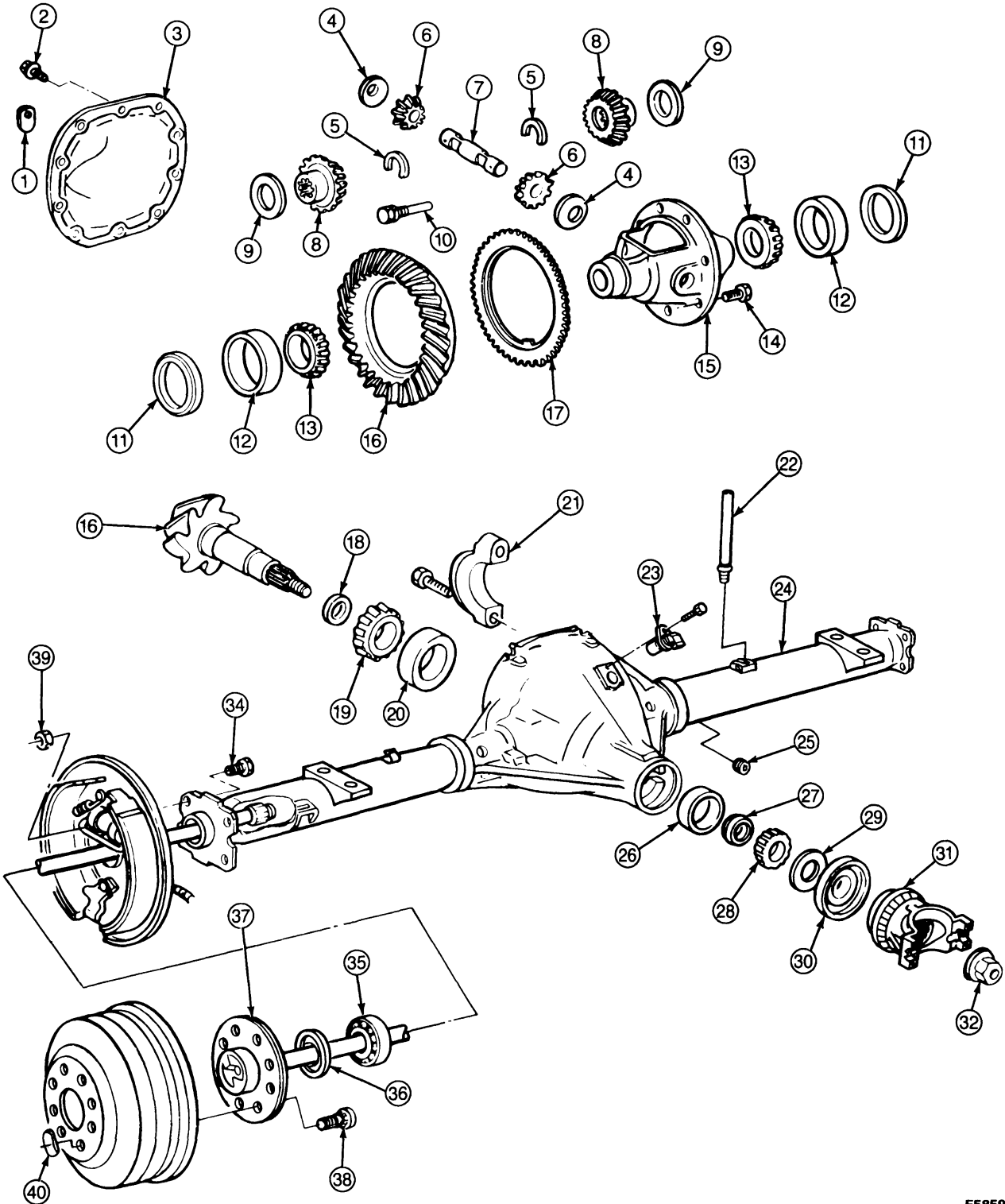
Inside the case, two differential pinion gears are mounted on the differential pinion shaft which is pinned (with lock bolt) to the case. These pinion gears are engaged with the side gears, to which the axle shafts are splined. Therefore, as the differential case turns, it rotates the axle shafts and rear wheels. When it is necessary for one wheel and axle shaft to rotate faster than the other, the faster turning side gear causes the pinions to roll on the slower turning side gear to allow differential action between the two axle shafts.

Integral Carrier, Rear Axle Assembly

E6109-D

DESCRIPTION AND OPERATION (Continued)

Integral Carrier, Rear Axle Assembly, Disassembled View, Semi-Floating Axle, Typical



E5859-F

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	Not Serviced	Ratio Tag
2	390864-S2	Cover Screw
3	4033	Cover
4	4230	Thrust Washer
5	4N237	C-Lock (Semi-Float Only)
6	4215	Differential Pinion Gear
7	4211	Differential Pinion Shaft
8	4236	Side Gear
9	4228	Thrust Washer
10	390266-S100	Differential Pinion Shaft Lock Bolt
11	4067	Differential Shims
12	4222	Differential Bearing Cup
13	4221	Differential Bearing
14	43114-S100	Ring Gear Bolt
15	4204	Differential Case
16	4209	Gear Set
17	4B409	Speed Sensor Ring
18	4663	Pinion Shim
19	4630	Rear Pinion Bearing
20	4628	Rear Pinion Bearing Cup
21	46157-S	Bearing Cap Bolt
22	—	Axle Vent Assembly
23	9E731	Sensor
24	4010	Axle Housing Assembly
25	390943-S100	Filler Plug
26	4616	Front Pinion Bearing Cup
27	4662	Spacer
28	4621	Front Pinion Bearing
29	4670	Slinger
30	4676	Pinion Seal
31	4851	Companion Flange
32	4851	Pinion Nut
34	—	Bolt, Brake Backing Plate
35	1225	Bearing, Wheel
36	1177	Seal
37	4234	Axle Shaft Assembly
38	390540-S	Wheel Bolt

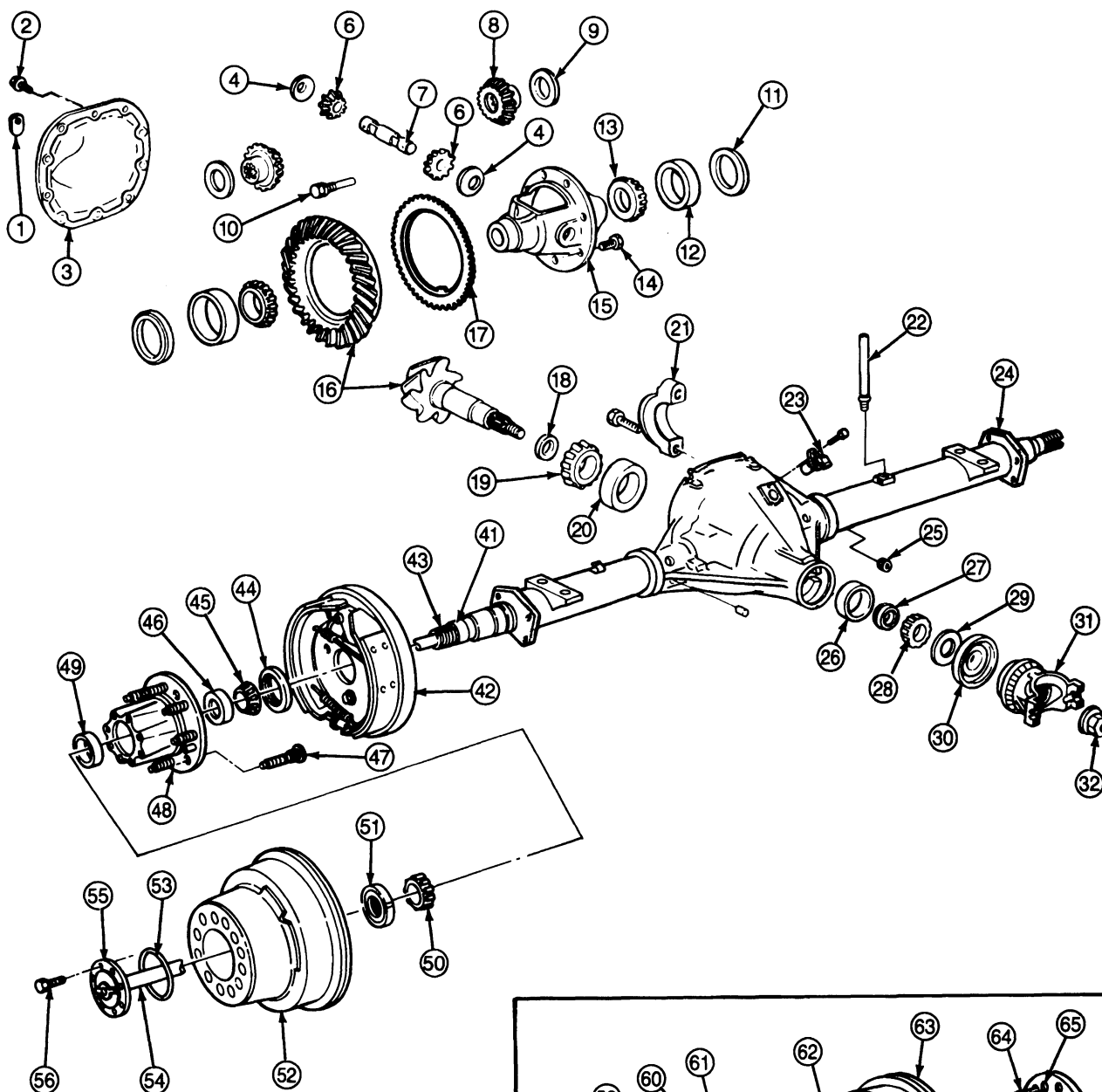
(Continued)

Item	Part Number	Description
39	391220-S56	Brake Backing Plate Nut
40	Not Serviced	Spring Push-on Nut
41	—	Spindle (Part of 4010 Housing)
42	—	Backing Plate and Brake Shoe Assembly
43	—	Keyway (Part of 4010 Housing)
44	1177	Hub Oil Seal
45	1244	Inner Bearing
46	1243	Inner Bearing Cup
47	390268-S	Press Fit Stud
48	1116	Hub
49	1239	Outer Bearing Cup
50	1240	Outer Bearing
51	1A124-R.H. 1A125-L.H.	Hub Nut — CAUTION: Hub Nut has left-hand thread for left axle tube and right-hand thread for right axle tube.
52	1126	Brake Drum
53	390258-S	O-Ring, Axle Shaft
54	4234	Axle Shaft
56	46053-S100	Bolt, Axle Shaft
57	—	Wheel Lug Nut
58	—	Outside Wheel
59	—	Locating Hole in Wheel
60	—	Wheel Pin is Inserted through Drum and Hub
61	305136-S7	Locating Pin in Wheel
62	—	Four Clearance Holes in Drum for Wheel Pin and Hub
63	—	Rear Brake Drum
64	—	Wheel Studs
65	—	Two Wheel Pin Locating Holes
66	—	Hub Locating Pin is Inserted through Drum and Both Wheels

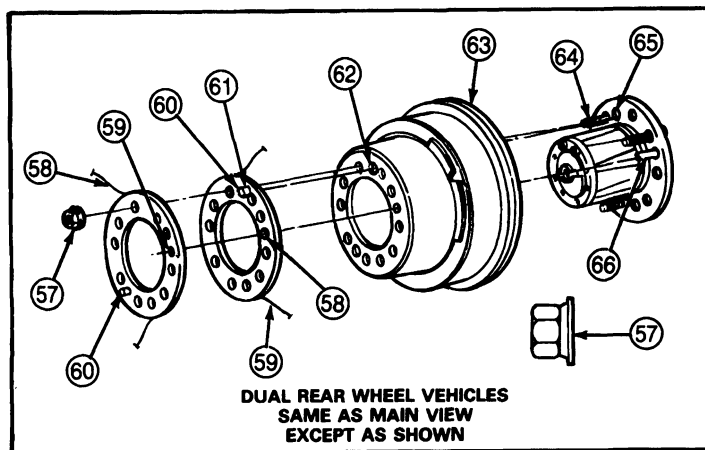
TE5859A

DESCRIPTION AND OPERATION (Continued)

Integral Carrier, Rear Axle Assembly, Disassembled View, Full Floating Axle, Typical



① HUB NUT HAS LEFT-HAND THREAD
FOR LEFT AXLE TUBE AND RIGHT-HAND
THREAD FOR RIGHT AXLE TUBE



DUAL REAR WHEEL VEHICLES
SAME AS MAIN VIEW
EXCEPT AS SHOWN

E6472-E

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	Not Serviced	Ratio Tag
2	390864-S2	Cover Screw
3	4033	Cover
4	4230	Thrust Washer
5	4N237	C-Lock (Semi-Float Only)
6	4215	Differential Pinion Gear
7	4211	Differential Pinion Shaft
8	4236	Side Gear
9	4228	Thrust Washer
10	390266-S100	Differential Pinion Shaft Lock Bolt
11	4067	Differential Shims
12	4222	Differential Bearing Cup
13	4221	Differential Bearing
14	43114-S100	Ring Gear Bolt
15	4204	Differential Case
16	4209	Gear Set
17	4B409	Speed Sensor Ring
18	4663	Pinion Shim
19	4630	Rear Pinion Bearing
20	4628	Rear Pinion Bearing Cup
21	46157-S	Bearing Cap Bolt
22	—	Axle Vent Assembly
23	9E731	Sensor
24	4010	Axle Housing Assembly
25	390943-S100	Filler Plug
26	4616	Front Pinion Bearing Cup
27	4662	Spacer
28	4621	Front Pinion Bearing
29	4670	Slinger
30	4676	Pinion Seal
31	4851	Companion Flange
32	4851	Pinion Nut
34	—	Bolt, Brake Backing Plate
35	1225	Bearing, Wheel
36	1177	Seal
37	4234	Axle Shaft Assembly
38	390540-S	Wheel Bolt

(Continued)

Item	Part Number	Description
39	391220-S56	Brake Backing Plate Nut
40	Not Serviced	Spring Push-on Nut
41	—	Spindle (Part of 4010 Housing)
42	—	Backing Plate and Brake Shoe Assembly
43	—	Keyway (Part of 4010 Housing)
44	1177	Hub Oil Seal
45	1244	Inner Bearing
46	1243	Inner Bearing Cup
47	390268-S	Press Fit Stud
48	1116	Hub
49	1239	Outer Bearing Cup
50	1240	Outer Bearing
51	1A124-R.H. 1A125-L.H.	Hub Nut — CAUTION: Hub Nut has left-hand thread for left axle tube and right-hand thread for right axle tube.
52	1126	Brake Drum
53	390258-S	O-Ring, Axle Shaft
54	4234	Axle Shaft
56	46053-S100	Bolt, Axle Shaft
57	—	Wheel Lug Nut
58	—	Outside Wheel
59	—	Locating Hole in Wheel
60	—	Wheel Pin is Inserted through Drum and Hub
61	305136-S7	Locating Pin in Wheel
62	—	Four Clearance Holes in Drum for Wheel Pin and Hub
63	—	Rear Brake Drum
64	—	Wheel Studs
65	—	Two Wheel Pin Locating Holes
66	—	Hub Locating Pin is Inserted through Drum and Both Wheels

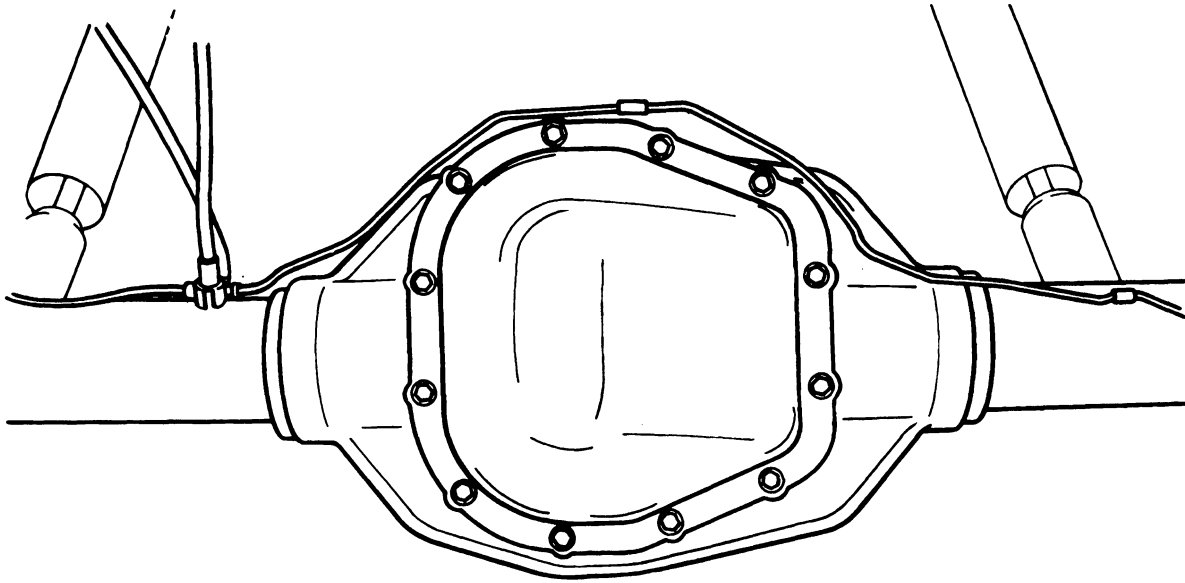
TE6472A

REMOVAL AND INSTALLATION

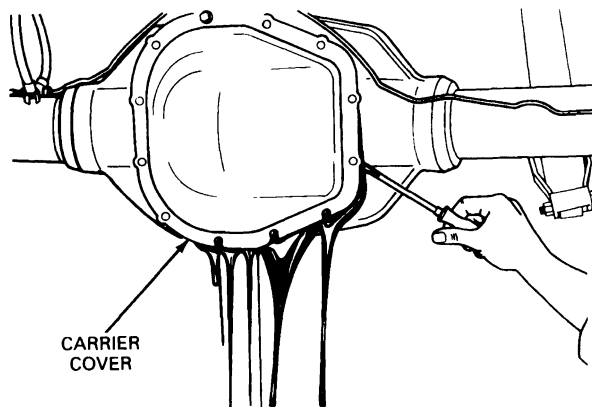
Axle Shaft, Semi-Floating Axle**Removal**

NOTE: Refer to Section 05-02B for full floating axle shaft removal.

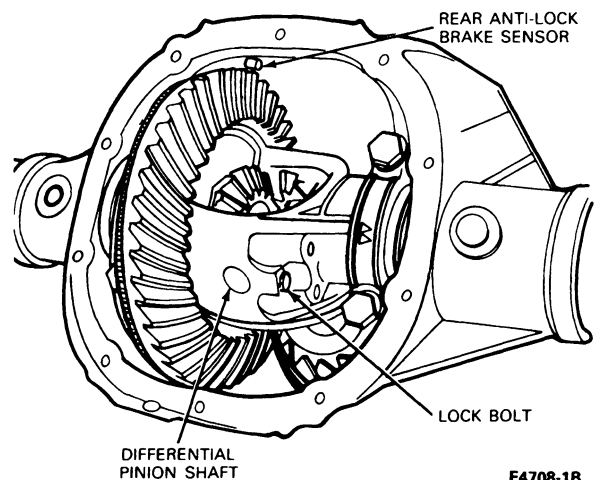
1. Clean all dirt from the area of carrier cover with a wire brush and/or cloth.

REMOVAL AND INSTALLATION (Continued)**Rear Axle Carrier Cover****E5863-2A**

2. Place a drain pan under the axle and drain rear axle lubricant by removing the housing cover.

Carrier Cover Removal**E5864-B**

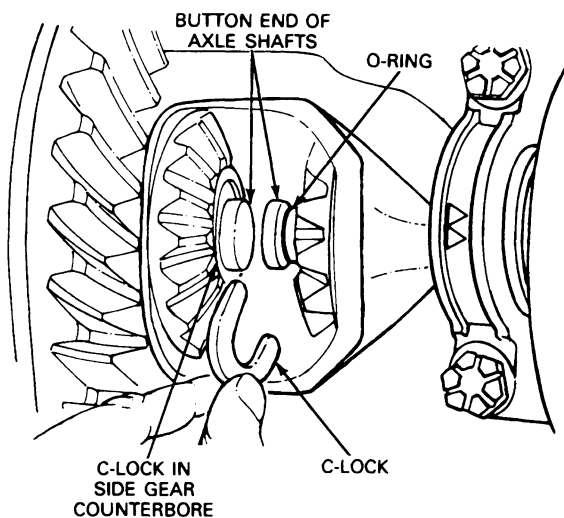
3. Remove differential pinion shaft lock bolt and differential pinion shaft.

**E4708-1B**

REMOVAL AND INSTALLATION (Continued)

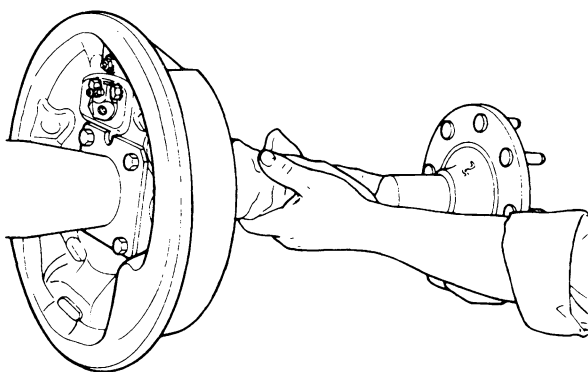
4. Push axle shafts inboard. Remove C-lock from the button end of each axle shaft.

NOTE: Use care not to lose or damage the rubber O-ring which is in the axle shaft groove under the C-lock.



E4709-1B

5. Remove the axle shaft from the housing, being careful not to damage the oil seal.

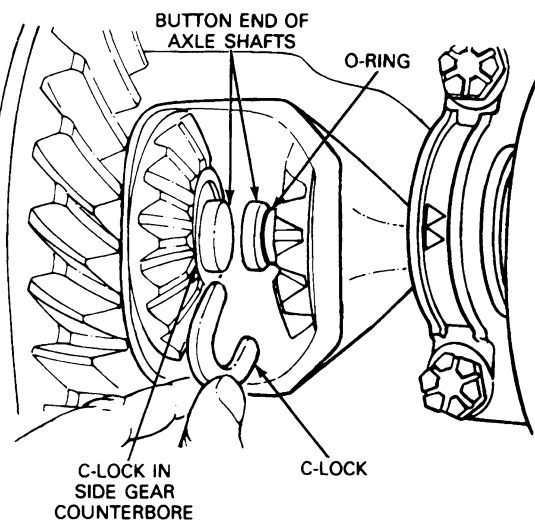


E4760-1B

Installation

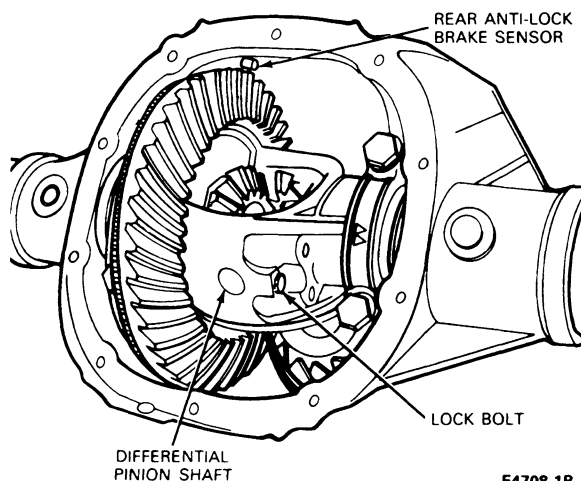
- Slide the axle shafts into place in the axle housing. Exercise care so that the splines or any portion of the axle shafts do not damage the oil seals. Push the shafts inboard (toward the center of the vehicle) enough to allow installation of the C-lock.
- Install the axle shaft C-locks on the button end of the axle shafts and push the shafts outboard so that the shaft lock seats in the counterbore of the differential side gear.

NOTE: A rubber O-ring is used to hold the C-lock in position on the axle shaft. Be sure that the O-ring is in the groove at the button end of the axle shaft before installing the C-lock.



E4709-1B

3. Position the differential pinion shaft through the case and pinions, aligning the hole in the shaft with the lock bolt hole. Apply Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A) or equivalent to the lock bolt threads. Install lock bolt and tighten to 20-40 N·m (15-30 ft·lb).



E4708-1B

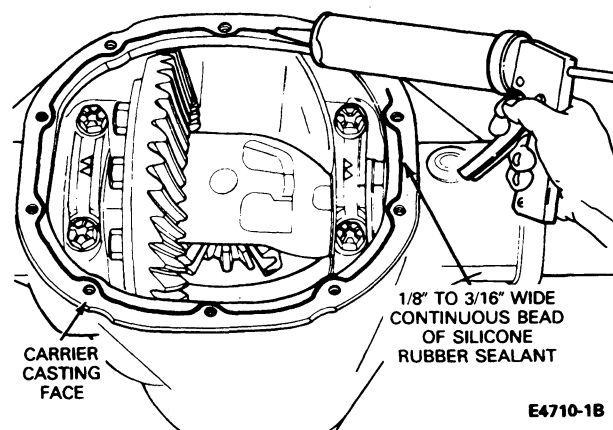
4. Clean the gasket mating surface of the rear axle carrier casting and cover.

CAUTION: Make sure machined surfaces on both cover and carrier are clean and free of oil before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent contamination.

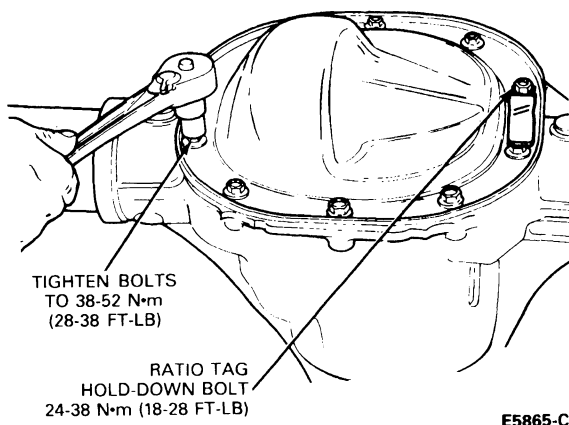
REMOVAL AND INSTALLATION (Continued)

5. Apply a new continuous bead of Silicone Rubber D6AZ-19562-AA or -BA (ESB-M4G92-A or ESE-M4G195-A) or equivalent to the carrier casting face inboard of the cover bolt holes.

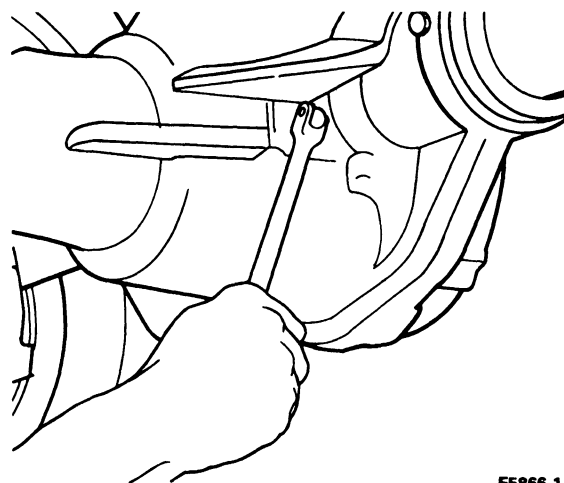
NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.



6. Install cover and tighten cover bolts to 38-52 N·m (28-38 ft·lb) as shown. Tighten the cover bolts in a cross-wise pattern to make sure cover is drawn down uniformly. Tighten the ratio tag hold-down bolt to 24-38 N·m (18-28 ft·lb).



7. For in-vehicle repairs, add lubricant through the filler hole until the lubricant level reaches the bottom of the filler hole with the axle in the running position (approximately 6.5 U.S. pints). For out-of-vehicle repairs, add 7.5 U.S. pints of lubricant. Use Rear Axle Lubricant XY-90-QL or KL (ESP-M2C154-A) or equivalent for conventional axles, plus 8 ounces of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent for complete refill of Limited-Slip applications.
8. Lower vehicle and road test.



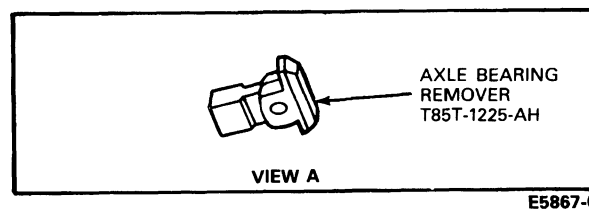
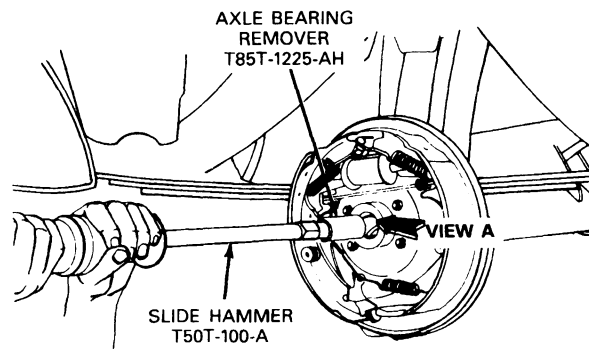
E5866-1A

Oil Seal and Wheel Bearing, Semi-Floating Axle

NOTE: For full floating axle service procedures, refer to Section 05-02B.

Removal

1. Remove axle as described in this section.
2. Using Slide Hammer T50T-100-A and Axle Bearing Remover T85T-1225-AH or equivalents, insert into the bore as shown and position it behind the bearing so the tangs on the tool engage the bearing outer race.
3. Remove the bearing and seal as a unit, using the slide hammer.



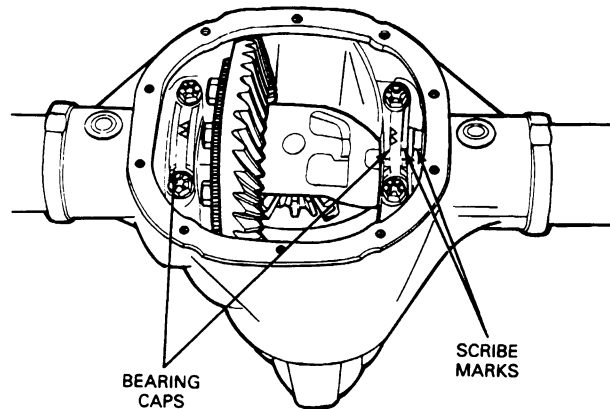
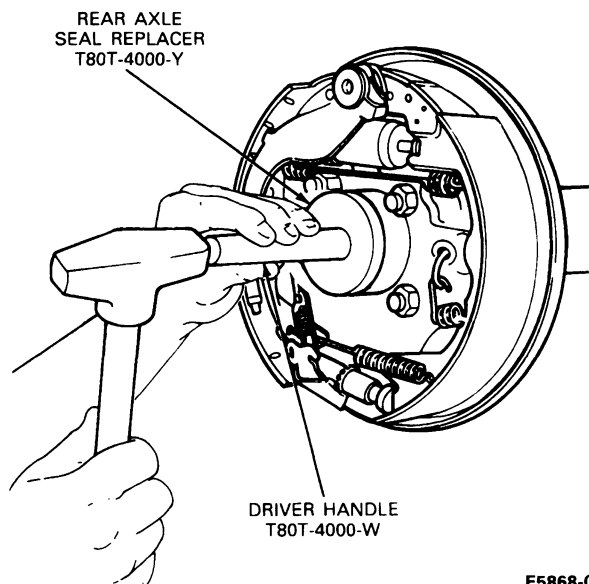
E5867-C

REMOVAL AND INSTALLATION (Continued)

Installation

1. Lubricate the new bearing with rear axle lubricant and install the bearing into the housing bore using Driver Handle T80T-4000-W and Rear Axle Seal Replacer T80T-4000-Y.
2. Coat the lips of the seal with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent and using the Driver Handle and Rear Axle Seal Replacer used to install the bearing, install the axle shaft seal.

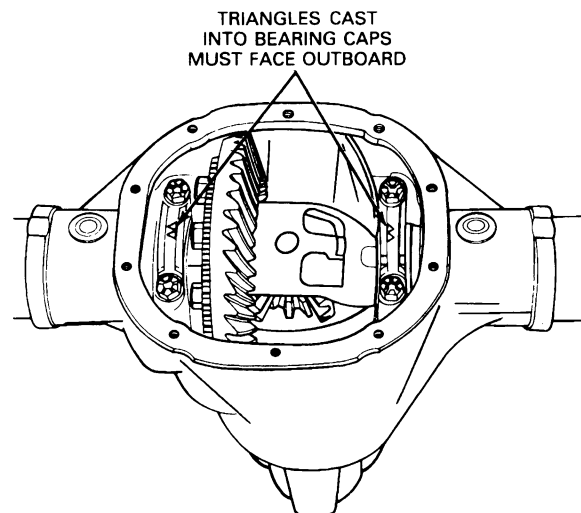
CAUTION: Installation of the bearing or seal assembly without the proper tool may result in an early bearing or seal failure. If seal becomes cocked in the bore during installation, remove it and install a new one.



E4707-1C

3. Loosen the differential bearing cap bolts and bearing caps.

NOTE: The direction of triangles on bearing caps must be noted. When re-assembled, the triangles must be pointing in the same direction (outboard) as before removal.



E4763-C

Differential Case and Drive Pinion

Removal

1. If not previously removed, remove the axle shafts as described in this section (semi-floating axles) or in Section 05-02B (full floating axles).
2. Mark one differential bearing cap to make sure the caps are installed in their original positions during assembly.

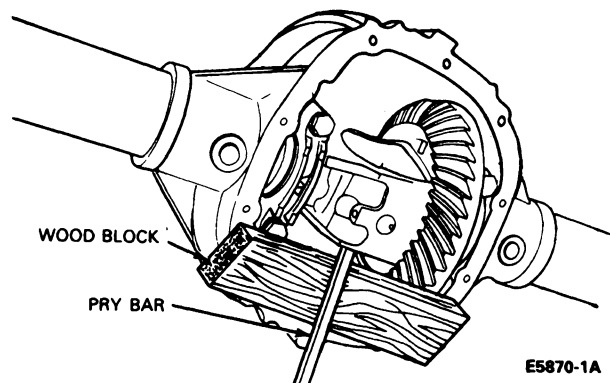
CAUTION: Right and left bearing caps must not be interchanged.

NOTE: Before removing the differential case, check the ring gear runout as described in the Cleaning and Inspection portion of this section. If ring gear runout exceeds 0.101mm (0.004 inch), the differential case and ring gear must be removed to perform the Differential Runout Check. The Differential Runout Check will isolate the cause of excessive ring gear runout.

REMOVAL AND INSTALLATION (Continued)

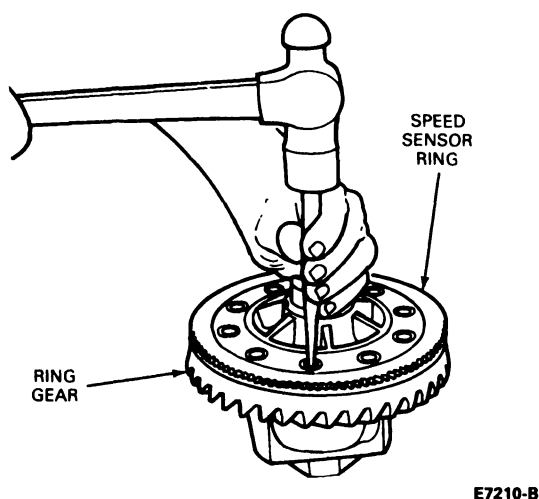
4. Pry the differential case, bearing cups and shims out until they are loose in the bearing caps. Remove the bearing caps and remove the differential assembly from the carrier.

CAUTION: When using the pry bar, place a wood block between the pry bar and the axle housing to protect the machined surface from damage.

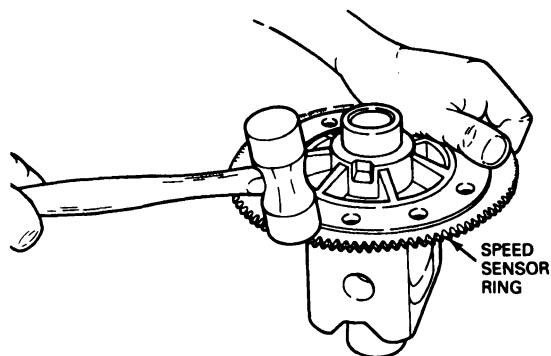


5. If required, remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case by striking at alternate holes around the gear.

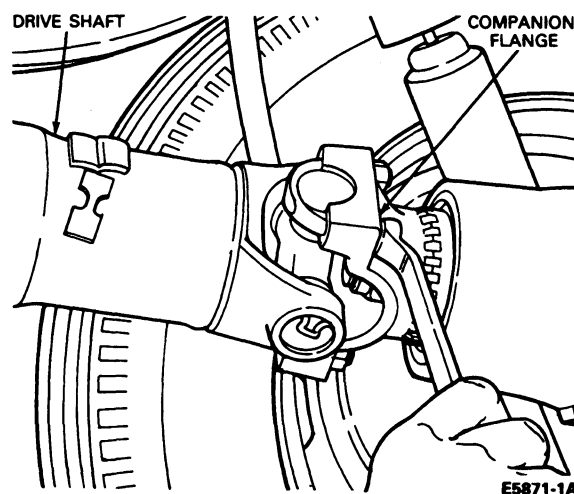
CAUTION: Do not damage speed sensor ring when removing ring gear. If speed sensor ring is removed from case, it must be replaced with a new one.



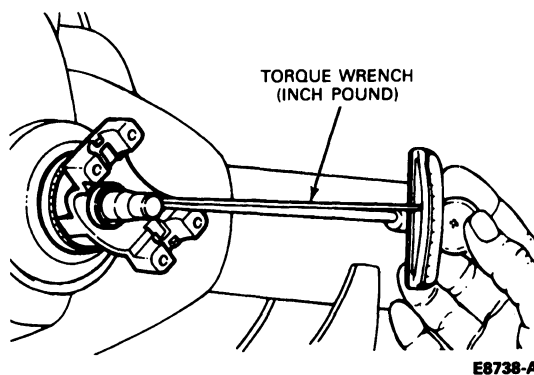
6. If required, remove the speed sensor ring with a soft-faced hammer. Discard the sensor ring.



7. Mark the driveshaft in relation to the companion flange. Remove the drive shaft-to-axle-companion flange U-bolts and nuts. Wrap U-joint with tape and position driveshaft out of the way..

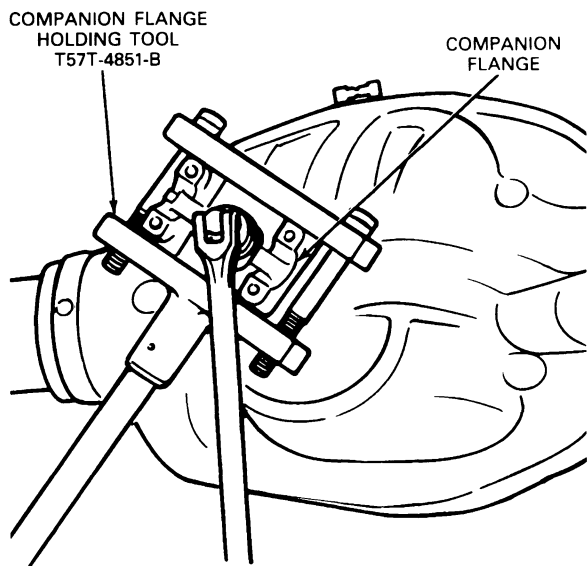


8. Install an inch-pound torque wrench on the pinion nut. Record the torque required to maintain rotation of the pinion through several revolutions.



REMOVAL AND INSTALLATION (Continued)

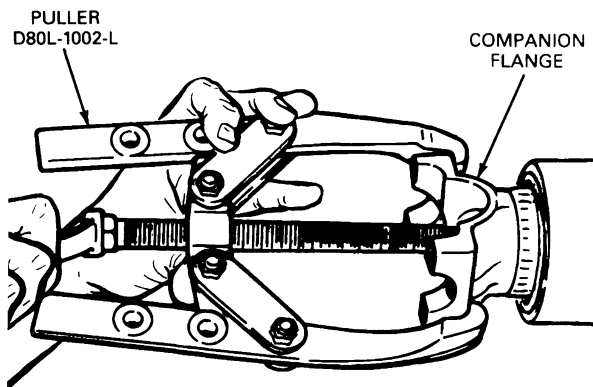
9. Install Companion Flange Holding Tool T57T-4851-B or equivalent on the companion flange and remove the pinion nut.



E5872-B

NOTE: Scribe a mark on the companion flange and pinion stem for alignment during assembly.

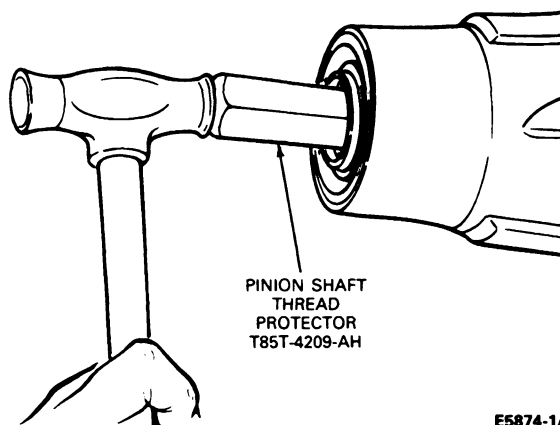
10. Remove the companion flange using Puller D80L-1002-L or equivalent.



E5873-B

11. With a soft-faced hammer, drive the pinion out of the front bearing cone and remove it through the rear of the housing.

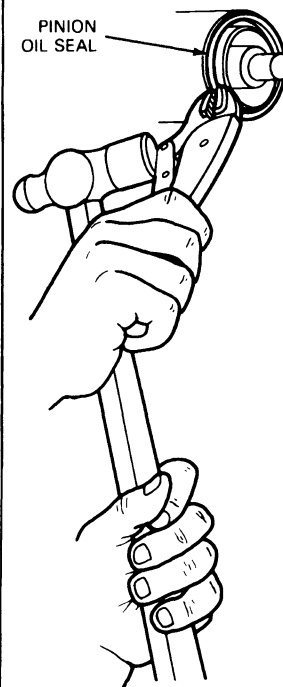
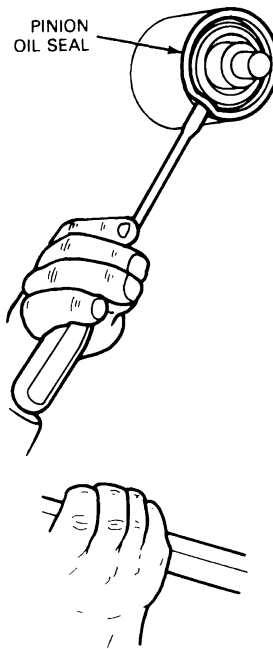
If available, install Pinion Shaft Thread Protector T85T-4209-AH on the pinion threads and drive the pinion from the housing. Care should be taken not to allow the drive pinion to fall from the housing.



E5874-1A

12. Pry up on metal flange of pinion seal. Install gripping pliers and strike with hammer until pinion seal is removed.

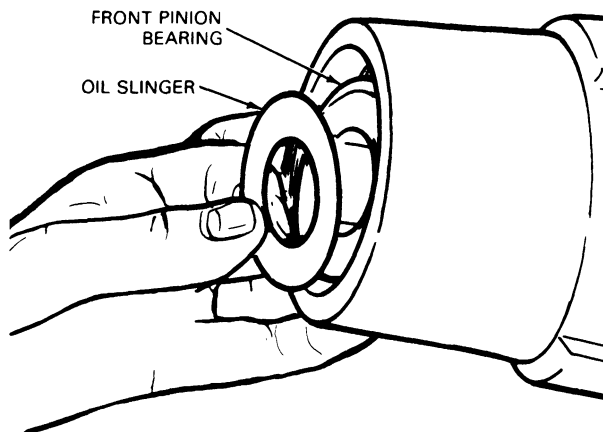
CAUTION: Use care not to damage seal bore in housing.



E8613-1A

REMOVAL AND INSTALLATION (Continued)

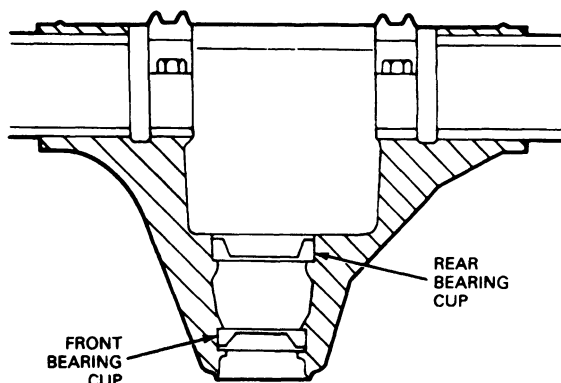
13. Remove oil slinger and front pinion bearing from axle housing.



E6512-1B

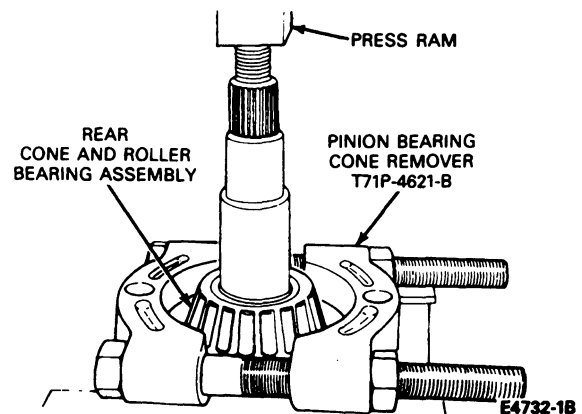
NOTE: Do not remove the pinion bearing cups from the carrier casting unless the cups are damaged.

14. If the pinion bearing cups are to be replaced, tap alternately (with a brass drift of suitable length) on opposite sides of the cup during removal to prevent cup from cocking in the casting.



E5877-1A

15. To remove the pinion rear cone and roller bearing assembly, use Pinion Bearing Cone Remover T71P-4621-B or equivalent as shown.

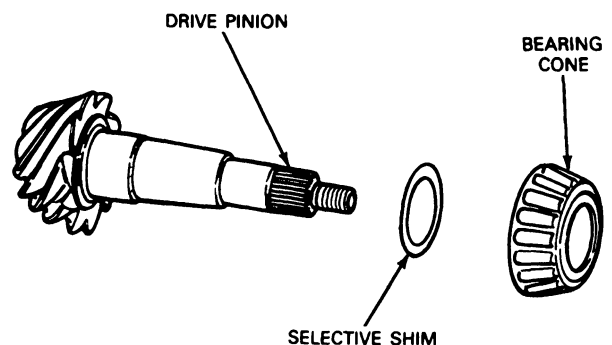


E4732-1B

16. Remove the selective shim from the drive pinion.

NOTE: Measure the shim, which is found under the bearing cone, with a micrometer and record the thickness (as a reference to be compared to the shim gauge reading prior to installing the bearing).

For differential case disassembly procedures, refer to Differential Case, Disassembly and Assembly in this section. Refer to Section 05-02C for Limited-Slip Differential.



E5878-1A

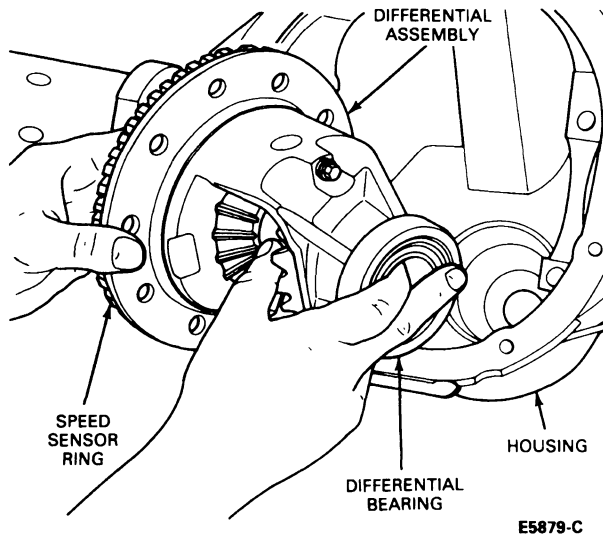
Differential Runout Check

If the ring gear runout check (before disassembly) exceeds specification, the condition may be caused by a warped ring gear, a damaged case, excessively worn differential bearings or foreign material between mating surfaces (burrs, shavings, etc.). To determine the cause of excessive runout, proceed as follows:

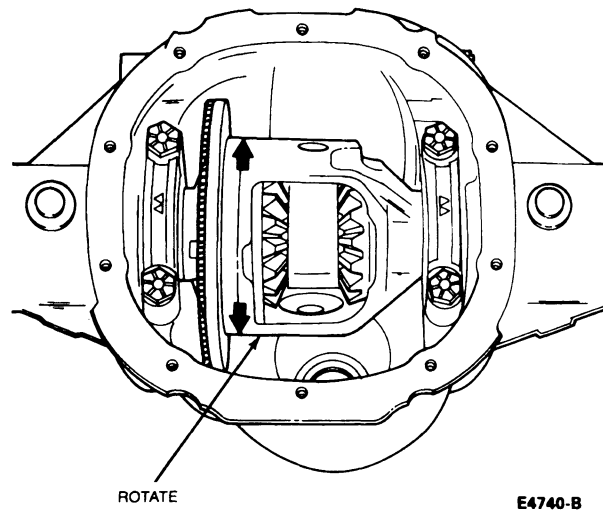
1. Remove the differential case from the axle housing (refer to Differential case and Drive Pinion Removal in this section) and remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case with a hammer and a drift.

REMOVAL AND INSTALLATION (Continued)

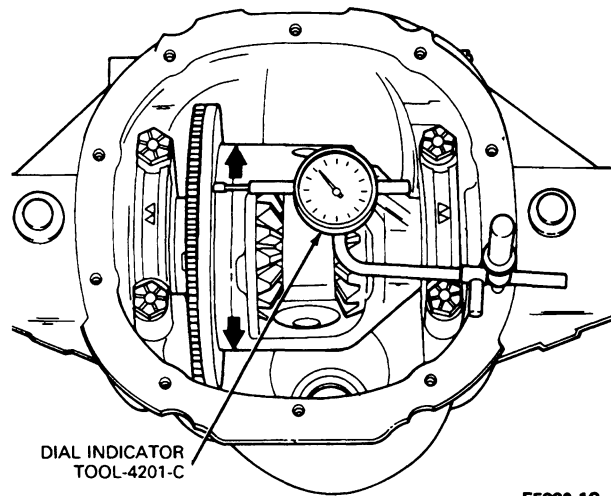
2. Install the differential assembly including the bearing cups and shims in the axle housing. Tighten the bearing cap bolts to 109-129 N·m (80-95 ft·lb).



3. Rotate assembly to make sure differential bearings seat properly.



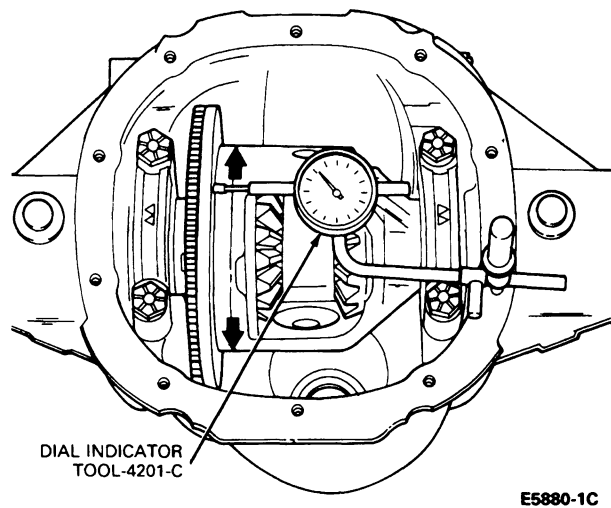
4. Check the runout of the differential case flange with Dial Indicator TOOL-4201-C or equivalent. If the runout is within specification (0.076mm [0.003 inch] maximum), install a new ring and pinion gear. If the runout exceeds specification, the ring gear is true and the trouble is due to either a damaged case or bearings. Visually inspect the bearings. If bearings are not damaged, replace both the case and bearings. Recheck the runout with new parts (case and bearings).



5. Install new differential bearings on the case hubs using Differential Bearing Cone Replacer D81T-4221-A or equivalent and install the differential assembly in the carrier without the ring gear.

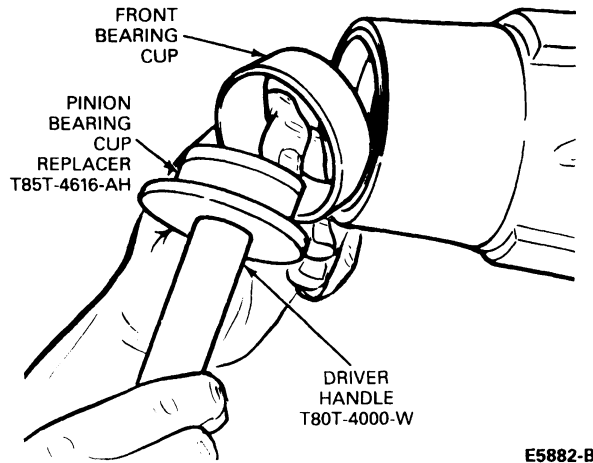
NOTE: Press against the bearing cone only.

6. Check the case runout again with the new bearings. If the runout is now within limits, use the new bearings for assembly. If the runout is still excessive, the case is damaged and should be replaced.

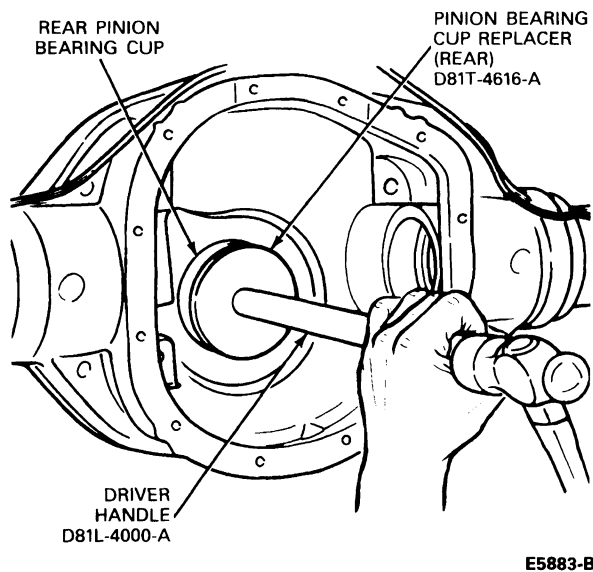


REMOVAL AND INSTALLATION (Continued)**Front and Rear Pinion Bearing Cups****Installation**

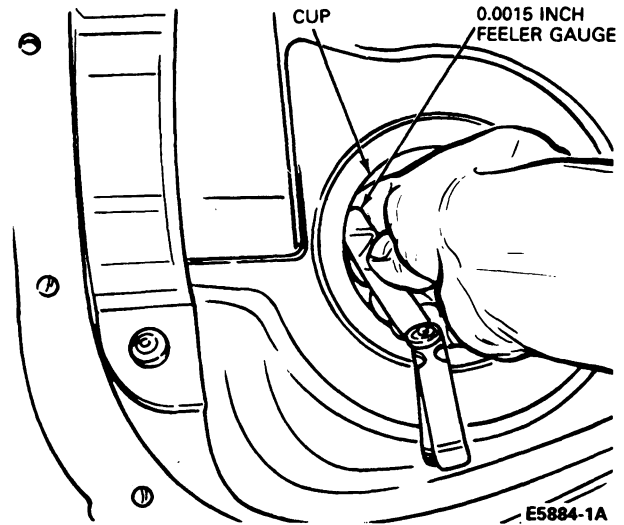
1. Drive the front pinion bearing cup into the housing using Pinion Bearing Cup Replacer (Front) T85T-4616-AH and Driver Handle T80T-4000-W.



2. Drive the rear pinion bearing cup into the housing using Pinion Bearing Cup Replacer (Rear) D81T-4616-A and Driver Handle D81L-4000-A.



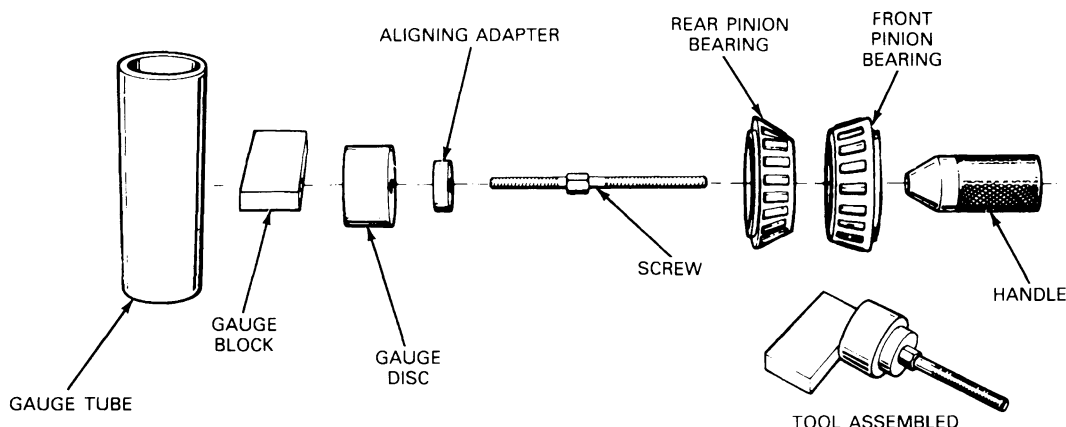
3. Make sure the cups are properly seated in their bores. If a 0.038mm (0.0015-inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup is not properly seated. Whenever the cups are replaced, the cone and roller assembly should also be replaced.

**Drive Pinion Shim Selection**

1. Individual differences in machining the carrier casting and the gear set and variation in bearing widths require a shim between the pinion rear bearing and pinion head, in order to locate the pinion for correct tooth contact with the ring gear. When replacing a ring and pinion gear, the correct shim thickness for the new gear set to be installed is determined by the following procedure using the tools listed below.

REMOVAL AND INSTALLATION (Continued)

Rear Axle Pinion Depth Gauge Tools



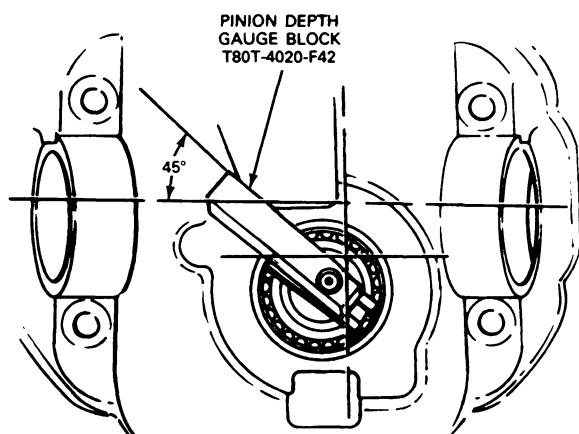
E5885-B

REAR AXLE PINION DEPTH GAUGE TOOL

Tool Number	Description
T85T-4020-AH1	Aligning Adapter
T80T-4020-F43	Screw
T80T-4020-F42	Gauge Block
T76P-4020-A11	Handle
T85T-4020-AH2	Gauge Disc
D81T-4020-F51	Gauge Tube

- Assemble the aligning adapter, gauge disc and gauge block to the screw.
- Place the rear pinion bearing (new, or used if in good condition) over the aligning tool and insert it into the rear pinion bearing cup of the carrier. Place the front bearing into the front bearing cup and assemble the tool handle into the screw. Roll the assembly back and forth a few times to seat the bearings while tightening the tool handle by hand. Tighten the tool handle to 27 N·m (20 ft-lb).

NOTE: The gauge block must be off-set as shown (45 degrees) to obtain an accurate reading.



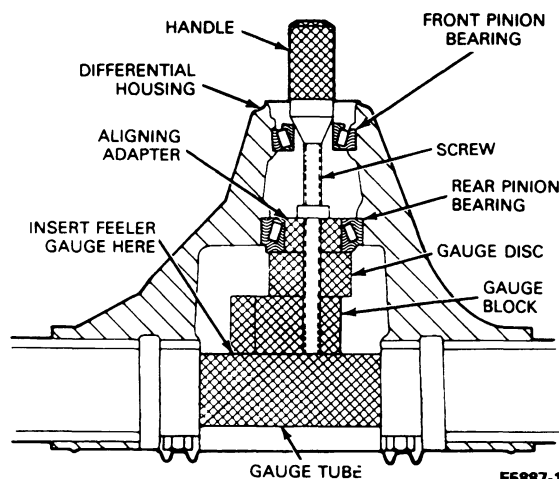
E5886-1A

- Center the gauge tube into the differential bearing bore. Install the bearing caps and tighten the bolts to 95-115 N·m (70-85 ft-lb). Caps are to be installed with the triangles pointing outboard.

Utilize pinion shims as the gauge for shim selection. This will minimize errors in attempting to stack feeler gauge stock together or simple addition errors in calculating correct shim thickness.

NOTE: Shims must be flat. Do not use dirty, bent, nicked or mutilated shims as a gauge.

It is important to feel a slight drag on the shim for correct selection. Do not attempt to force the shim between the gauge block and the gauge tube. This will minimize selection of a shim thicker than required which results in a deep tooth contact in final assembly of integral axles.



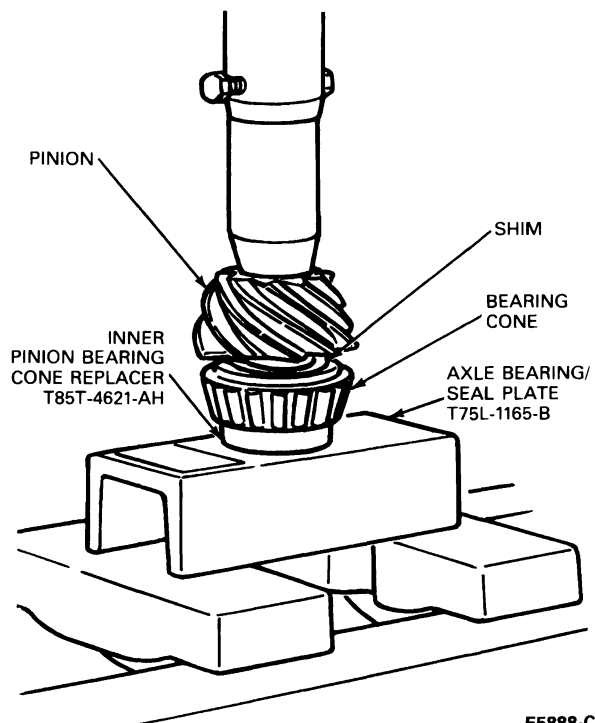
E5887-1A

REMOVAL AND INSTALLATION (Continued)

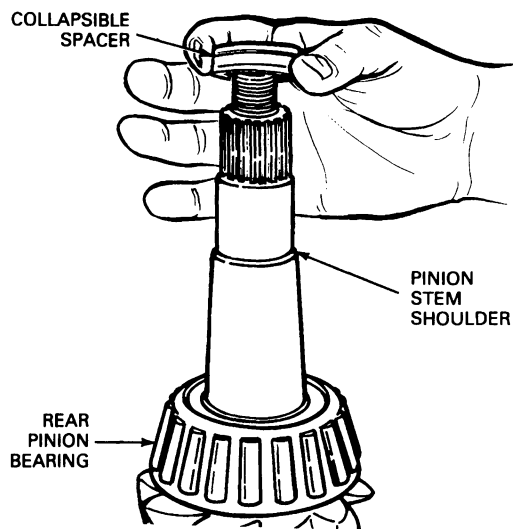
5. Place the selected shim(s) on the pinion and press the pinion bearing cone and roller assembly until it is firmly seated on the shaft using Inner Pinion Bearing Cone Replacer T85T-4621-AH and Axle Bearing / Seal Plate T75L-1165-B.

NOTE: The same rear pinion bearing used in this procedure must be used in final assembly of the axle.

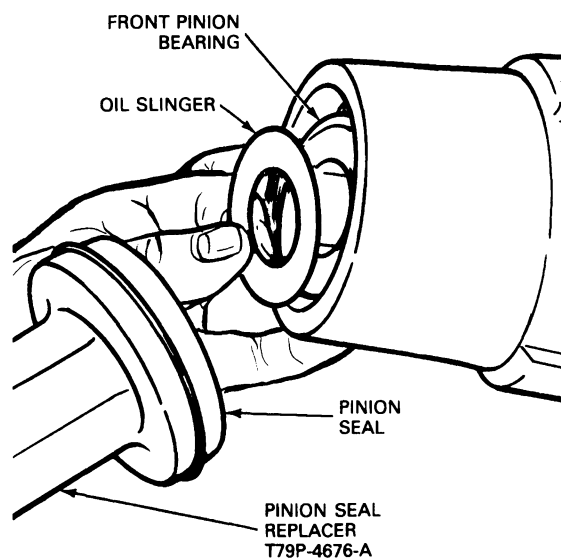
NOTE: Be sure that press load is not applied to the bearing cage.



6. Check splines on the pinion stem to be sure they are free of burrs. If burrs are evident, remove them by using a fine crocus cloth, working in a rotational motion. Wipe the pinion clean.
7. Place the collapsible spacer on the pinion stem against the pinion stem shoulder.



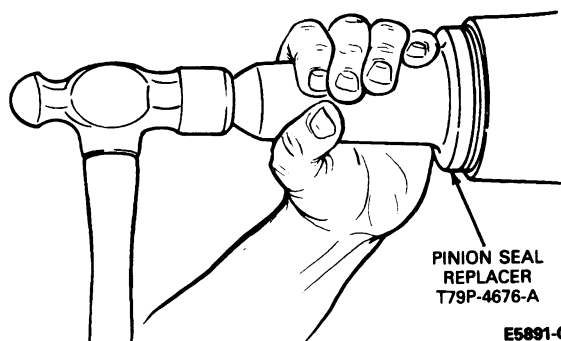
8. Install the front pinion bearing and oil slinger in the housing bore and install the pinion seal on the Pinion Seal Replacer T83T-4676-A.



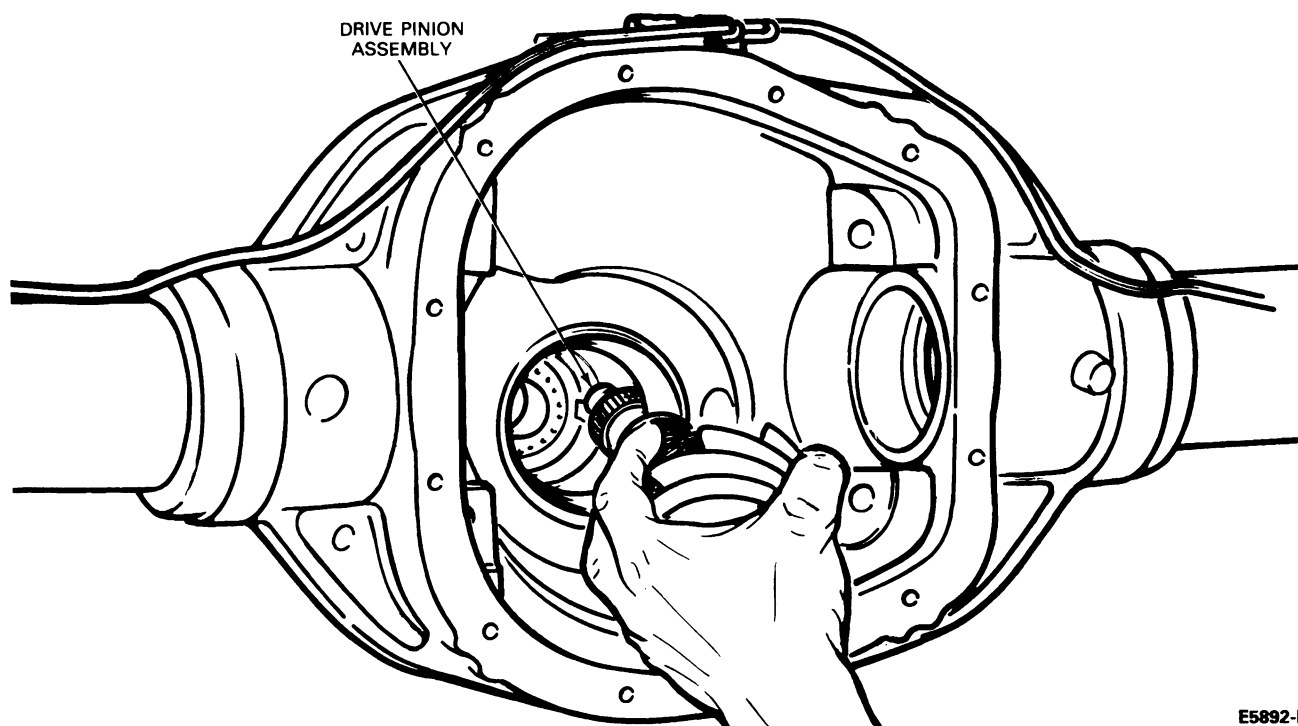
REMOVAL AND INSTALLATION (Continued)

9. Clean the oil seal seat surface. Install the seal in the housing bore using Pinion Seal Replacer T83T-4676-A. Coat the lips of the seal with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.

CAUTION: Installation without the proper tool may result in early seal failure. If seal becomes cocked during installation, remove it and install new one.



10. From the rear of the axle housing, install the drive pinion assembly (drive pinion, shim(s), rear bearing cone and roller, and collapsible spacer) into the housing pinion shaft bore.

Drive Pinion Installation

11. Apply a small amount of lubricant to the companion flange shaft splines. Align the mark on the companion flange with the mark on the pinion stem.

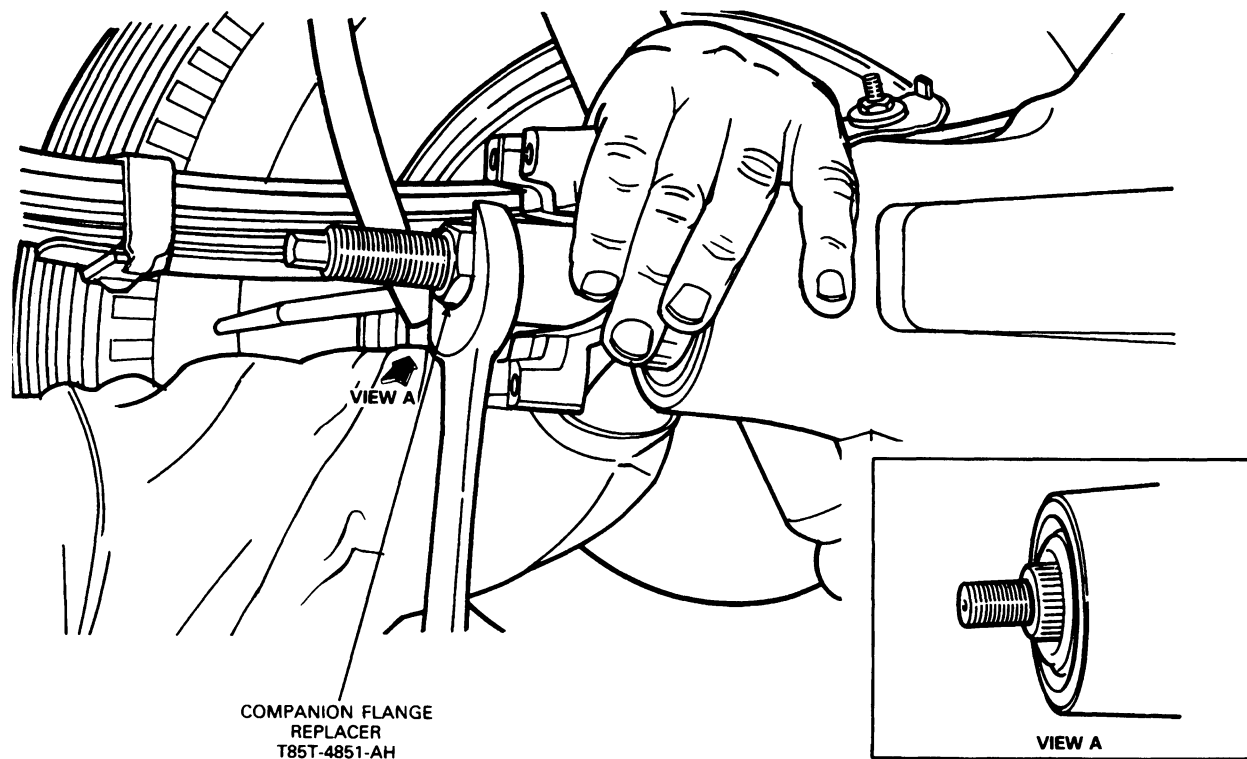
With the drive pinion in place in the housing, install companion flange using Companion Flange Replacer T85T-4851-AH or equivalent.

NOTE: If a new companion flange is being installed, disregard the scribe mark on the pinion stem.

NOTE: The companion flange must never be hammered on or installed with power tools.

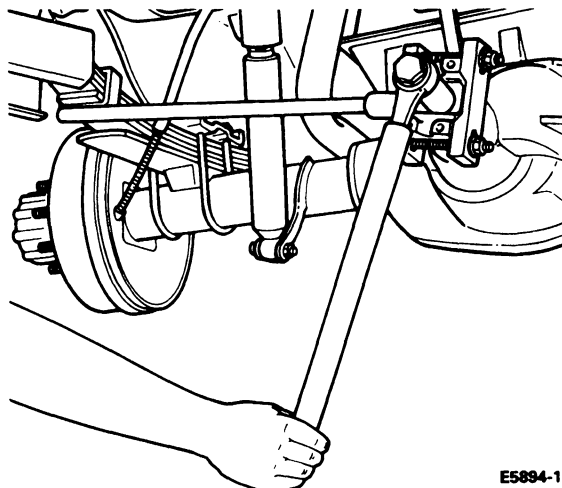
REMOVAL AND INSTALLATION (Continued)

Companion Flange Installation



E5893-2A

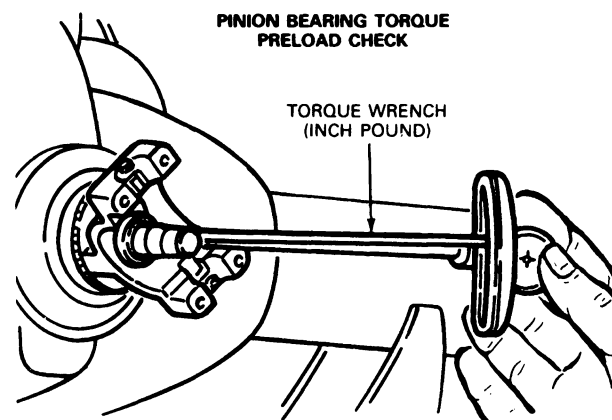
12. Hold the companion flange with Companion Flange Holding Tool T57T-4851-B or equivalent while tightening the nut.
13. Tighten the pinion nut (minimum torque of 217 N·m or 160 ft·lb), rotating the pinion occasionally to make sure pinion bearings are seating properly. Take frequent pinion bearing torque preload readings until the original recorded preload reading is obtained by rotating the pinion with a N·m (inch-pound) torque wrench.



E5894-1A

If the original recorded preload is lower than specification (original bearings .9-1.5 N·m [8-14 in·lb]; new bearings 1.8-3.3 N·m [16-29 in·lb]), tighten to specification. If the preload is higher than specification, tighten to original reading as recorded.

Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.



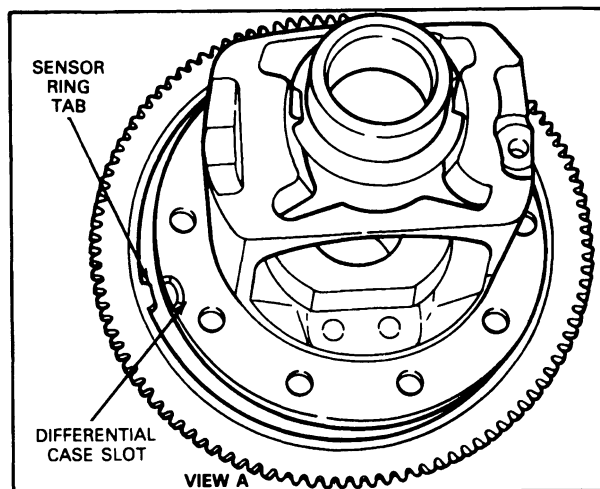
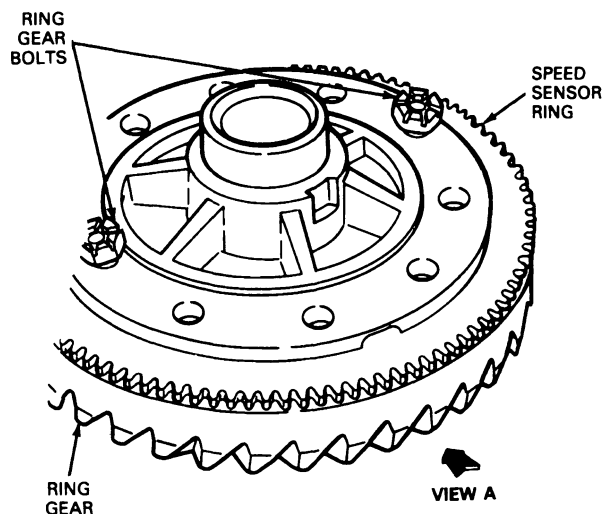
E5895-1A

REMOVAL AND INSTALLATION (Continued)

14. Align tab in speed sensor ring with slot in differential case. Start two ring gear bolts through the case into the ring gear to make sure ring gear bolt holes align with case bolt holes properly.

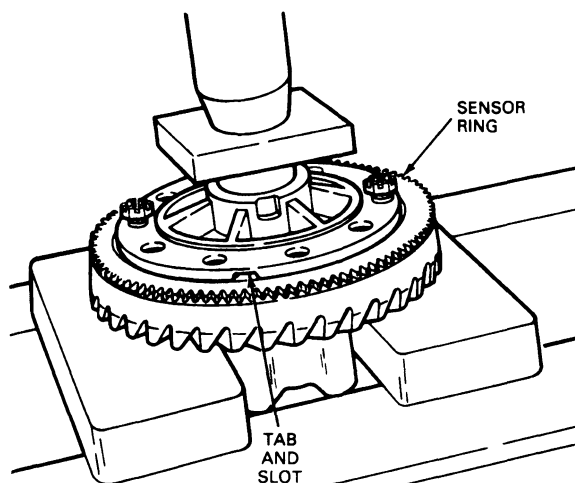
CAUTION: Tab on sensor ring must be aligned with slot in differential case.

Aligning Ring Gear and Case Bolt Holes



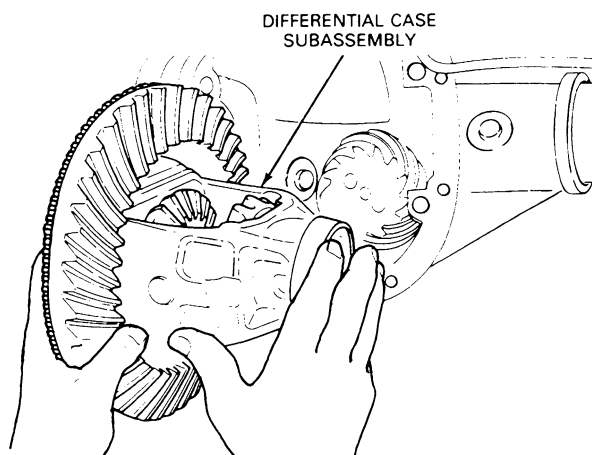
E7207-B

15. Press the sensor ring and ring gear on the differential case. The ring gear acts as a pilot for the sensor ring. Apply Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A) or equivalent to ring gear bolts and tighten to 136-163 N·m (100-120 ft-lb).



E7208-B

16. With pinion depth set and pinion installed, place differential case subassembly (with ring gear, speed sensor ring, thrust washers, side gears, bearings and cups) in carrier.

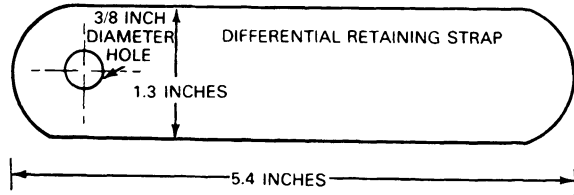


E4749-1B

NOTE: To simplify installation, fabricate two differential case retaining straps from metal stock as shown. These retaining straps will prevent the differential from falling out of the housing.

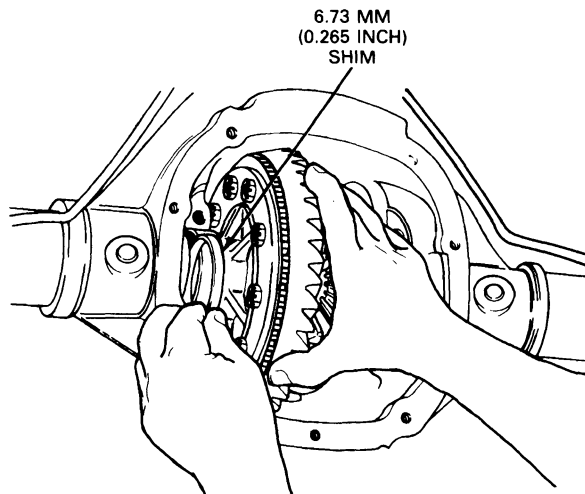
REMOVAL AND INSTALLATION (Continued)

17. Attach the straps at the 11 o'clock and 1 o'clock positions in the cover bolt holes. Install bolts and rotate straps to contact the bearing cups. Make sure access is available for shim installation.



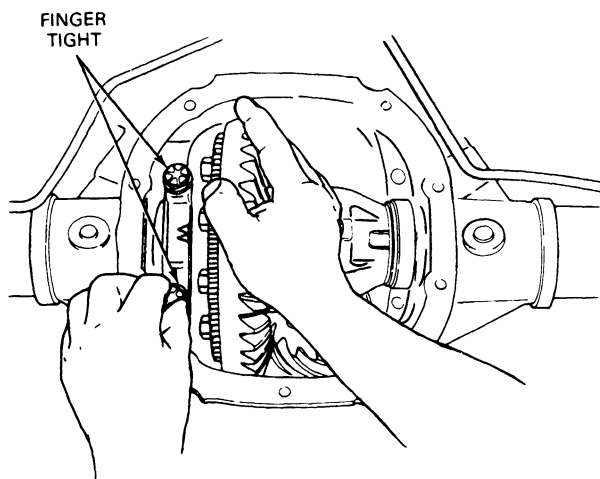
E5896-1A

18. Install a 6.73mm (0.265 inch) shim on left side.



E4750-D

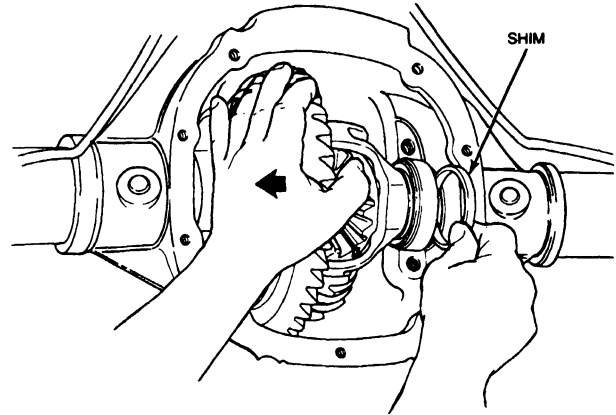
19. Install left bearing cap and tighten bolts finger-tight.



E4751-1B

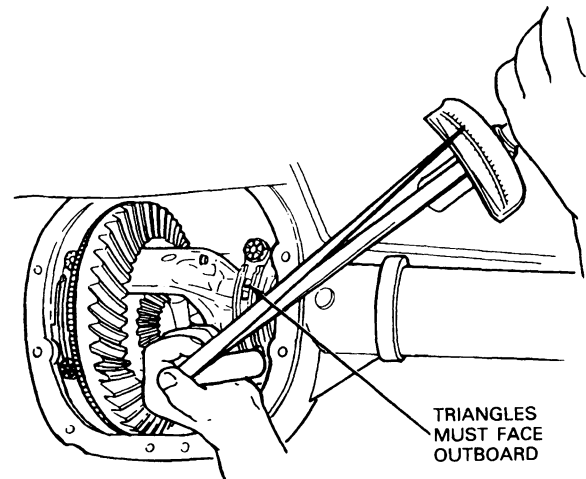
20. Install progressively larger shims on the right side until the largest shim selected can be installed by hand.

NOTE: Apply pressure toward left side to ensure that the left bearing cup is seated.



E4752-1A

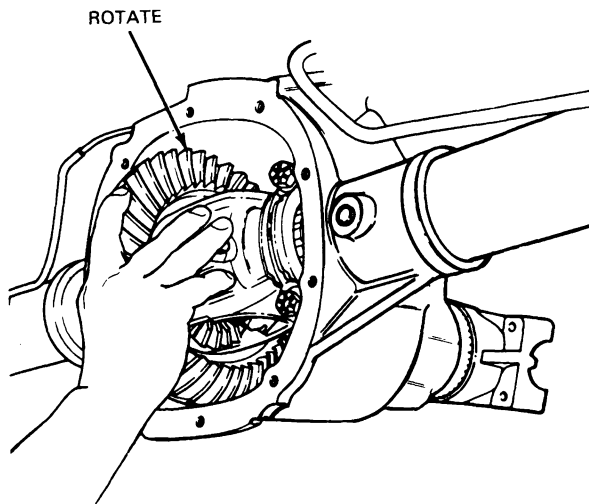
21. Install right side bearing cap and tighten bearing cap bolts to 95-115 N·m (70-85 ft·lb).



E9079-A

REMOVAL AND INSTALLATION (Continued)

22. Rotate assembly to make sure it rotates freely.



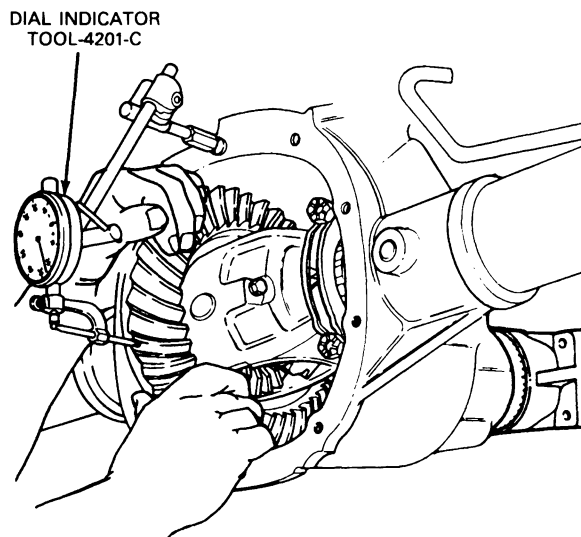
E9081-A

23. Check ring gear and pinion backlash with a Dial Indicator TOOL-4201-C.

If the backlash is 0.20-0.38mm (0.008-0.015 inch) (0.30-0.38mm [0.012-0.015 inch] preferred), proceed to Step 29.

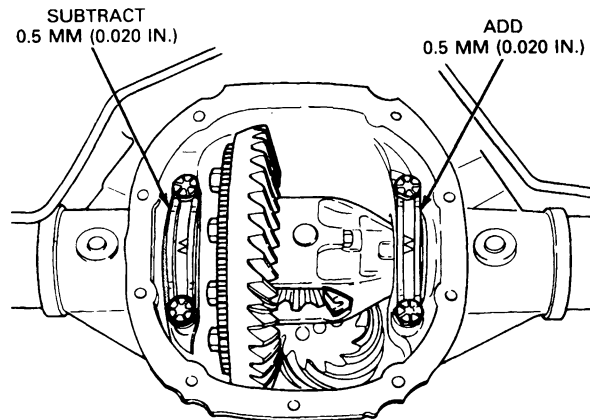
If the backlash is zero, proceed to Step 24.

If the backlash is 0.025-0.177mm (0.001-0.007 inch) or greater than 0.38mm (0.015 inch), proceed to Step 25.



E5897-B

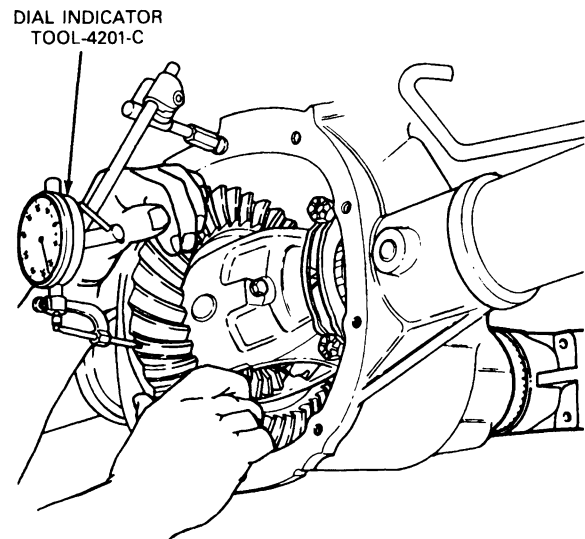
24. If a zero backlash condition occurs, add 0.50mm (0.020 inch) to the right side and subtract 0.50mm (0.020 inch) from the left side.



E4756-B

25. Recheck backlash. If backlash is within specification, go to Step 30.

If backlash is not within specification, proceed to Step 26.



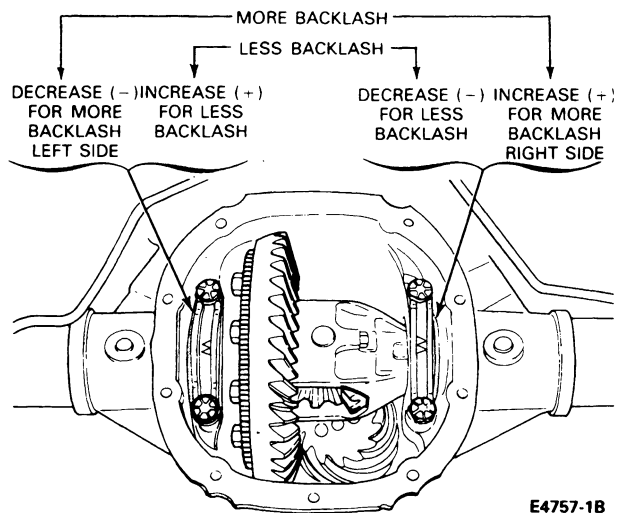
E5897-B

26. If backlash is 0.025-0.177mm (0.001-0.007 inch), or greater than 0.38mm (0.015 inch), correct backlash by increasing thickness of one shim and decreasing thickness of the other shim by the same amount. Refer to chart for approximate shim change.

REMOVAL AND INSTALLATION (Continued)

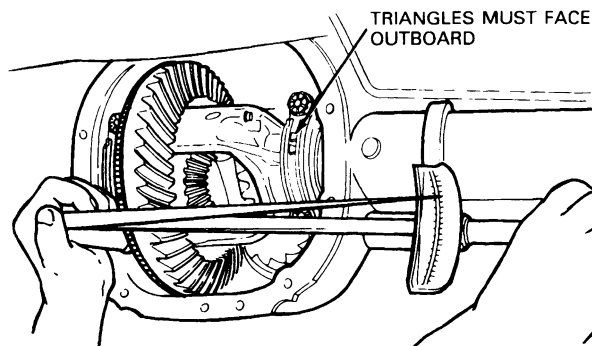
Backlash Change Required		Thickness Change Required		Backlash Change Required		Thickness Change Required	
mm	Inches	mm	Inches	mm	Inches	mm	Inches
.025	.001	.050	.002	.228	.009	.304	.012
.050	.002	.050	.002	.254	.010	.355	.014
.076	.003	.101	.004	.279	.011	.355	.014
.101	.004	.152	.006	.304	.012	.406	.016
.127	.005	.152	.006	.330	.013	.457	.018
.152	.006	.203	.008	.355	.014	.457	.018
.178	.007	.254	.010	.381	.015	.508	.020
.203	.008	.254	.010	—	—	—	—

TE5113A



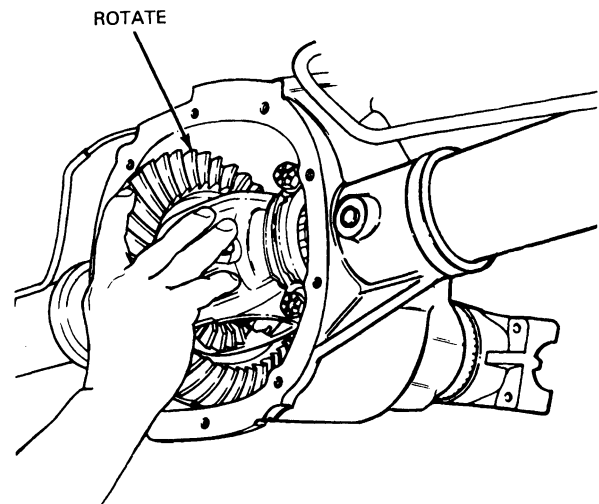
E4757-1B

27. Install shim and bearing caps. Tighten cap bolts to 109-128 N·m (80-95 ft·lb).



E4753-C

28. Rotate assembly several times to make sure differential bearings seat properly.



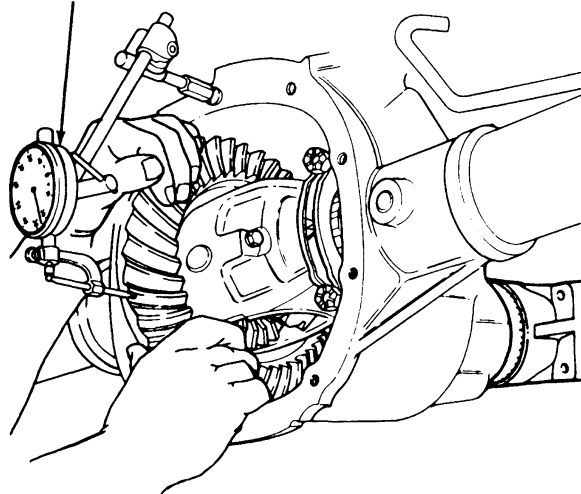
E9081-A

REMOVAL AND INSTALLATION (Continued)

29. Recheck backlash. If backlash is within specification, go to Step 30. If backlash is not within specification, repeat Step 26.

Backlash Specification: 0.20-0.38mm
(0.008-0.015 inch). Preferred range:
0.30-0.38mm (0.012-0.015 inch).

DIAL INDICATOR
TOOL-4201-C

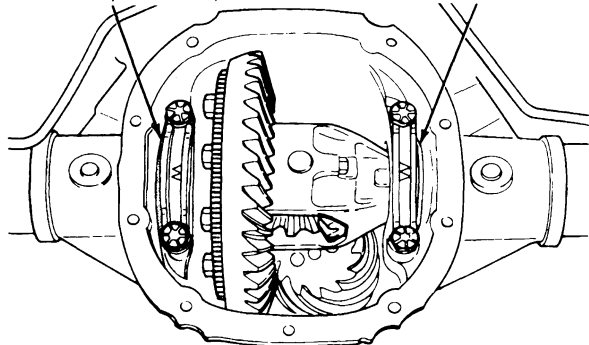


E5897-B

30. Remove bearing caps and bolts. To establish differential bearing preload, increase both left and right shim sizes by 0.152mm (0.006 inch). Make sure shims are fully seated and assembly turns freely.

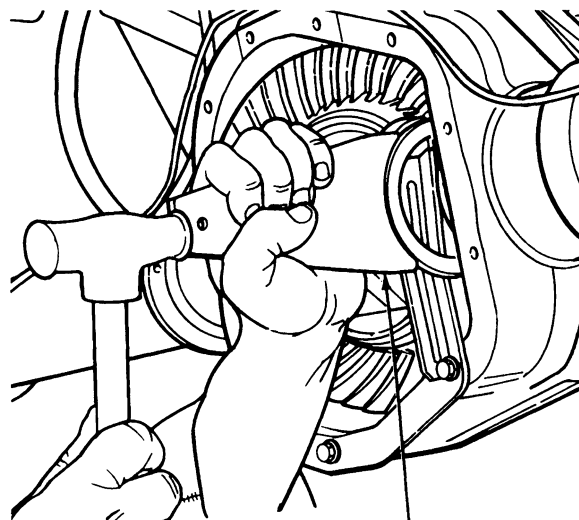
INCREASE
SHIM BY
0.152 MM (0.006 INCH)

INCREASE
SHIM BY
0.152 MM (0.006 INCH)



E4758-E

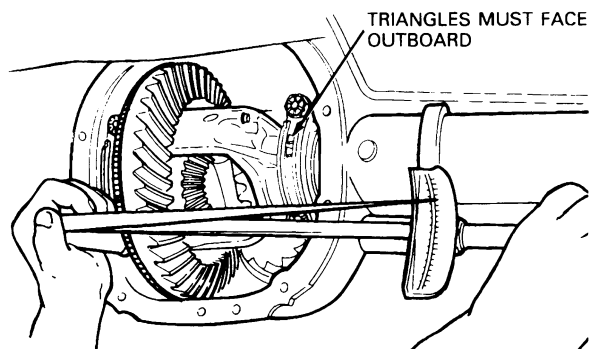
31. Install the shims by driving into position with Shim Driver T85T-4067-AH.



SHIM DRIVER
T85L-4067-AH

E5900-D

32. Install bearing caps and tighten cap bolts to 109-128 N-m (80-95 ft-lb). Recheck backlash. If not to specification, repeat Step 22.



E4753-C

33. Install the driveshaft. Align the scribe marks on the axle companion flange and driveshaft and connect the driveshaft.

Tighten attaching bolts and nuts to 11-20 N-m
(8-15 ft-lb).

34. Install the axle shafts and axle housing cover as described under Axle Shafts in this section.

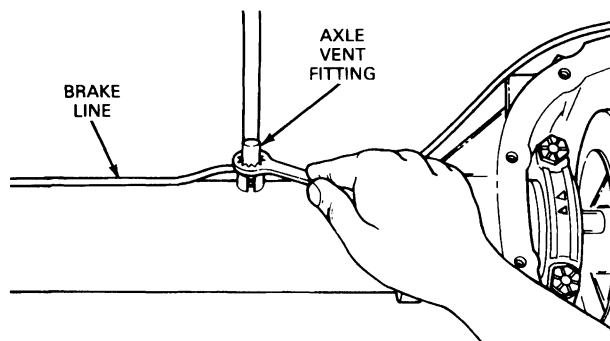
Axle Housing**Removal**

1. Raise the vehicle and install safety stands. Remove the rear wheels and tires and the brake drums.
2. Remove rear anti-lock brake sensor hold-down bolt, and carefully remove sensor. See Rear Anti-lock Brake System sensor in this section.

REMOVAL AND INSTALLATION (Continued)

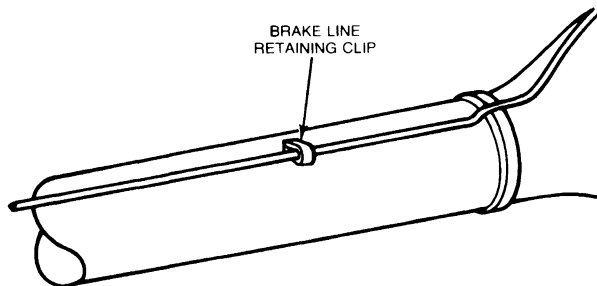
3. Mark the driveshaft axle end flange and the axle companion flange to make sure driveshaft is positioned properly during assembly. Disconnect the driveshaft from the rear axle companion flange. Remove the driveshaft.
4. Remove axle shafts (semi-float axle) or hub (full-float axle).
5. Disconnect brake lines at wheel cylinders.
6. Remove the four retaining nuts from each backing plate.
7. Disconnect the vent hose from the vent and the vent from the rear axle housing.

NOTE: The axle vent is secured to the housing assembly through the brake junction block.



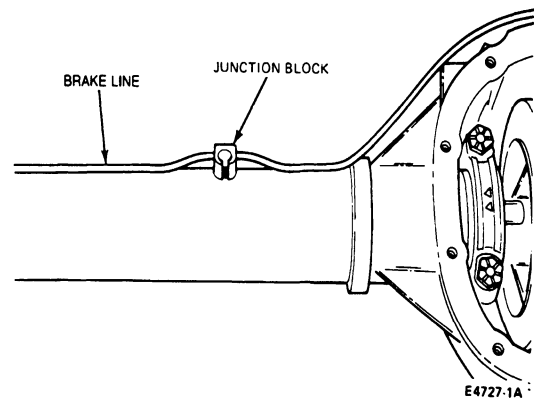
E4726-1B

8. Disengage the brake line from the clips that retain the line to the axle housing and carrier.



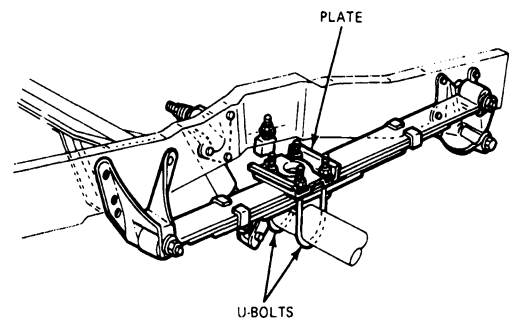
E4728-1A

9. Remove the hydraulic brake junction block and brake lines from the axle housing.

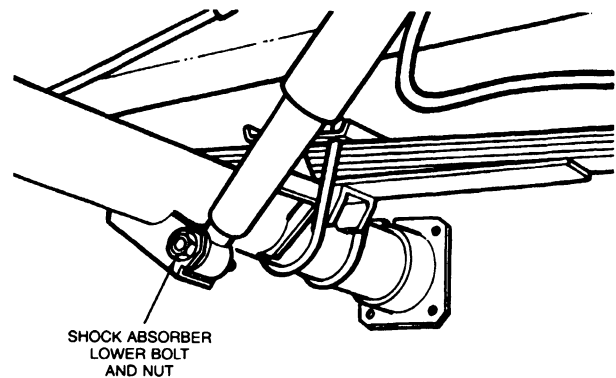


E4727-1A

10. Support the rear axle housing on a jack, and then remove the U-bolt nuts. Remove the U-bolts and plates.
11. Disconnect the shock absorber lower bolts from the mounting brackets on the axle housing.
12. Remove the housing from the vehicle.



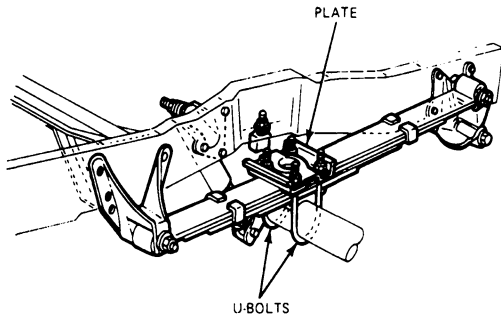
E4730-1A



E4729-1A

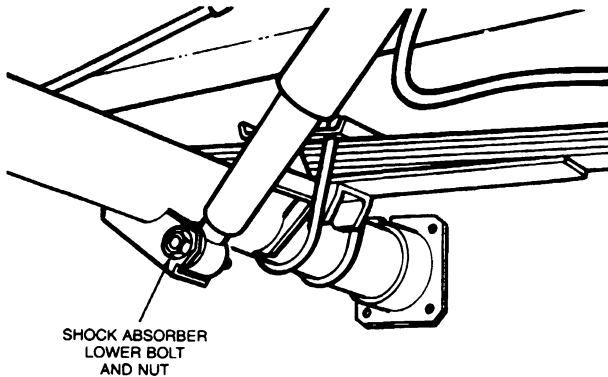
REMOVAL AND INSTALLATION (Continued)**Installation**

1. Raise the axle housing into position so that the U-bolt plates can be installed. Tighten the U-bolt nuts to the specification listed in Section 04-02. (There are different specifications, depending on the vehicle.)



E4730-1A

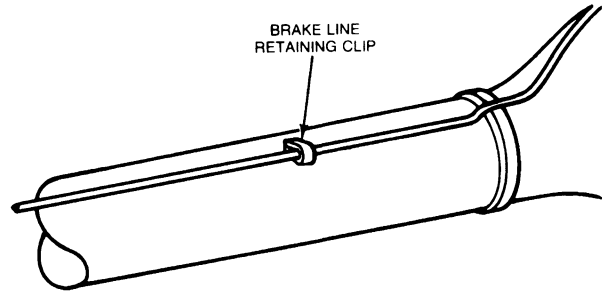
2. Connect the shock absorber lower bolts to the mounting bracket on the axle housing. Install the attaching nuts and tighten to the specification listed in Section 04-02.



E4729-1A

3. Insert the vent fitting into the hydraulic junction block and position the assembly over the housing vent hole. Hand start the vent fitting and tighten to 20 N·m (15 ft-lb).
4. Position the brake lines to the axle housing and secure with the retaining clips at the right axle tube and vent fitting through the junction block. Attach brake lines to wheel cylinders and bleed brake system. Refer to Section 06-00.
5. Install the brake backing plates on the axle housing flanges (no gaskets required). Tighten the attaching bolts to 68-115 N·m (50-85 ft-lb).
6. Align the scribe marks on the axle companion flange and driveshaft and connect the driveshaft. Tighten attaching bolts and nuts to 11-20 N·m (8-15 ft-lb).

7. Install rear anti-lock brake system sensor as outlined in this section.
8. Install the brake drums.
9. Install the wheel and tire. Tighten the wheel lugnuts to specification. Install the wheel covers.



E4728-1A

Rear Anti-lock Brake System Sensor**Removal**

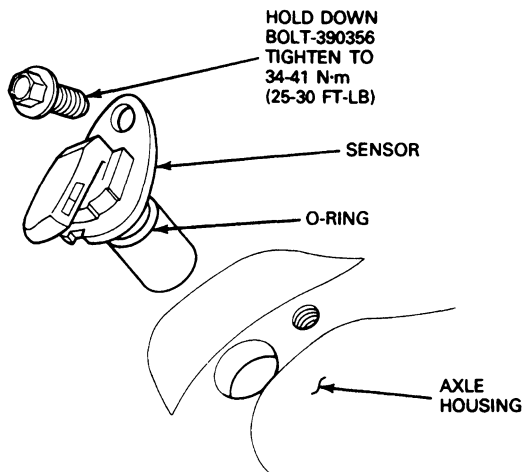
1. Remove sensor hold-down bolt. Remove sensor.
2. Clean axle mounting surface, using caution to prevent dirt from entering axle housing.

Installation

1. If new sensor is to be installed, lightly lubricate O-ring with motor oil.
 - a. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
 - b. Install hold-down bolt and tighten to 34-40 N·m (25-30 ft-lb).
2. If old sensor is to be reinstalled, clean and blow off metal particles using compressed air.
 - a. Remove and replace O-ring with a new O-ring.
 - b. Apply a light film of motor oil to O-ring.
 - c. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.

REMOVAL AND INSTALLATION (Continued)

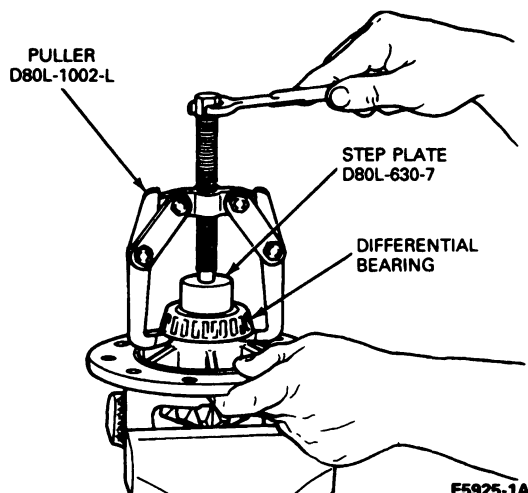
- d. Install hold-down bolt and tighten to 34-40 N·m (25-30 ft·lb).



E7209-1C

DISASSEMBLY AND ASSEMBLY**Differential Case****Disassembly**

1. If required, remove the ring gear, speed sensor ring, side gears, pinion gears and thrust washers.
2. Remove the differential case from the housing and remove the differential bearings from the case using Puller D80L-1002-L and Step Plate D80L-630-7 or equivalents.

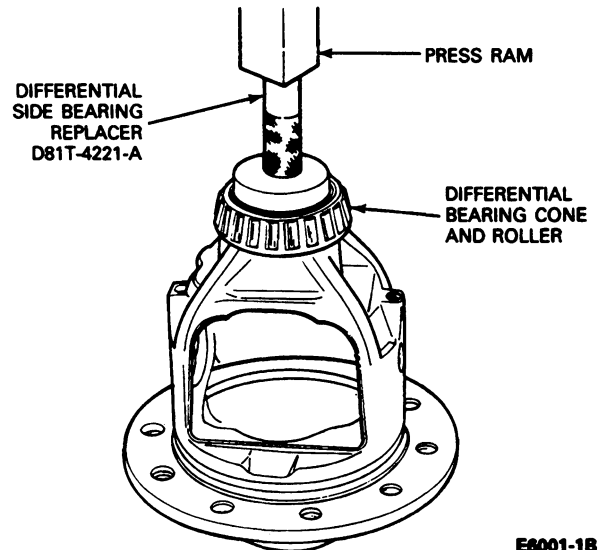


E5925-1A

Assembly

1. Install differential bearings on the case hubs using Differential Bearing Cone Replacer D81T-4221-A.

NOTE: Press against the bearing cone only.



E6001-1B

2. Press the ring gear and speed sensor ring onto the differential case, and install the attaching bolts. Tighten the bolts to 135-162 N·m (100-120 ft·lb).

CAUTION: Before performing this step, refer to ring gear / speed sensor ring installation procedures in this section.

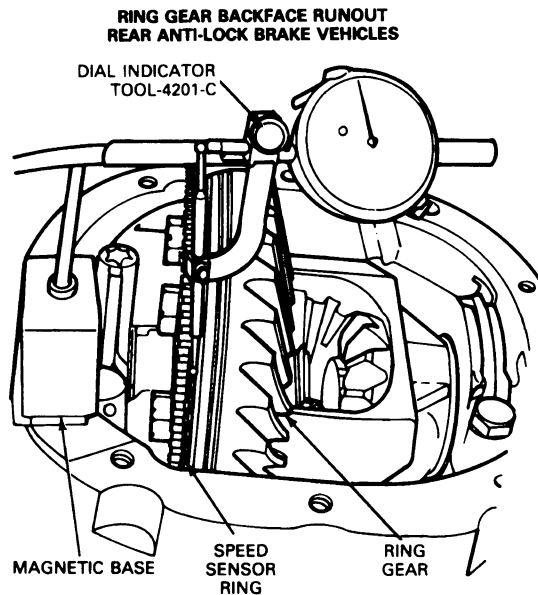
CLEANING AND INSPECTION**Inspection Before Disassembly**

The differential case assembly and drive pinion should be inspected before they are removed from the carrier casting. These inspections can determine the cause of the concern and the resolution.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and / or damage.
2. Rotate the gears to see if there is any roughness which would indicate damaged bearings or gears.

CLEANING AND INSPECTION (Continued)

3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks / chips.

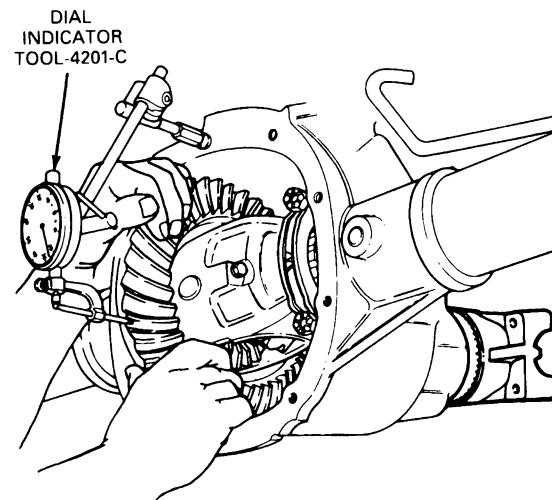


E7162-C

4. Set up a dial indicator and check ring gear backlash and ring gear backface runout. Backlash should be 0.20-0.38 mm (0.008-0.015 inch), with 0.30-0.38 mm (0.012-0.015 inch) preferred. To check ring gear backface runout, mount Dial Indicator with Bracketry TOOL-4201-C or equivalent on the carrier so the tip of the dial indicator contacts the backface of the ring gear. Backface runout should be no more than 0.101mm (0.004 inch).

NOTE: There is a space provided between the speed sensor ring and the ring gear for measuring ring gear backface runout.

5. A contact pattern is not an acceptable guide to check for noise. Proper gear set assembly must be checked using the Rear Axle Pinion Depth Gauge Tool set T74P-4020-A or equivalent which shows the correct pinion shim required to assure acceptable running condition.

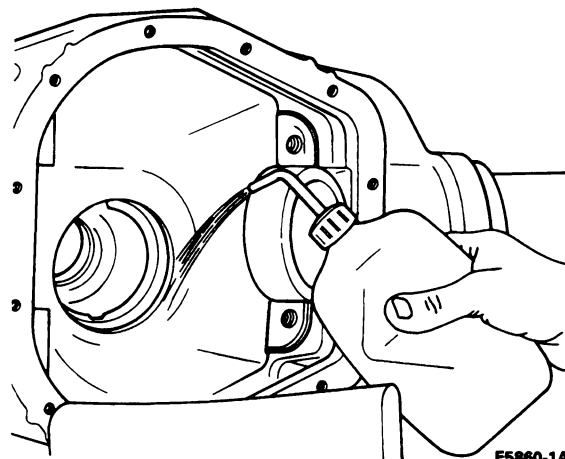


RING GEAR BACKLASH

E9082-A

Inspection After Disassembly

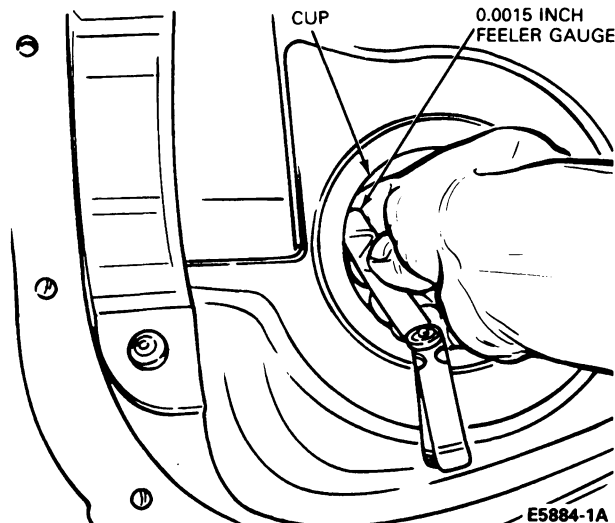
1. Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air.
2. Oil the bearings immediately to prevent rusting.
3. Inspect the parts for any major damage.
4. Clean the inside of the housing before rebuilding. When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly. Inspection procedures for individual parts are outlined as follows.



E5860-1A

CLEANING AND INSPECTION (Continued)**Bearing Cups**

Check bearing cups for deep scores, galling, or spalling. If a 0.0381mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup must be re-seated.

**Cone and Roller Assemblies**

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

Companion Flange

Be sure that the flange half-rounds and lugs have not been damaged in removing the driveshaft or in removing the flange from the pinion. The end of the flange that contacts the bearing cone as well as the nut counterbore and seal surface must be smooth and free of nicks.

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Carrier Housing

Make sure that the differential and pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores. Check for cracks in thrust washers.

SPECIFICATIONS**TORQUE SPECIFICATIONS (INTEGRAL CARRIER)**

Description	N-m	Lb-Ft
Differential Bearing Cap Bolt	109-129	80-95
Differential Pinion Shaft Lock Bolt Using Loctite E0AZ-19554-B (or equivalent)	20-40	15-30
Ring Gear Attaching Bolts Using Loctite E0AZ-19554-B (or equivalent)	136-163	100-120
Rear Cover Screw	38-52	28-38
Ratio Tag Hold-Down Bolt	24-38	18-28
Oil Filler Plug	20-40	15-30
Brake Backing Plate Nuts — E-250, F-250	68-95	50-70
Driveshaft to Axle Companion Flange	11-20	8-15
Axle Vent	20	15
Wheel Lug Nut (Both Single and Dual Rear Wheel)	190	140
Rear Anti-lock Brake System Sensor Bolt	34-40	25-30

ADJUSTMENT TORQUE SPECIFICATIONS (INTEGRAL CARRIER)

Description	N-m	Ft-Lb
Minimum torque required to tighten pinion flange nut to obtain correct pinion bearing preload	217	160*
Pinion Bearing Preload (Collapsible Spacer)		
— Used bearings	.9-1.5	8-14 In-Lb
— New bearings	1.8-3.3	16-29 In-Lb

- a If pinion bearing preload exceeds specifications before this torque is obtained, install a new collapsible spacer.

TE5904A

SPECIFICATIONS (Continued)

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER)

Vehicle	Axle	Approximate Lubricant Capacity (In-Vehicle Repair) ^{a,b}		
		U.S. Pints	Imperial Pints	Liters
F-250, F-350 Regular & Chassis CAB, F-250/350 H.D.	10.25-Inch Ring Gear	6.5 ^{c,d}	5.4	3.0

- a Ford design conventional Axles use Rear Axle Lubricant XY-90-QL or -KL (ESP-M2C154-A) or equivalent.
 b Service refill capacities are determined by filling the axle with the specified lubricant to the bottom of the filler hole with the vehicle in running position.
 c Plus 8 oz. (U.S. measure) additive friction modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent for limited-slip applications.
 d Rear axle lube quantities must be replaced every 100,000 miles (160 000 km) or if the axle has been submerged in water. Otherwise, the lube should not be checked or changed unless a leak is suspected or repair required.

NOTE: 6.5 pints of lubricant is the fill specification when the axle is installed in the vehicle. If the axle is out of the vehicle, fill with 7.5 pints of specified lubricant.



TE6524A

CLEARANCE, TOLERANCE AND ADJUSTMENTS (INTEGRAL CARRIER)

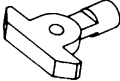
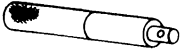



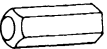
Description	mm	Inches
Maximum Runout of Back Face of Ring Gear	0.101	0.004
Maximum Runout of Back Face of Differential Case Flange	0.076	0.003
Differential Side Gear Thrust Washer Thickness	0.76-0.81	0.030-0.032
Differential Pinion Gear Thrust Washer Thickness	0.76-0.81	0.030-0.032
Nominal Pinion Locating Shim	0.76	0.030
Available Pinion Gear Shims in Steps of 0.001 Inch	0.53-0.94	0.021-0.037
Backlash Between Ring Gear & Pinion Teeth	0.20-0.38 (0.30-0.38 Preferred)	0.008-0.015 (0.012-0.015 Preferred)
Maximum Backlash Variation Between Teeth	0.101	0.004
Maximum Radial Runout of Companion Flange in Assembly	0.304	0.012 T.I.R.
Sensor Pole to Top of Sensor Ring Gap	0.127-1.143	0.005-0.045

TE9080A

SPECIAL SERVICE TOOLS





Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T75L-1165-B Axle Bearing / Seal Plate	 T75L-1165-B




(Continued)

Tool Number / Description	Illustration
T85T-1225-AH Axle Bearing Remover	 T85T-1225-AH
T80T-4000-W Driver Handle	 T80T-4000-W
T80T-4000-Y Rear Axle Seal Replacer	 T80T-4000-Y
T79P-4020-A Pinion Depth Gauge Kit	 T79P-4020-A
T85T-4067-AH Shim Driver	 T85T-4067-AH
T85T-4209-AH Pinion Shaft Thread Protector	 T85T-4209-AH

(Continued)

SPECIAL SERVICE TOOLS (Continued)

Tool Number/ Description	Illustration
T85T-4616-AH Pinion Bearing Cup Replacer	 T85T-4616-AH
T71P-4621-B Pinion Bearing Cone Remover	 T71P-4621-B
T85T-4621-AH Inner Pinion Bearing Cone Replacer	 T85T-4621-AH
T83T-4676-A Pinion Seal Replacer	 T83T-4676-A
(Continued)	

Tool Number/ Description	Illustration
T57T-4851-B Companion Flange Holding Tool	 T57T-4851-B
T85T-4851-AH Companion Flange Replacer	 T85T-4851-AH
TOOL-4201-C Dial Indicator With Bracketry	 TOOL-4201-C

SECTION 05-02B Wheel Hubs and Bearings, Ford Full Floating Axle

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION		REMOVAL AND INSTALLATION	
Full Floating Hub Assembly.....	05-02B-1	Axle Shaft, Hub, Oil Seal and Outer Wheel Bearing.....	05-02B-2
DISASSEMBLY AND ASSEMBLY		SPECIAL SERVICE TOOLS.....	05-02B-13
Hub, Full Floating Axle.....	05-02B-8	SPECIFICATIONS.....	05-02B-13
		VEHICLE APPLICATION.....	05-02B-1

VEHICLE APPLICATION

F-250 HD and F-350 Vehicles

DESCRIPTION

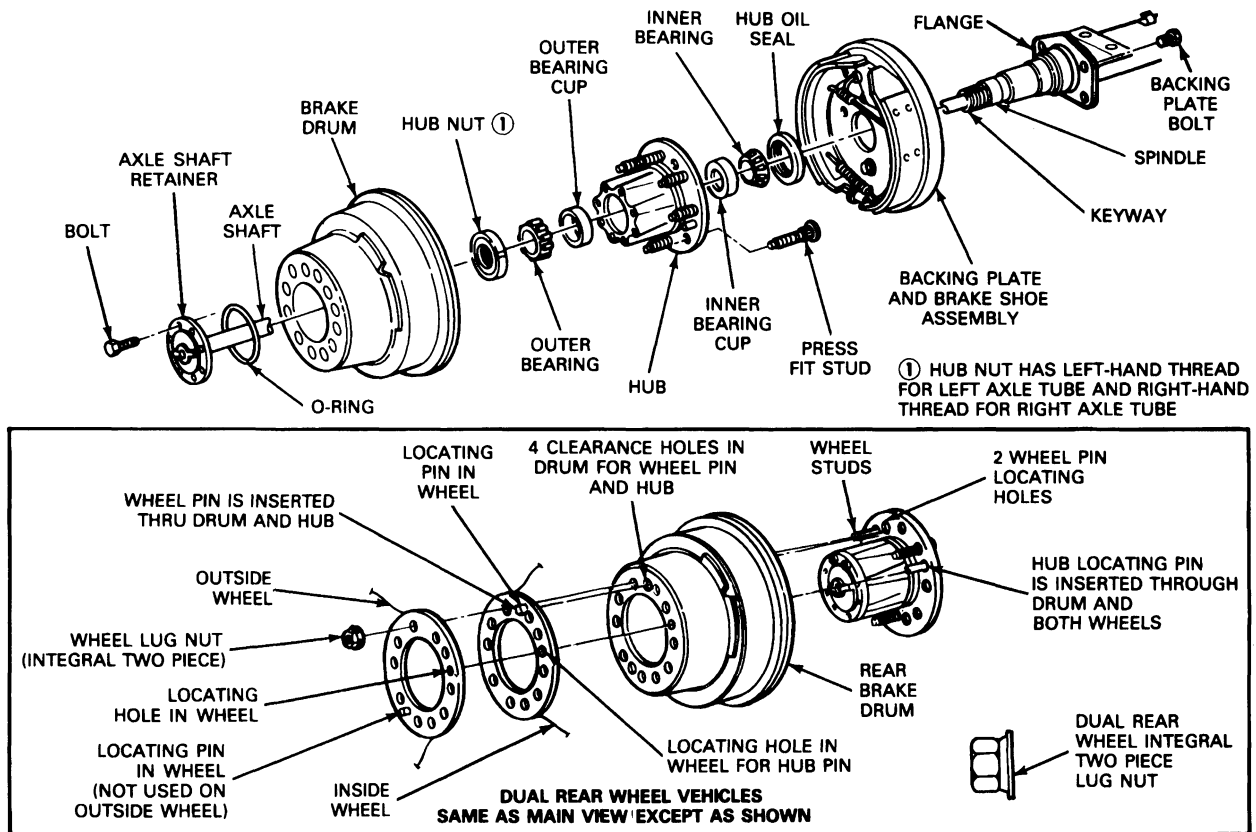
Full Floating Hub Assembly

The full floating rear axle features brake drums that are mounted outboard of the hub. Therefore, when brake inspection or replacement is required the hub assembly need not be removed.

The hub is supported or floats on the axle spindle on two opposed tapered roller bearings. It is retained on the spindle by a ratcheting nut that is tabbed to a slot on the spindle. **If, for any reason, the hub is removed from the spindle, the old hub seal must be removed and a new hub seal installed.**

DESCRIPTION (Continued)

Wheel Hub and Bearing Assembly, Ford Full Floating Axle



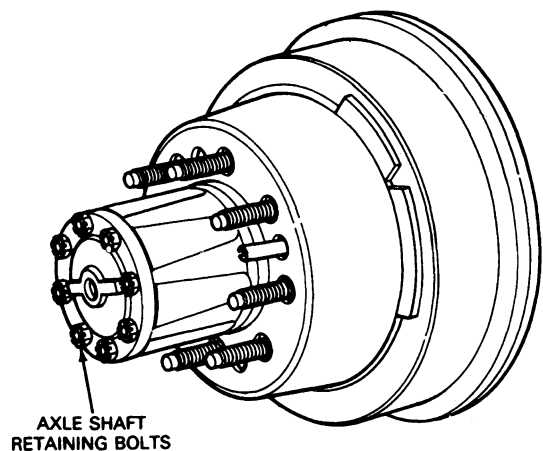
E8736-B

REMOVAL AND INSTALLATION

Axle Shaft, Hub, Oil Seal and Outer Wheel Bearing

Removal

1. Set the parking brake and loosen the eight axle shaft retaining bolts.
2. Raise the vehicle to the desired working height, keeping the axle parallel with the floor.
3. Release parking brake and back off the rear brake adjustment, if necessary.
4. Remove the wheel and tire assembly.

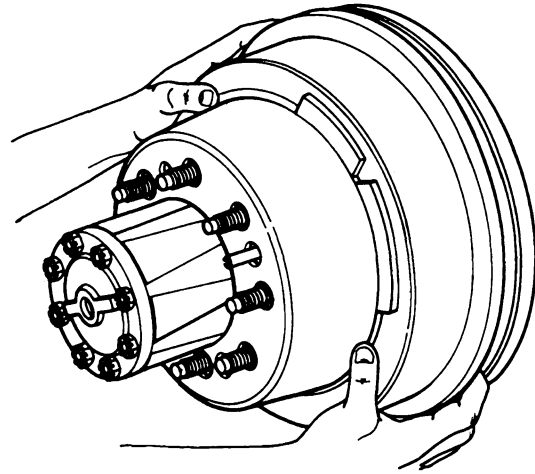


E6473-1A

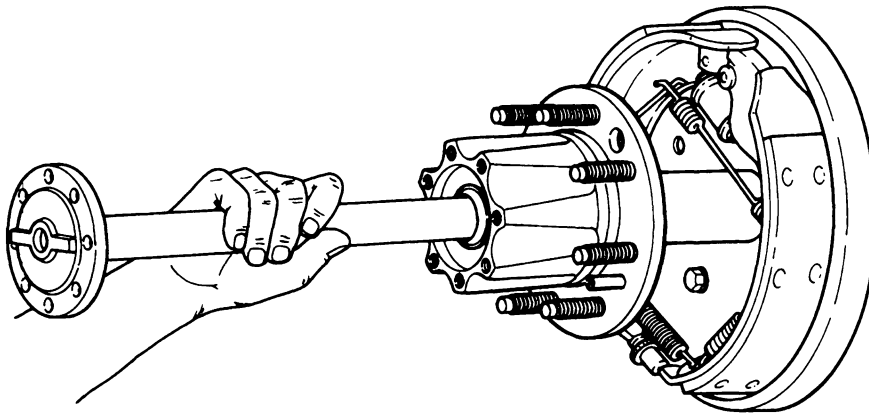
REMOVAL AND INSTALLATION (Continued)

5. Remove brake drum. If so equipped, push-on (sheet metal) drum retainer nuts may be discarded.

NOTE: Push-on retainer nuts are used for shipping purposes only and have no effect on vehicle function.

**E6474-1A**

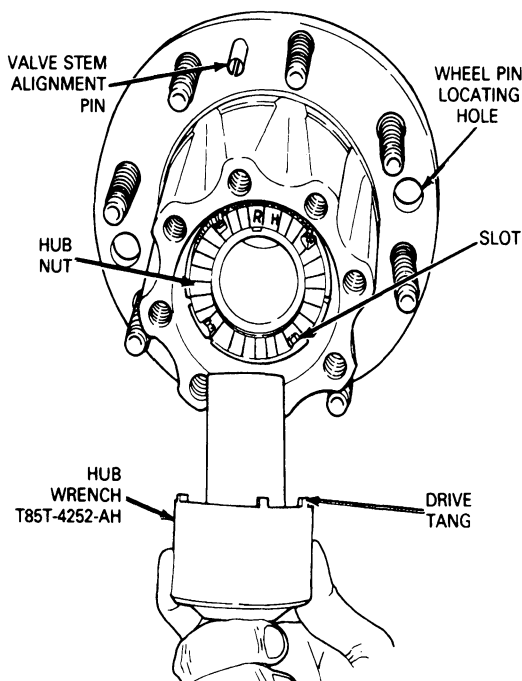
6. Remove the eight 7 / 16-inch axle shaft bolts and remove the axle shaft.

Axle Shaft Removal**E6475-2A**

REMOVAL AND INSTALLATION (Continued)

7. Install Hub Wrench T85T-4252-AH so that the drive tangs of the tool engage the four slots in the hub nut.

CAUTION: The hub nuts are right-hand thread (right hub) and left-hand thread (left hub). Each hub nut is stamped RH for the right hub nut or LH for the left hub nut.

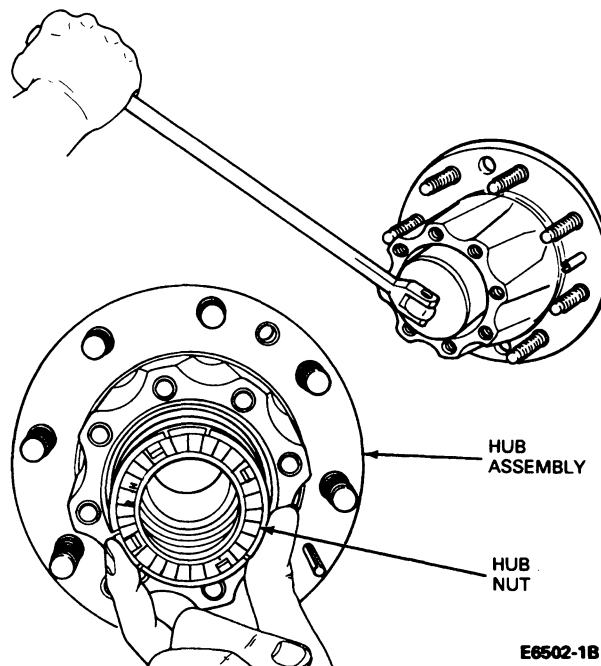


E6501-1B

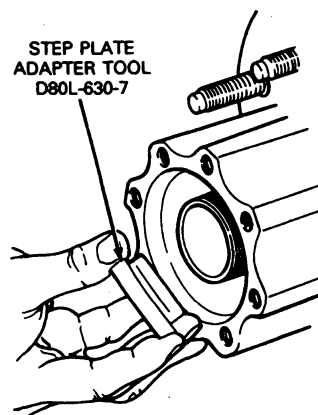
8. Remove hub nut (counterclockwise for right-hand thread; clockwise for left-hand thread).

CAUTION: Under no circumstances are power impact tools to be used when performing these operations.

NOTE: The hub nut will ratchet during this operation.



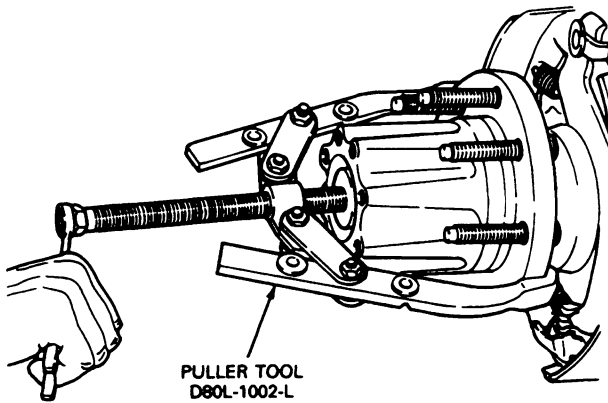
9. Install Step Plate Adapter Tool D80L-630-7.



E6503-1A

REMOVAL AND INSTALLATION (Continued)

10. Install Puller Tool D80L-1002-L or equivalent and loosen hub to the point of removal. Remove puller tool and step plate.



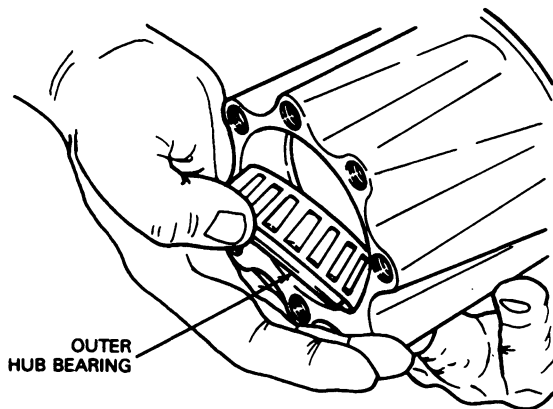
E6504-1A

11. Remove hub assembly.

CAUTION: Do not drop outer hub bearing.

12. To replace hub oil seal, refer to Hub Disassembly and Assembly in this section.

NOTE: The inner bearing is located behind the hub oil seal.



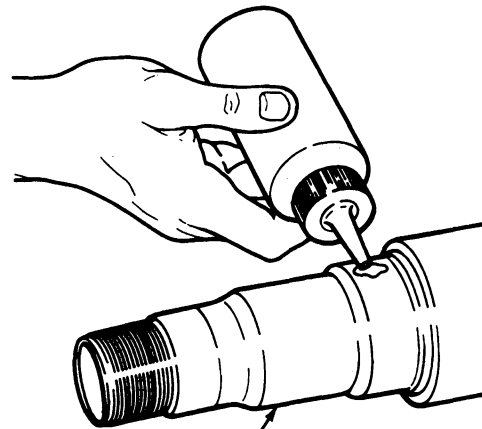
E6506-1A

Installation

1. Clean spindle thoroughly after hub removal, then coat the spindle with axle lubricant.

NOTE: Hub bearings must be prelubed with grease prior to installation. Use Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.

2. Pack each bearing cone and roller assembly with a bearing packing tool, using Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.



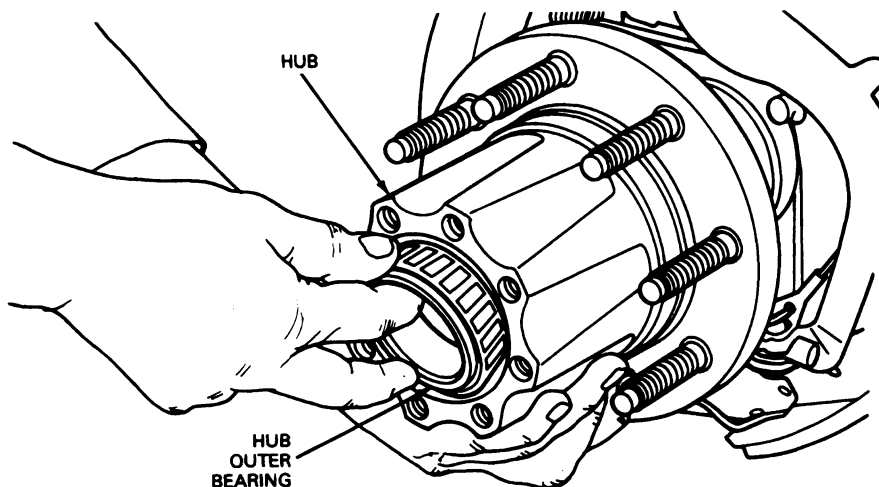
E6506-1A

3. Coat the spindle with recommended axle lubricant. Push hub and hub outer bearing onto spindle.

NOTE: Installing the hub in this manner causes the hub outer bearing to act as a pilot making the installation easier.

REMOVAL AND INSTALLATION (Continued)

Hub and Hub Outer Bearing Installation

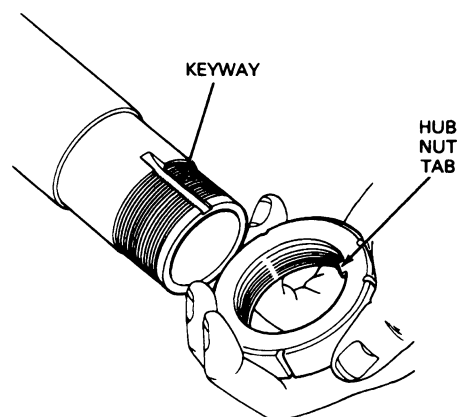
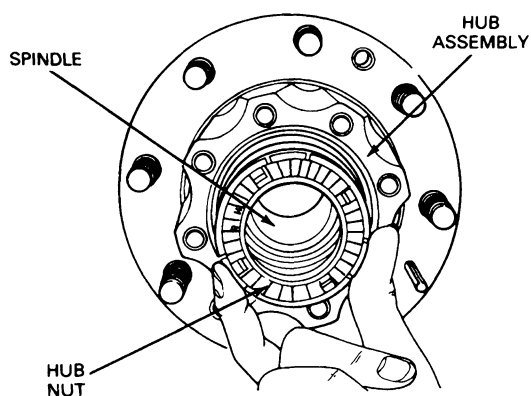


E6507-2A

4. Install the hub nut on the spindle. Turn hub nut clockwise for right-hand thread, counterclockwise for left-hand thread.

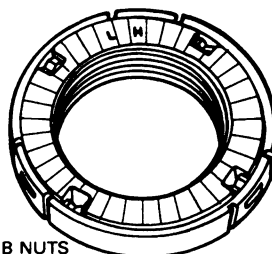
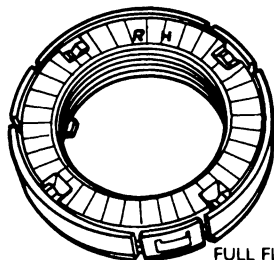
CAUTION: Make sure the hub nut tab is located in the keyway prior to thread engagement.

Hub Nut Installation



RIGHT HAND THREAD
(INSTALL CLOCKWISE)

LEFT HAND THREAD
(INSTALL COUNTER-CLOCKWISE)



FULL FLOAT AXLE HUB NUTS

E6508-2C

REMOVAL AND INSTALLATION (Continued)

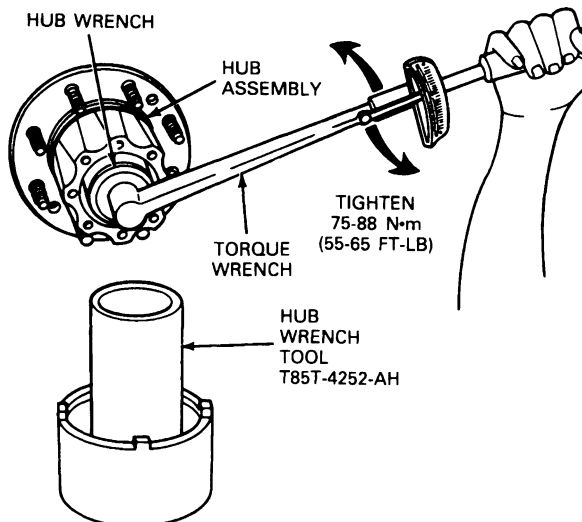
5. Install Hub Wrench Tool T85T-4252-AH on spindle.
6. Tighten hub nut to 75-88 N·m (55-65 ft-lb). Rotate hub occasionally while tightening.

NOTE: The hub nut will ratchet as torque is applied.

7. Hub nut adjustment:
 - a. For new bearings, after tightening to specification 75-88 N·m (55-65 ft-lb), ratchet back five teeth or notches on the hub nut. Five clicks must be heard during this operation in order to have performed it correctly.
 - b. For used bearings, after tightening to specification 75-88 N·m (55-65 ft-lb), ratchet back eight teeth or notches on the hub nut. Eight clicks must be heard during this operation in order to have performed it correctly.

Hub Nut Adjustment, New Bearings

AFTER TIGHTENING TO 75-88 N·m (55-65 FT-LB) RATCHET BACK (BACK OFF) 5 NOTCHES ("CLICKS")
NOTE: FIVE (5) NOTCHES — 1/8 TURN



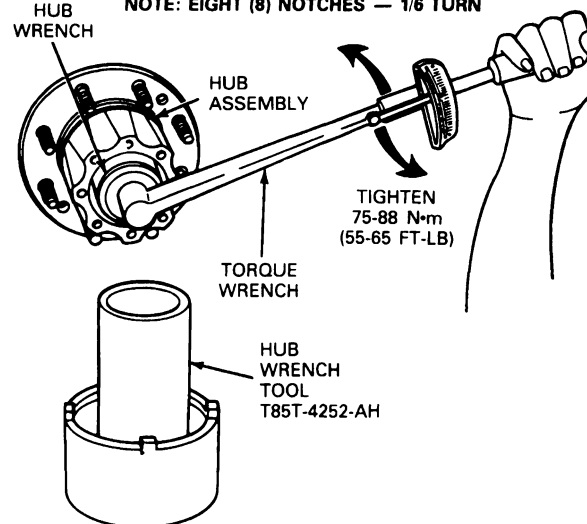
NEW BEARINGS

CAUTION: THIS OPERATION PICTURES A RIGHT HAND THREAD NUT BEING TIGHTENED. REVERSE THIS PROCEDURE FOR LEFT HAND THREAD NUT.

E8946-A

Hub Nut Adjustment, Used Bearings

AFTER TIGHTENING TO 75-88 N·m (55-65 FT-LB) RATCHET BACK (BACK OFF) 8 NOTCHES ("CLICKS")
NOTE: EIGHT (8) NOTCHES — 1/6 TURN



CAUTION: THIS OPERATION PICTURES A RIGHT HAND THREAD NUT BEING TIGHTENED. REVERSE THIS PROCEDURE FOR LEFT HAND THREAD NUT.

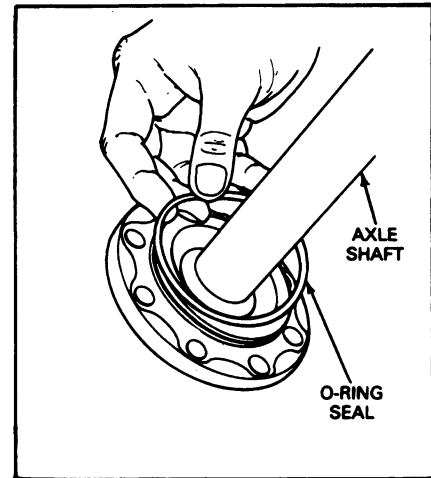
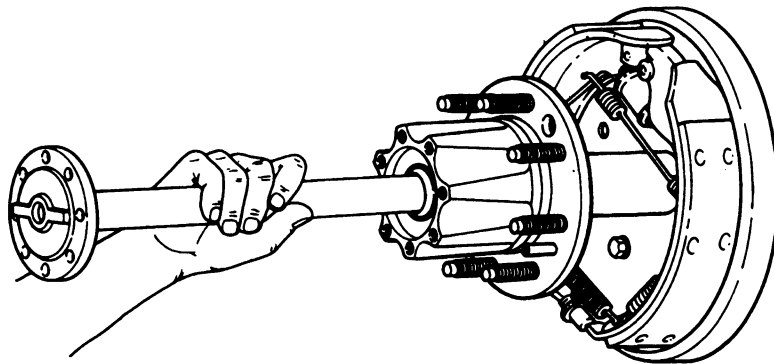
USED BEARINGS

E8947-A

8. Inspect axle shaft O-ring seal for cracks, nicks or wear and replace if required.
9. Install the axle shaft.
10. Coat the threads of all eight axle shaft retaining bolts with Loctite® or equivalent.
11. Install and tighten axle shaft retaining bolts until they seat.

REMOVAL AND INSTALLATION (Continued)

Axle Shaft Installation

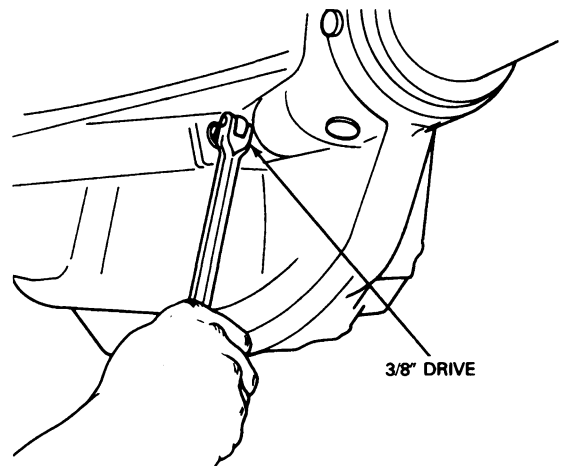


E6510-2A

NOTE: Prior to installing drum, adjust brake so that brake diameter is 0.762mm (0.030 inch) less than drum diameter.

CAUTION: Remember, the last step of this procedure is to tighten the axle shaft bolts to specification, after the wheel lugnuts have been tightened.

12. Install brake drum.
13. Install wheel and tire assembly.
14. Loosen filler plug. If axle lube begins to seep out, retighten filler plug. If there is no lubricant seepage, remove filler plug and fill to bottom of filler plug hole with specified lubricant.
15. Wipe particles off magnetic fill plug.
16. Install filler plug and tighten to 21-40 N·m (15-30 ft-lb).
17. Lower the vehicle.
18. Make brake adjustments if necessary.
19. Tighten wheel lugnuts, Single Rear Wheel (SRW) and/or Dual Rear Wheels (DRW) to 190 N·m (140 ft-lb).
20. Tighten eight axle shaft retaining bolts to 82-108 N·m (60-80 ft-lb).



E6511-1B

DISASSEMBLY AND ASSEMBLY

Hub, Full Floating Axle

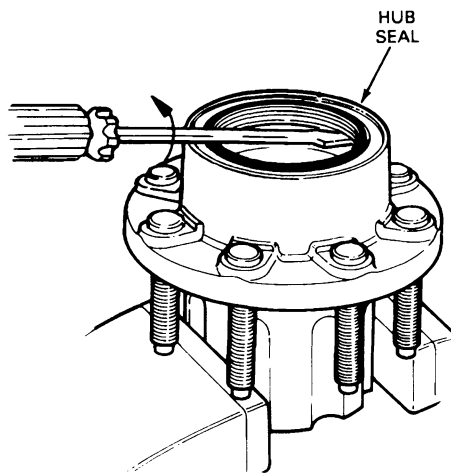
Disassembly

1. Install hub in soft-jawed vise and remove hub seal as shown.

NOTE: Use thin blade screwdriver to pry up seal from bottom of bore. Then use larger blade to finish removal.

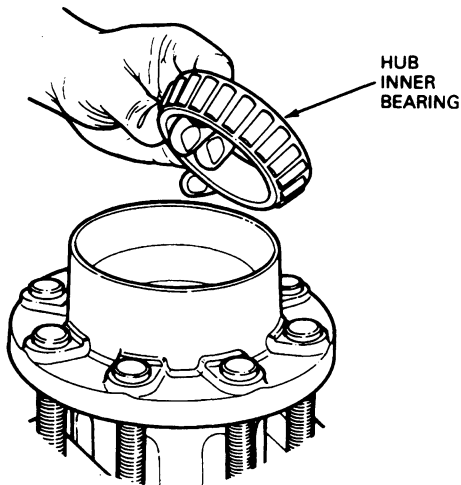
DISASSEMBLY AND ASSEMBLY (Continued)

CAUTION: Care must be taken not to damage hub seal bore with seal removal tool.



E6513-C

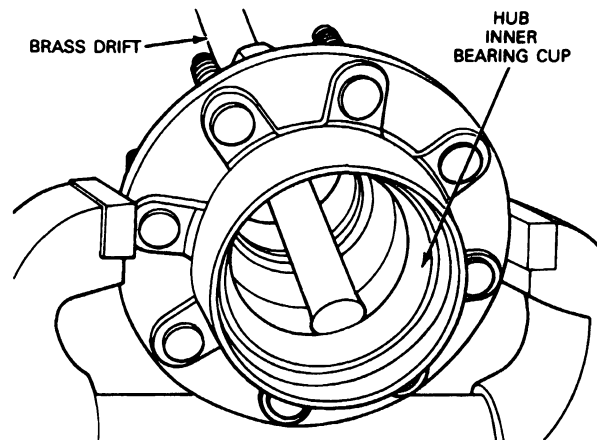
2. Remove hub inner bearing.



E6514-1A

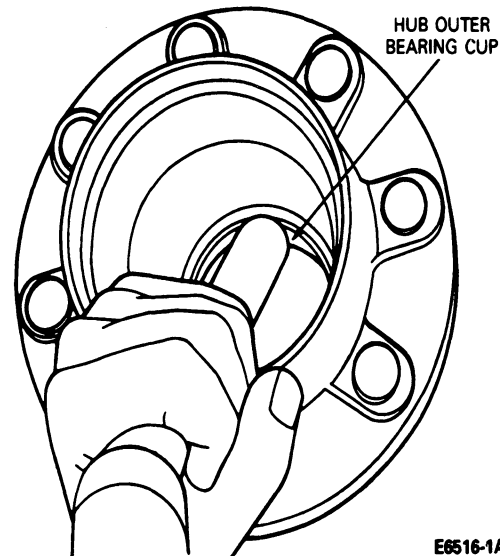
3. Re-position the hub in the vise and remove the hub inner bearing cup with a brass drift.

CAUTION: Make sure hub is secure in vise.



E6515-1A

4. Re-position the hub in the vise and remove the hub outer bearing cup with a brass drift.



E6516-1A

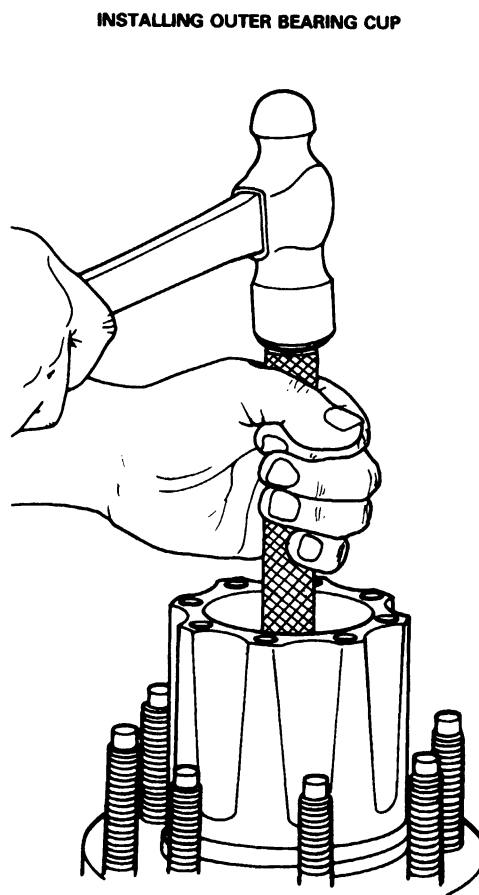
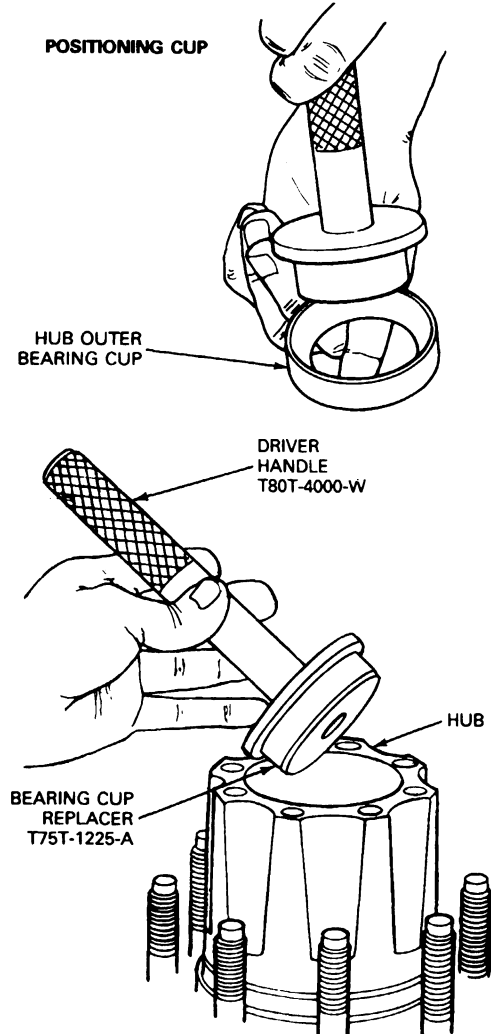
Assembly

1. Place the outer bearing cup in the hub.
2. Position Bearing Cup Replacer T85T-1225-A and Driver Handle T80T-4000-W or equivalents squarely into hub and strike handle until outer bearing is fully seated.

CAUTION: Bearing cup replacer must be held straight during installation to make sure bearing cup seats properly.

DISASSEMBLY AND ASSEMBLY (Continued)

Outer Bearing Cup Installation



E6517-2B

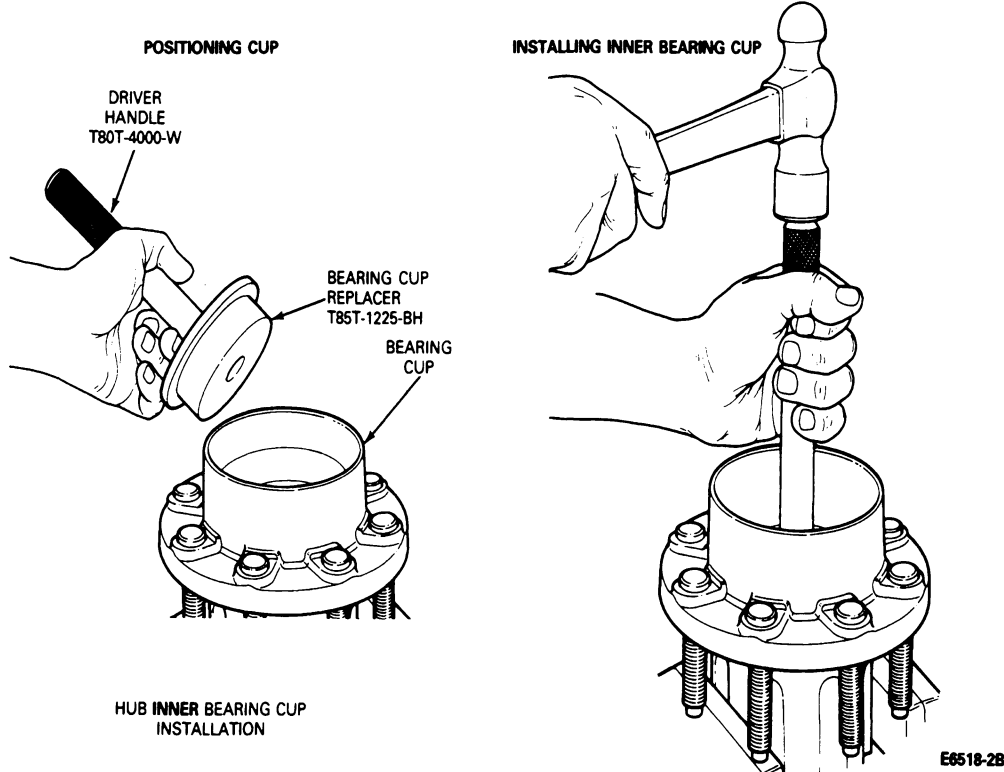
3. Place the inner bearing cup in the hub.

4. Position Bearing Cup Replacer T85T-1225-BH and Driver Handle T80T-4000-W or equivalents squarely into hub and strike handle until outer bearing is seated.

CAUTION: Bearing cup replacer must be held straight during installation to make sure bearing cup seats properly.

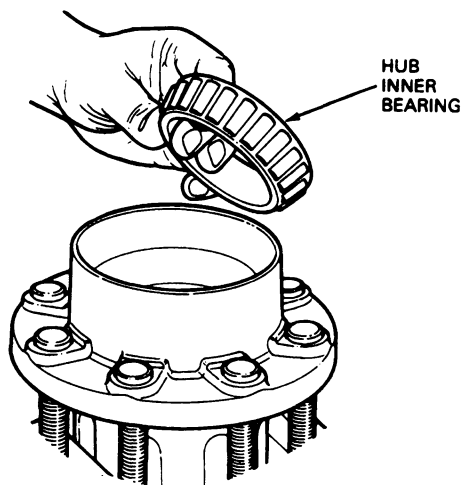
DISASSEMBLY AND ASSEMBLY (Continued)

Inner Bearing Cup Installation



5. Place hub inner bearing in the cup.

NOTE: Hub bearings must be prelubed with grease prior to installation. Use Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Pack each bearing cone and roller assembly with a bearing packing tool using Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.



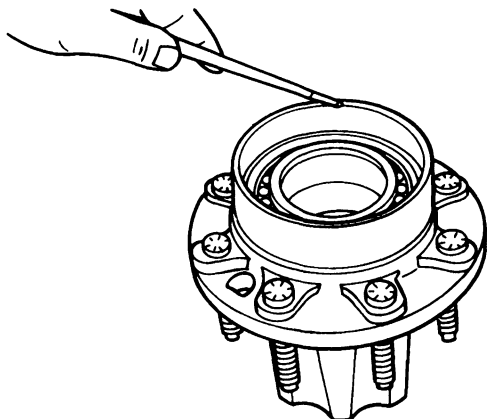
6. Thoroughly clean and inspect hub bore.

CAUTION: Make sure hub bore is free of dirt, grease, burrs or nicks.

NOTE: Hub bearings must be prelubed with grease prior to installation. Use Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.

DISASSEMBLY AND ASSEMBLY (Continued)

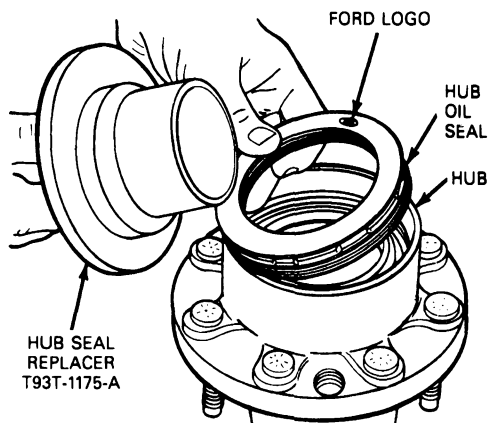
Pack each bearing cone and roller assembly with a bearing packing tool.



E8776-A

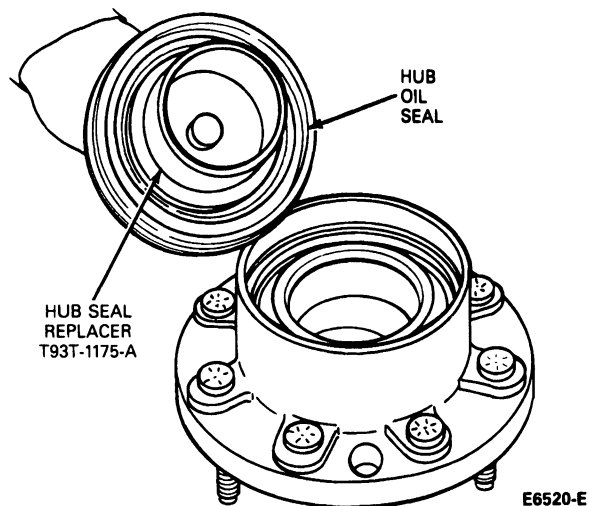
7. Using Hub Seal Replacer T93T-1175-A, install seal in hub with Ford logo facing up. Refer to the following steps.

CAUTION: Hub seal must be free of dirt or grease.



E6519-E

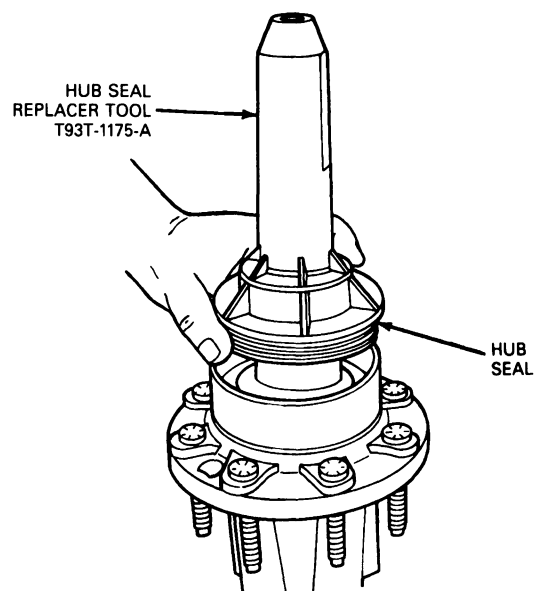
8. Install hub oil seal on Hub Seal Installer T93T-1175-A.



E6520-E

9. Insert tool with seal squarely into hub.

NOTE: Coat oil seal inner diameter with clean motor oil.

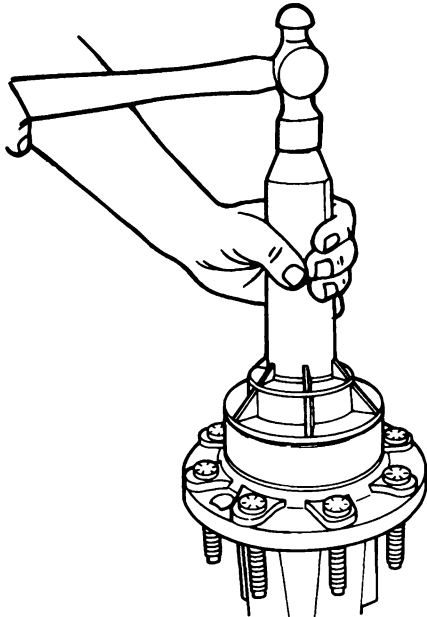


E8777-B

DISASSEMBLY AND ASSEMBLY (Continued)

10. **Hold tool straight.** Strike handle until hub seal is fully seated (until tool strikes hub).

CAUTION: Install new seal if seal is misaligned during or after installation.



E8778-A

SPECIFICATIONS**TORQUE SPECIFICATION, FULL FLOATING AXLE ONLY**

Description	N-m	Lb-Ft
Hub Nut ^a	75-88	55-65
Wheel Lug Nut (both Single & Dual Rear Wheel)	190	140

(Continued)

TORQUE SPECIFICATION, FULL FLOATING AXLE ONLY (Cont'd)

Description	N-m	Lb-Ft
Axle Shaft-To-Hub Bolts	82-108	60-80
Filler Plug	21-40	15-30

- a After tightening hub nut to specifications, ratchet back (back off) five notches (clicks) for new bearings, or eight notches (clicks) for used bearings.

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T93T-1175-A Hub Seal Installer	 T93T-1175-A
T80T-4000-W Driver Handle	 T80T-4000-W
T85T-4252-AH Hub Wrench	 T85T-4252-AH
T85T-1225-BH Bearing Cup Replacer — Inner	 T85T-1225-BH
T75T-1225-A Bearing Cup Replacer — Outer	 T75T-1225-A

SECTION 05-02C Differential, Limited-Slip, Ford 10.25-Inch Ring Gear

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION AND OPERATION	05-02C-1	REMOVAL AND INSTALLATION	
DIAGNOSIS AND TESTING		Differential Bearings	05-02C-3
Noise Acceptability	05-02C-2	Differential Case	05-02C-3
DISASSEMBLY AND ASSEMBLY		SPECIAL SERVICE TOOLS	05-02C-11
Differential Case	05-02C-4	SPECIFICATIONS	05-02C-11
		VEHICLE APPLICATION	05-02C-1

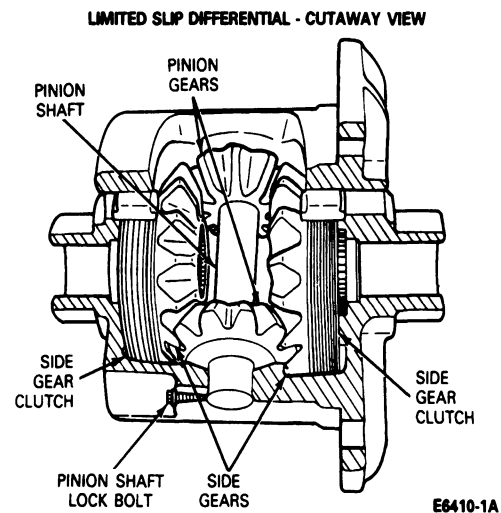
VEHICLE APPLICATION

F-250-350 Vehicles Equipped with Ford 10.25-Inch Ring Gear Axle and Limited-Slip Differential

DESCRIPTION AND OPERATION

The Ford Limited-Slip Differential option is available on F-250-350 vehicles with 10.25-inch ring gear rear axles.

The Limited-Slip assembly, except for the differential case and its internal components, is identical to the conventional axle. The limited-slip differential employs two sets of multiple-disc clutches to control differential action. The side gear mounting distance is controlled by 10 plates and one Belleville spring plate. The clutch pack consists of two plate designs: a splined plate that engages the splines of the side gear hub, and alternate-tabbed or stationary plates.



DIAGNOSIS AND TESTING

NOTE: Refer to Section 06-09A, for diagnostic and testing procedures. For speed sensor ring service procedures, refer to Section 05-02A.

If roughness or noises such as chatter are present while turning corners, the probable cause is incorrect or contaminated lubricant.

Before a differential is removed and disassembled for chatter concerns, the lubricant level should be determined.

Drain and refill the axle with the specified quantity of Hypoid Gear Lubricant E0AZ-19580-AA (ESP-M2C 154-A) or equivalent and add 0.237L (8 ounces) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C 118-A) or equivalent friction modifier for rear axles. Warm the axle up and recheck for chatter by making a minimum of ten figure-eight type turns.

DIAGNOSIS AND TESTING (Continued)

Noise Acceptability

A gear-driven unit (especially on a drive axle) will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions, as, for example, on a newly paved blacktop road. The slight noise is in no way detrimental to the operation of the rear axle and must be considered normal.

NOTE: For vehicles equipped with a limited-slip differential, a slight stick-slip noise on tight turns after extended highway driving is considered acceptable and has no detrimental effect.

A complete lubricant drain, flush and refill will usually correct chatter. The following procedure is recommended to make sure that the system is flushed of old lubricant:

1. Warm the lubricant by vehicle road operation or five minutes of operation in gear with both rear wheels off the ground on a hoist.

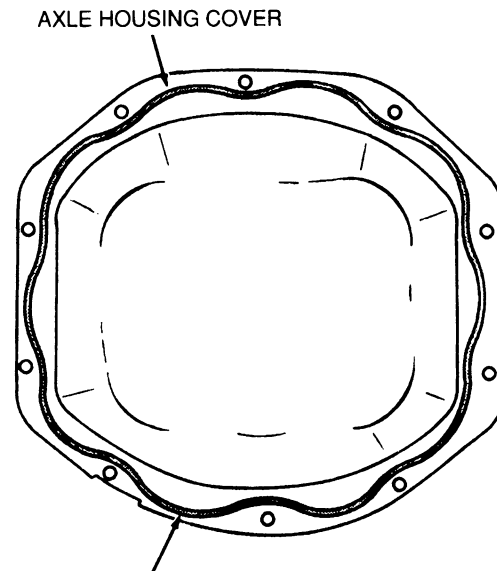
WARNING: A VEHICLE EQUIPPED WITH A LIMITED-SLIP DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. IF ONE WHEEL IS RAISED OFF THE FLOOR AND THE REAR AXLE IS DRIVEN BY THE ENGINE, THE WHEEL ON THE FLOOR COULD DRIVE THE VEHICLE OFF THE STAND OR JACK. ALWAYS MAKE SURE THAT BOTH WHEELS ARE OFF THE GROUND.

2. Drain lubricant while warm. Remove cover to drain completely. If cover is removed, it will be necessary to replace gasket at this time.
3. Clean the gasket mating surface of the rear axle carrier casting and cover.

Apply a new continuous bead of Silicone Rubber D6AZ-19562-AA or -BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to the cover as shown.

CAUTION: Make sure machined surfaces on both cover and carrier are clean and free of oil before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent contamination.

NOTE: Cover assembly must be installed within 15 minutes of application of the Silicone Rubber or new Silicone Rubber must be applied.



3.18-4.76mm (1/8-3/16 INCH)
WIDE CONTINUOUS BEAD OF
SILICONE RUBBER
(D6AZ-19562-AA OR -BA
(ESB-M4G92-A OR
ESE-M4G195-A) OR
EQUIVALENT)

PARTS MUST BE ASSEMBLED WITHIN
15 MINUTES AFTER APPLICATION OF
SILICONE RUBBER. GASKET SURFACE OF
HOUSING AND COVER MUST BE
FREE OF OIL.

F2667-F

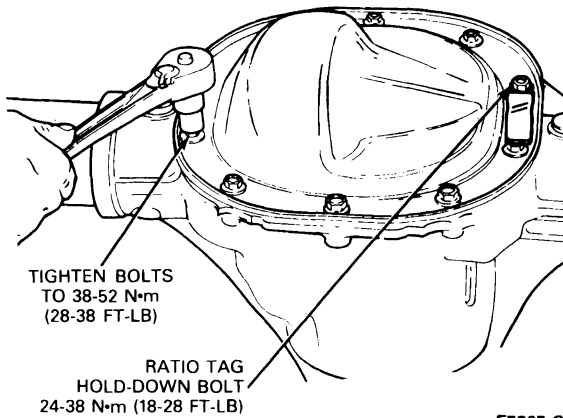
4. Install cover and tighten cover bolts to 34-47 N·m (25-35 ft·lb) as shown. Tighten the cover bolts in a cross-wise pattern to ensure uniform draw on cover.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone, or new sealant must be applied.

5. Add lubricant through the fill hole until the lubricant level reaches the bottom of the fill hole with the axle in the running position (approximately 3.0 liters [6.5 pints]). For out-of-vehicle repairs, add 3.5 liters (7.5 pints) of lubricant. Add 0.237L (8 oz) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A).

DIAGNOSIS AND TESTING (Continued)

6. Install the fill plug and tighten to 20-40 N·m (15-30 ft·lb).



7. Operate the vehicle for approximately 16 km (10 miles), making at least ten figure-eight turns to flush the old lubricant out of the clutch packs.
8. Repeat Steps 2, 3, 4 and 5, making sure to replace cover gasket.
9. It is possible that a slight chatter, requiring additional vehicle operation may remain after Step 6. If chatter still persists after 160 km (100 miles) of operation, or remains severe after Step 7 above, disassembly and repair will be necessary.

For further diagnostic and testing procedures refer to Section 05-00.

REMOVAL AND INSTALLATION**Differential Case**

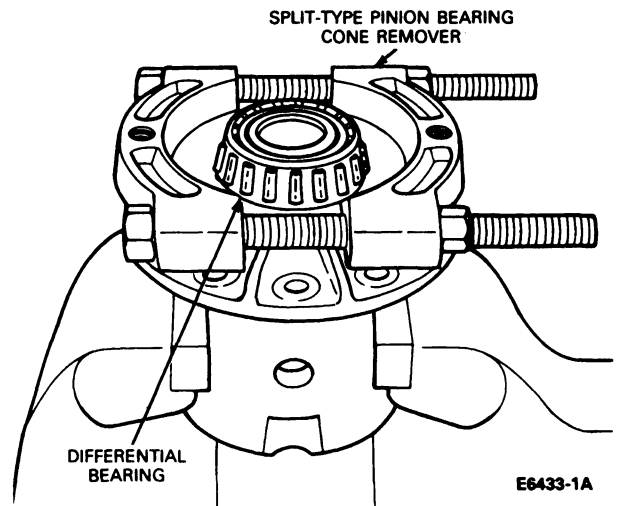
For Removal and Installation Procedures, refer to Section 05-02A.

Differential Bearings**Removal****Tools Required:**

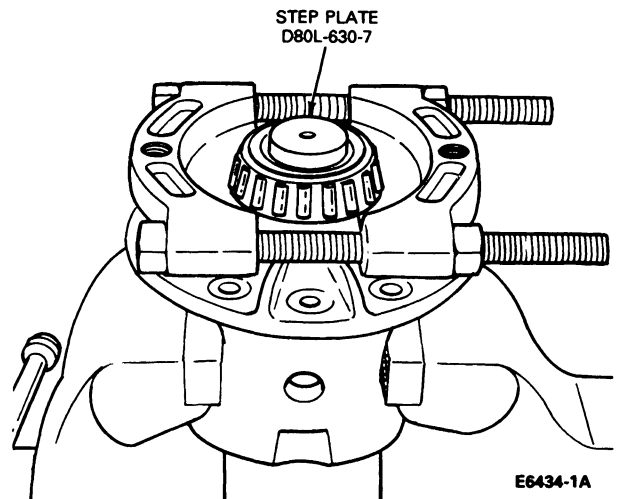
- Front Hub Remover / Replacer T81P-1104-C or equivalent
- Step Plate D80L-630-7 (part of Step Plate Adapter Set D80L-630-A) or equivalent
- Pinion Bearing Cone Remover D79L-4621-A or equivalent

NOTE: It is not necessary to remove the differential bearings as a part of the differential case disassembly procedure.

1. Mount the differential case in a vise. Use brass pads on vise jaws to prevent damage. Mount split-type pinion bearing cone remover on the differential case. Tighten bolts on puller to separate the bearing cone from the case face.



2. Place step plate on bearing inner cone. Apply a small amount of grease to the step plate bore.

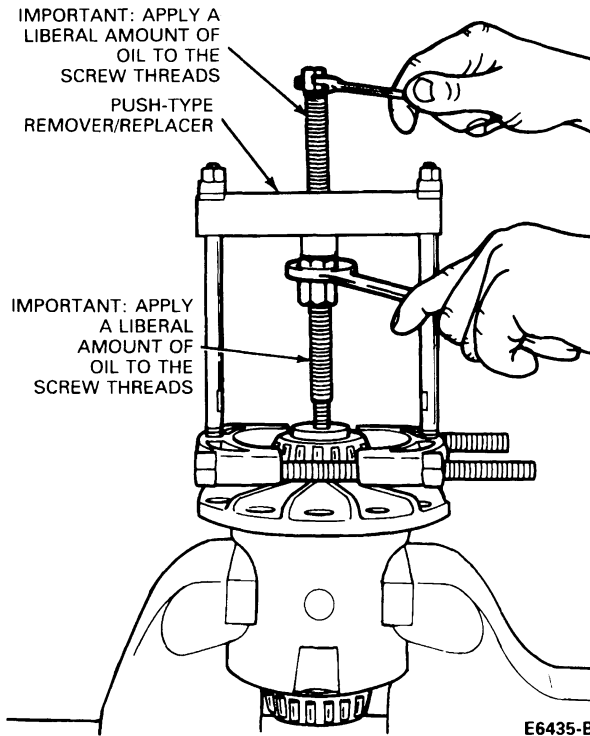


3. Mount push-type remover / replacer on the bearing cone remover, making sure that the remover / replacer shaft seats in the bore of the step plate. Pull the bearing off the differential case.

CAUTION: It is extremely important to apply a liberal amount of oil to the screw threads of remover / replacer.

REMOVAL AND INSTALLATION (Continued)

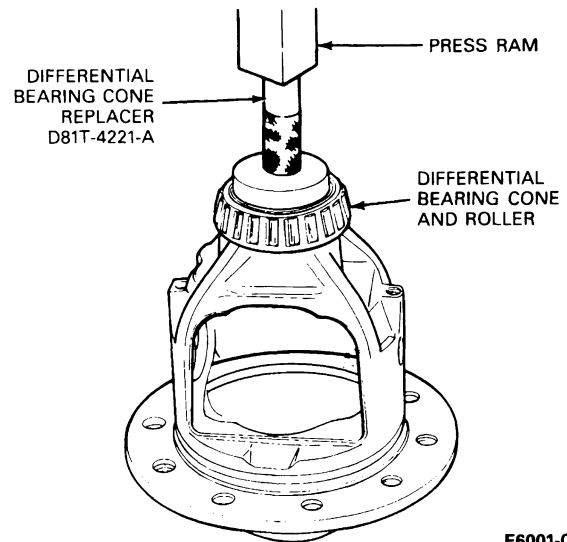
NOTE: Replace bearings whenever they are removed from the differential.



Installation

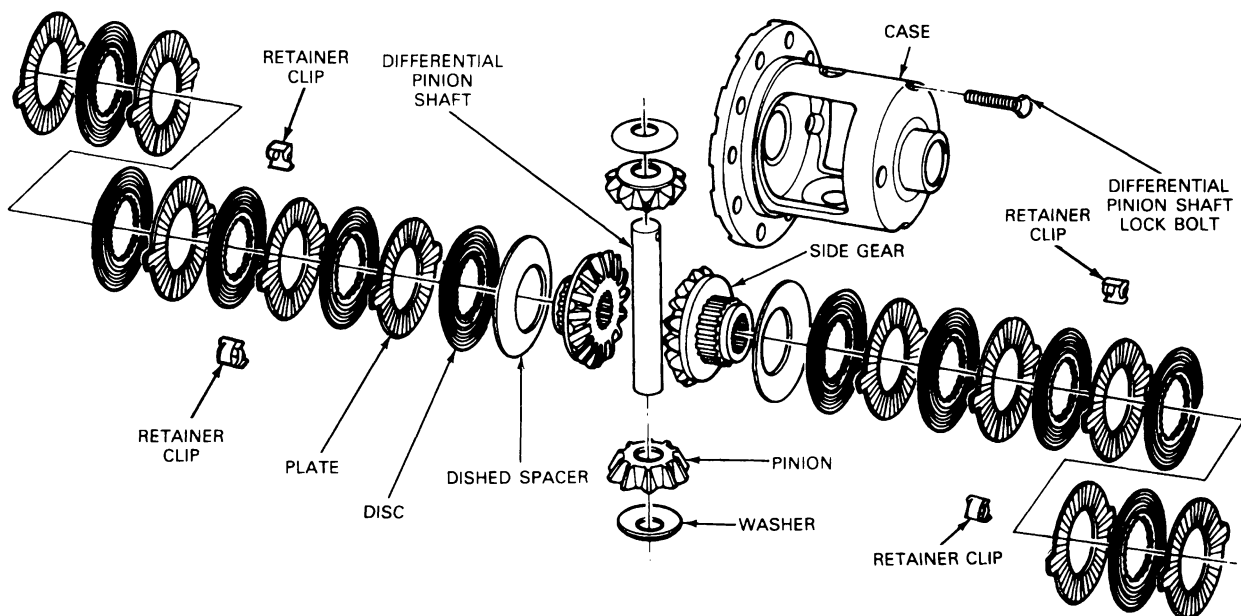
1. Install differential bearings on the case hubs using Differential Bearing Cone Replacer D81T-4221-A or equivalent.

NOTE: Press against the bearing cone only.



DISASSEMBLY AND ASSEMBLY

Differential Case



E6412-D

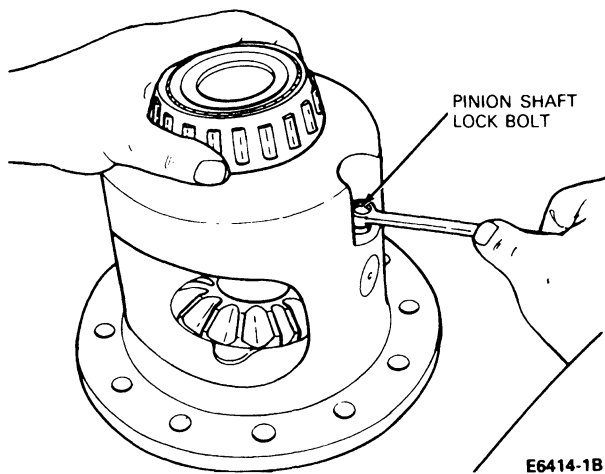
DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

NOTE: The differential bearings need not be removed to overhaul the Ford Limited-Slip Differential. If bearing removal is required, refer to Differential Bearings, Removal and Installation in this section.

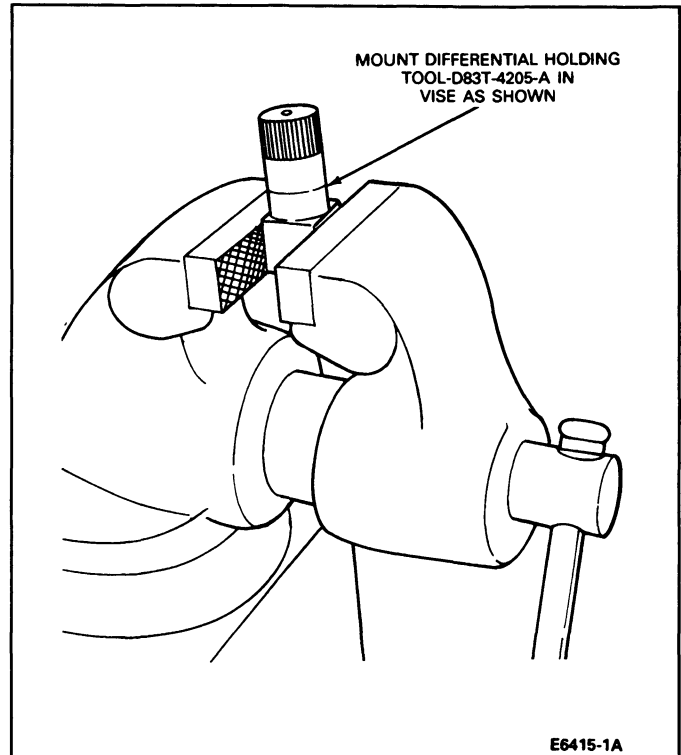
Tools Required:

- Limited-Slip Differential Rotating Handle T86T-4205-A or equivalent
- Limited-Slip Differential Tool D83T-4205-A
- Limited-Slip Differential Service Kit D83T-4205-C or equivalent (includes dowel bar, hex head screw, nut and step plate).

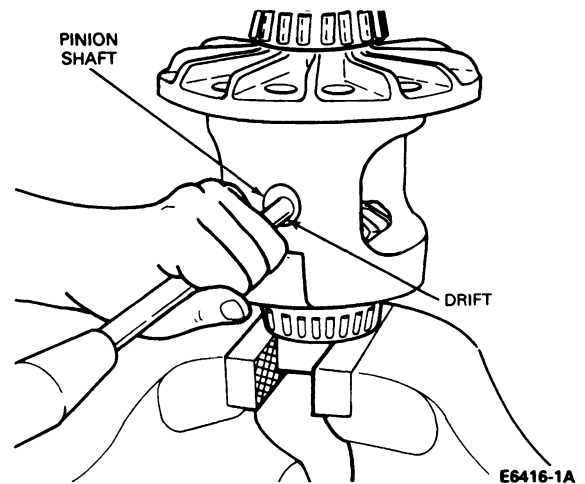
1. Remove the differential pinion shaft lockbolt.



2. Install holding tool D83T-4205-A in a suitable vise. Install differential assembly in the vise with the ring gear side facing up.

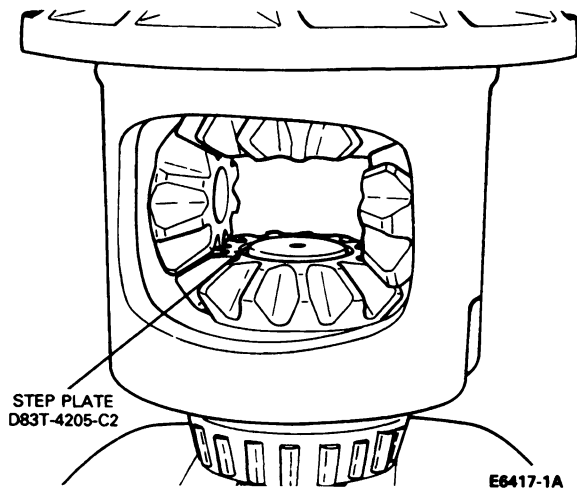


3. With a hammer and drift, drive the pinion shaft from the differential case.

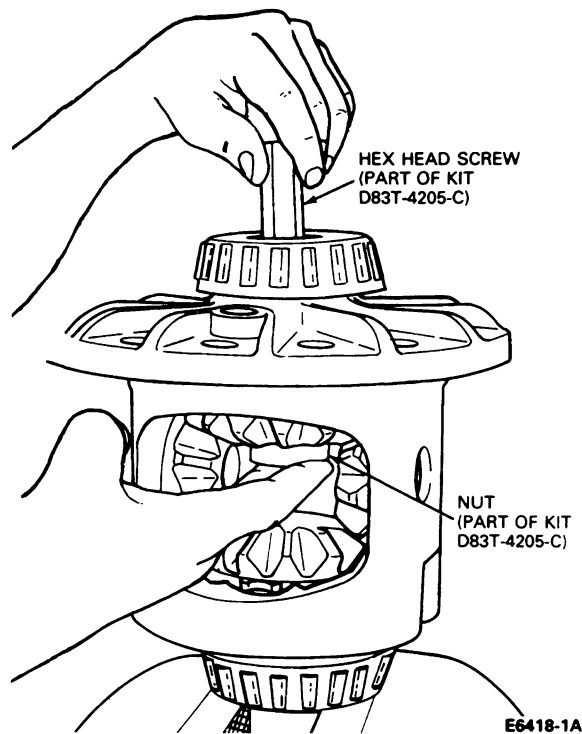


DISASSEMBLY AND ASSEMBLY (Continued)

4. Install step plate in bottom side gear bore. Apply a small amount of grease to centering hole of the step plate.

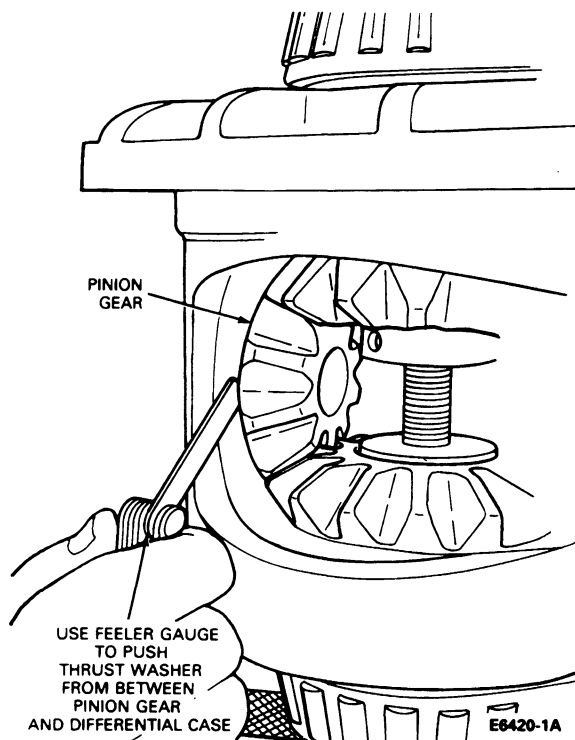
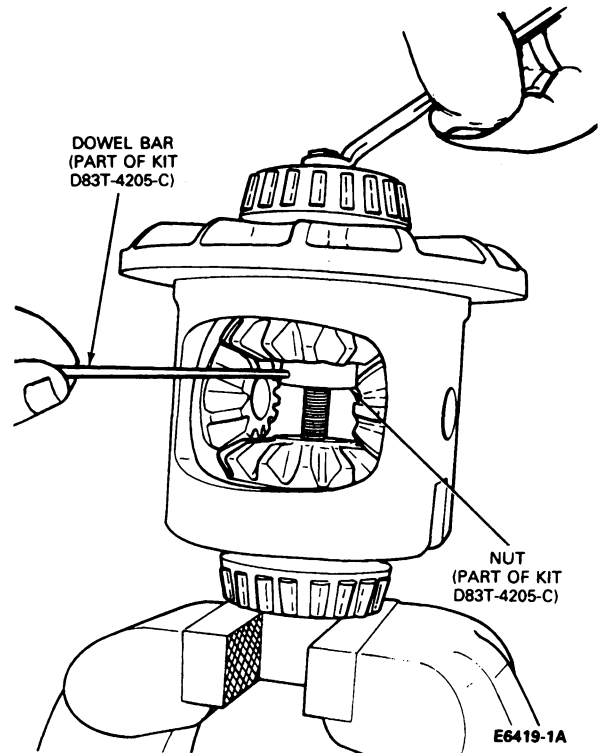


5. Install nut in upper side gear. Hold nut in position while installing hex screw.



6. Insert dowel bar in hole of nut. Tighten forcing screw to force side gears away from the pinion mating gears. The dowel bar is used to keep the nut from turning when the hex head screw is tightened.

7. With an appropriate-size feeler gauge, push the pinion gear thrust washers out from between the pinion gears and the differential case. Remove the thrust washers, then back off the forcing screw until it is loose (approximately one turn).



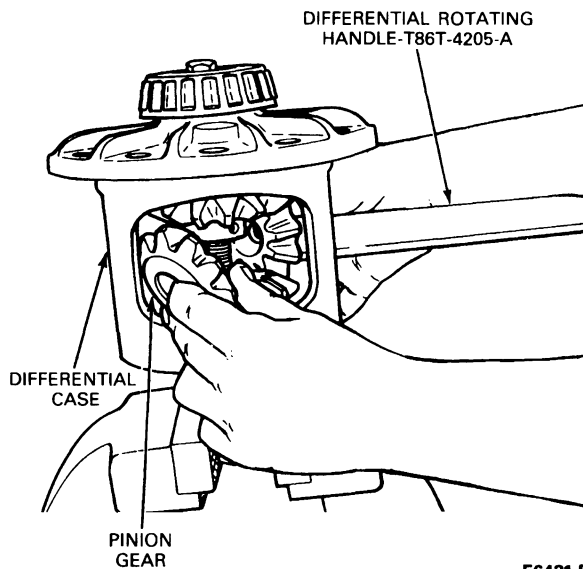
DISASSEMBLY AND ASSEMBLY (Continued)

8. Insert Rotating Handle T86T-4205-A in the pinion shaft bore and turn the case to "walk" the pinion gears out to the differential case windows.

WARNING: KEEP FINGERS/HANDS AWAY FROM DIFFERENTIAL GEARS WHEN ROTATING CASE WITH DIFFERENTIAL ROTATING HANDLE.

NOTE: Make sure vise is tightened securely during this step.

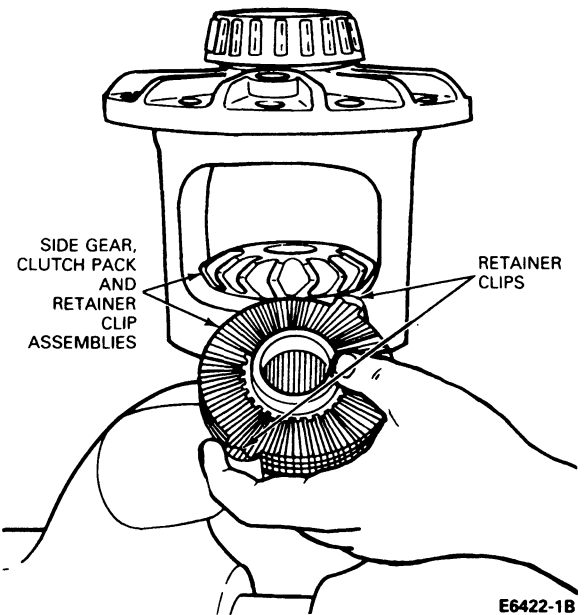
9. Remove the pinion gears.



E6421-B

10. Remove the forcing screw and step plates. Remove the side gears, retainer clips and clutch pack assemblies.
11. Remove the retainer clips from both clutch packs to allow separation of the discs and plates for cleaning and inspection. Refer to the exploded view at the beginning of this procedure.

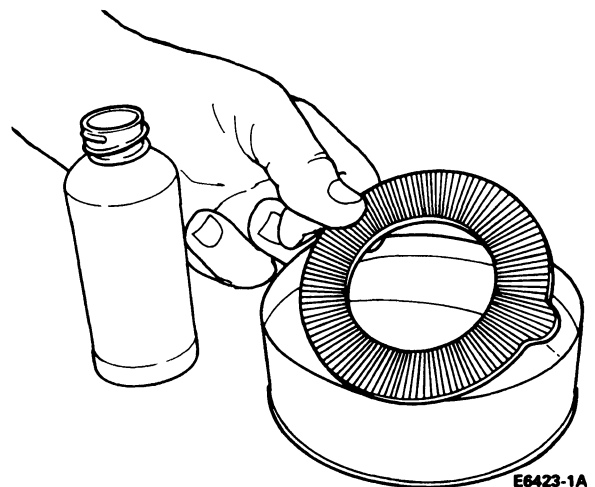
CAUTION: When separating the clutch plates and discs, note the sequence in which they are disassembled. They must be reassembled in the same sequence.



E6422-1B

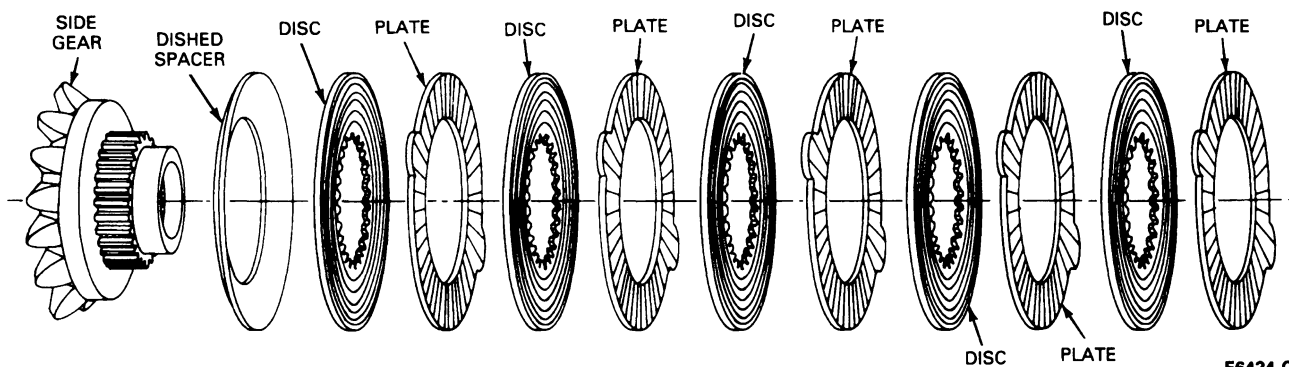
Assembly

1. Prelubricate each disc and plate with Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier lubricant.

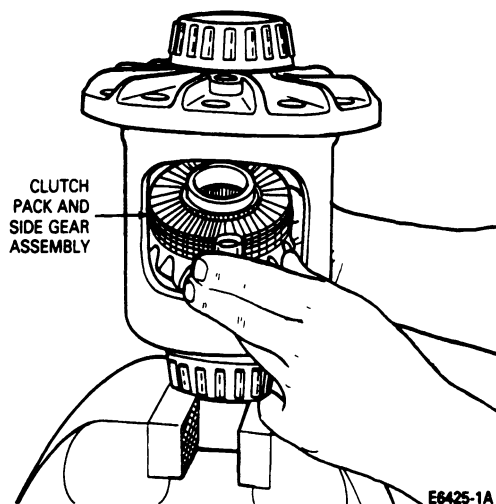


E6423-1A

2. Prelubricate the thrust face of the side gear. Assemble the plates and discs to the side gear splines in exactly the same sequence in which they were removed. Assemble the retainer clips to the ears of the plates. Make sure both clips are completely assembled and seated onto the ears of the plates.

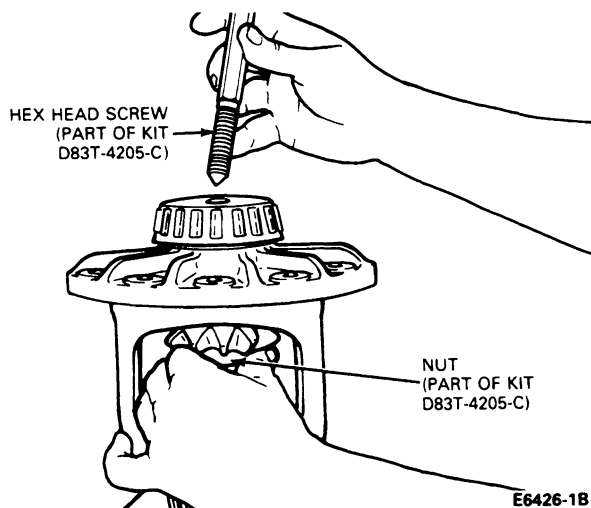
DISASSEMBLY AND ASSEMBLY (Continued)**Side Gear, Clutch Plates and Discs**

3. Install holding tool in a suitable vise. Place differential case on holding tool with ring gear side facing up. Insert the clutch pack and side gear assemblies into the differential case. Make sure that the clutch packs stay assembled to the side gear splines and that the retainer clips are completely seated in the pockets of the differential case. Hold the upper clutch pack and side gear assembly in place to prevent it from falling out of the differential case.

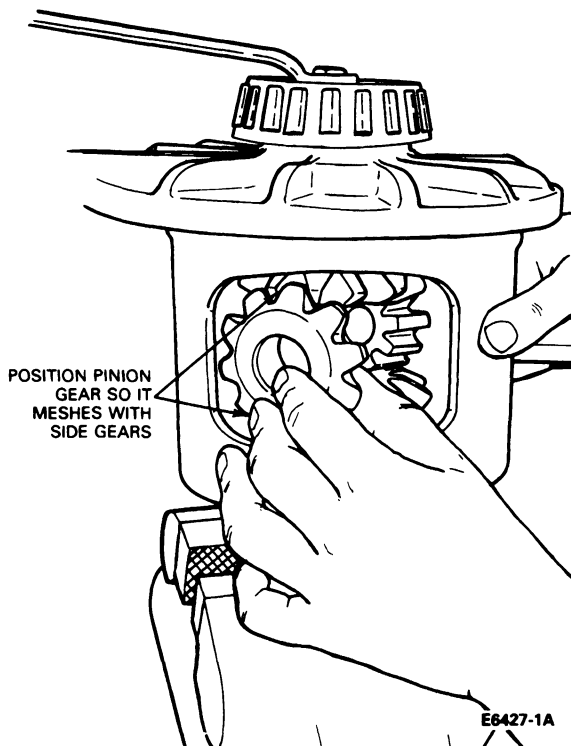


4. Position step plate in the bottom side gear bore. Apply a small amount of grease to the step plate bore. Position nut in the top side gear bore and hold it in place. Install the hex head screw and tighten it two turns after it contacts the bottom step plate. Insert the dowel bar in nut bore to keep the nut from turning as the hex screw is tightened.

5. Position the pinion gears in the window of the differential case so that they mesh with the side gear teeth. Hold the pinion gears in place. Make sure that the pinion gears are 180 degrees apart so they will correctly align with the pinion shaft bore.



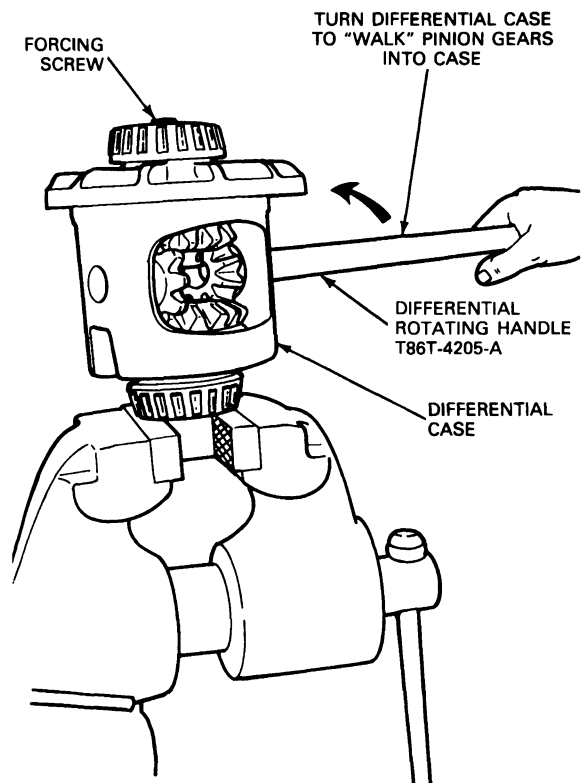
DISASSEMBLY AND ASSEMBLY (Continued)



6. Insert the rotating handle into the pinion shaft bore and turn the differential case. This will cause the pinion gears to engage the side gears and "walk" into the differential case. Rotate the differential case until the pinion mating shaft holes are lined up exactly with the holes in the pinion gears.

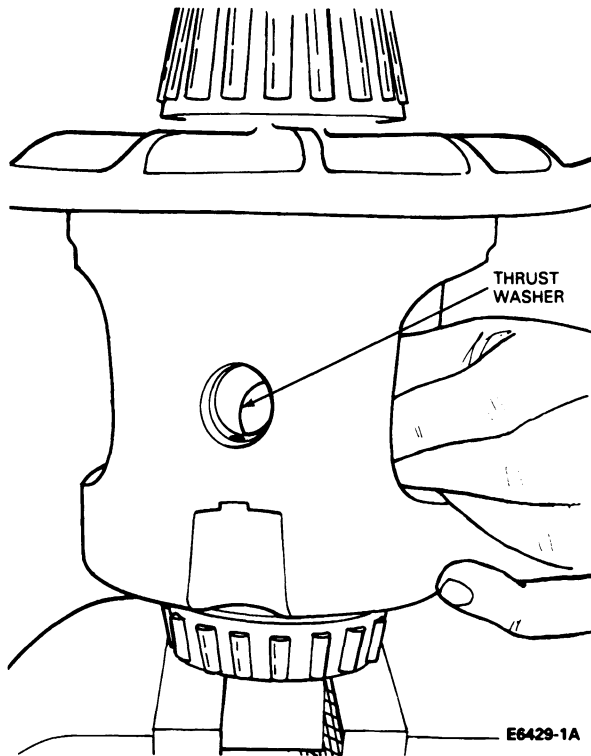
NOTE: It will probably be necessary to loosen or tighten the forcing screw to allow the pinions and side gears to rotate.

WARNING: KEEP FINGERS/HANDS AWAY FROM DIFFERENTIAL GEARS WHEN ROTATING CASE WITH DIFFERENTIAL ROTATING HANDLE.

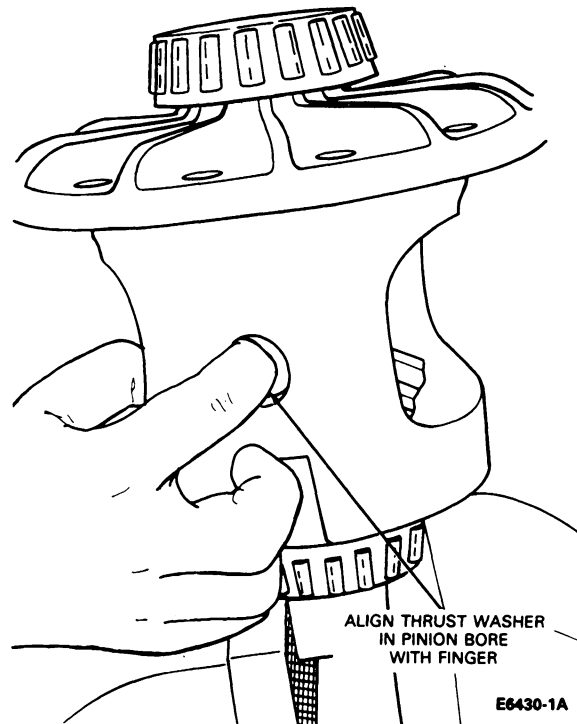


DISASSEMBLY AND ASSEMBLY (Continued)

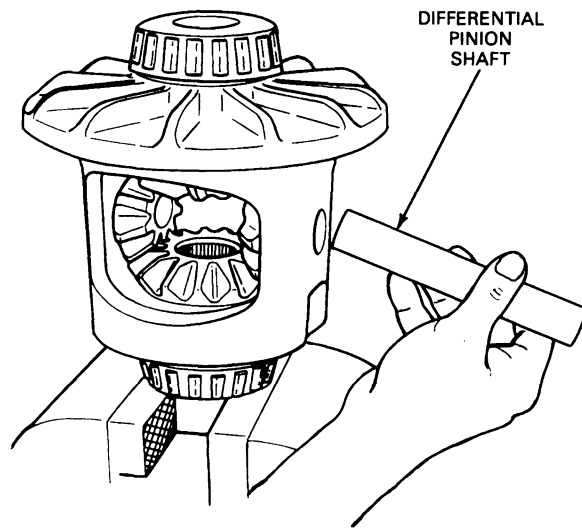
7. Prelubricate both sides of the pinion thrust washers with Hypoid Gear Lubricant EOAZ-19580-AA (ESP-M2C154-A) or equivalent. Apply torque to the forcing screw to allow clearance to insert the thrust washers. Insert the pinion gear thrust washers between the pinion gears and the differential case with the concave side facing in.



8. Be sure to align the thrust washer holes with the bore in the differential case PRIOR to installing differential pinion shaft.



9. Loosen the forcing screw and remove the step plate and nut from the side gear bores. Install the pinion shaft in the differential case. Install the pinion shaft lock bolt and tighten to 20-40 N·m (15-30 ft·lb).
10. If removed, install the ring gear on the differential case and tighten the attaching bolts to specifications. For detailed procedures and specifications, refer to Section 05-02A.



SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb·Ft
Cover bolts	34-47	25-35
Filler plug	20-40	15-30
Pinion shaft lock bolt	20-40	15-30
Ring gear bolts	95-115	70-85

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER)

Vehicle	Axle	Approximate Lubricant Capacity (In-Vehicle Repair) ^{a,b}		
		U.S. Pints	Imperial Pints	Liters
F-250, F-350 Regular & Chassis CAB, F-250/350 H.D.	10.25-Inch Ring Gear	6.5 ^{c,d}	5.4	3.0

a Ford design conventional Axles use rear axle lubricant — XY-90-QL or -KL (ESP-M2C154-A) or equivalent.

b Service refill capacities are determined by filling the axle with the specified lubricant to the bottom of the filler hole with the vehicle in running position.


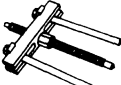
c Plus 8 oz. (U.S. measure) additive friction modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent for limited-slip applications.

d Rear axle lube quantities must be replaced every 100,000 miles (160 000 km) or if the axle has been submerged in water. Otherwise, the lube should not be checked or changed unless a leak is suspected or repair required.

NOTE: 6.5 pints of lubricant is the fill specification when the axle is installed in the vehicle. If the axle is out of the vehicle, fill with 7.5 pints of specified lubricant.

TE6524A

SPECIAL SERVICE TOOLS

Tool Number/ Description	Illustration
T86T-4205-A Differential Rotating Handle	 T86T-4205-A
T81P-1104-C Front Hub Remover/Replacer	 T81P-1104-C

SECTION 05-02D Axle, Rear, Dana

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS	05-02D-36	REMOVAL AND INSTALLATION	
DESCRIPTION AND OPERATION	05-02D-1	Drive Pinion Oil Seal	05-02D-8
DIAGNOSIS AND TESTING	05-02D-8	Oil Seal and Wheel Bearing, Full-Floating	
DISASSEMBLY AND ASSEMBLY		Axle	05-02D-14
Assembly	05-02D-22	Oil Seal and Wheel Bearing, Semi-Floating	
Assembly of Differential Into		Axle	05-02D-14
Housing	05-02D-30	Rear Axle	05-02D-11
Differential Case	05-02D-22	Rear Axle Shaft, Full-Floating Axle	05-02D-14
Disassembly	05-02D-15	Rear Axle Shaft, Semi-Floating Axle	05-02D-11
Inspection After Disassembly	05-02D-21	SPECIAL SERVICE TOOLS	05-02D-38
Inspection Before Disassembly	05-02D-15	SPECIFICATIONS	05-02D-36
Ring Gear and Pinion Tooth Pattern		VEHICLE APPLICATION	05-02D-1
Interpretation	05-02D-34		

VEHICLE APPLICATION

E-250-350 and F-Super Duty Vehicles

DESCRIPTION AND OPERATION

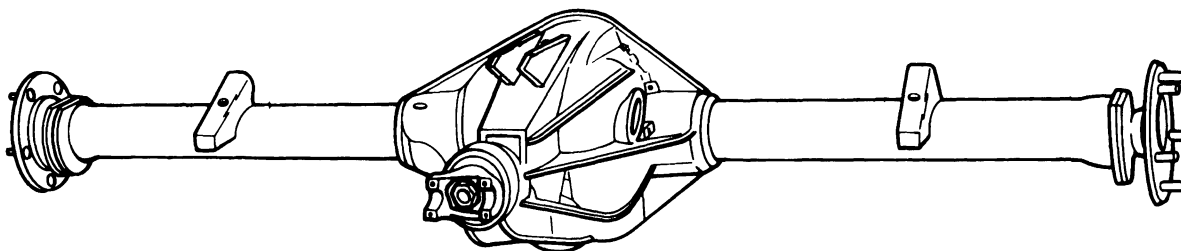
Several models of Dana rear axles are used in regular production or are available as options on the E-250-350 and F-Super Duty vehicles.

The model 60-1U rear axle has semi-floating axle shaft, meaning the axle shaft supports the loads. A semi-floating axle shaft is retained in the axle by C-washer locks positioned in a slot on the axle shaft splined end. These C-washers also fit into a machined recess in the differential side gears within the differential case. The shaft rides on one straight-roller bearing at the outboard end.

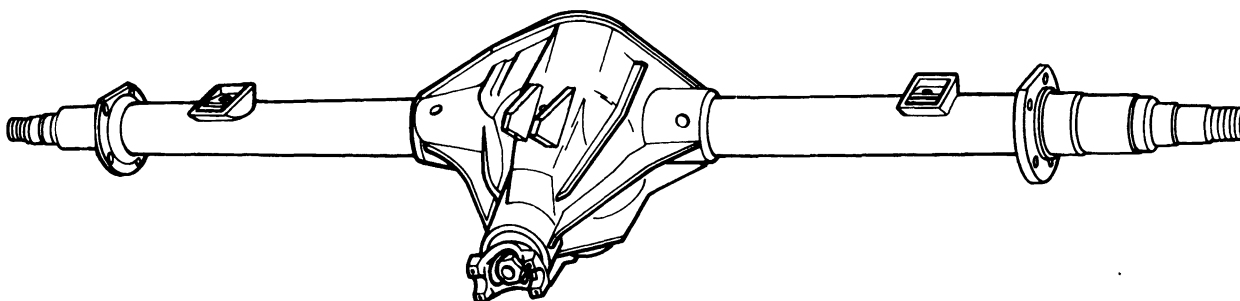
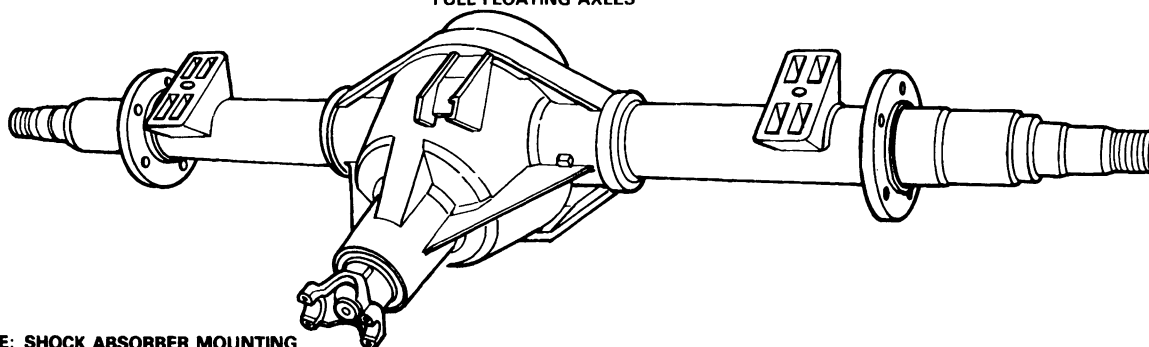
Model 80, 70-1HD, 70-2U and 60-1U rear axles are equipped with full-floating axle shafts, meaning loads are supported by the axle housing. These axles have an integral-type housing, hypoid gear design with the centerline of the pinion set below the centerline of the ring gear. The shaft is retained by bolts attached to the hub. The hub rides on two bearings at the outboard end. The housing assembly consists of a cast center section with two steel tube assemblies. A stamped rear cover uses silicone rubber or equivalent as a gasket. A metal tag, attached to housing by two cover bolts, is stamped with the gear ratio, part numbers and limited-slip (if applicable).

DESCRIPTION AND OPERATION (Continued)

Rear Axles, Dana



MODEL 60-1U – SEMI-FLOATING AXLE (E-250)

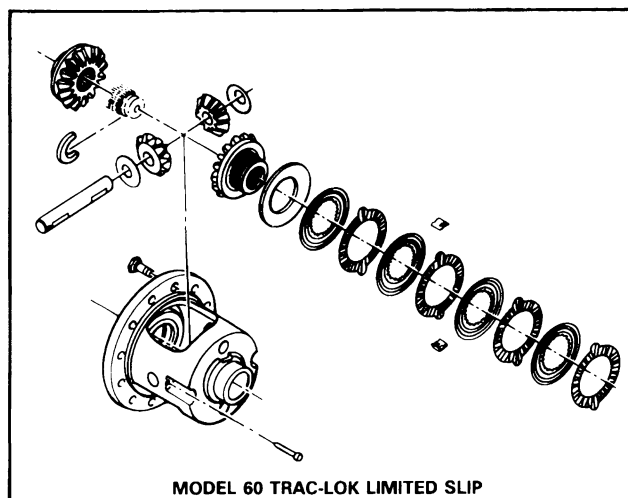
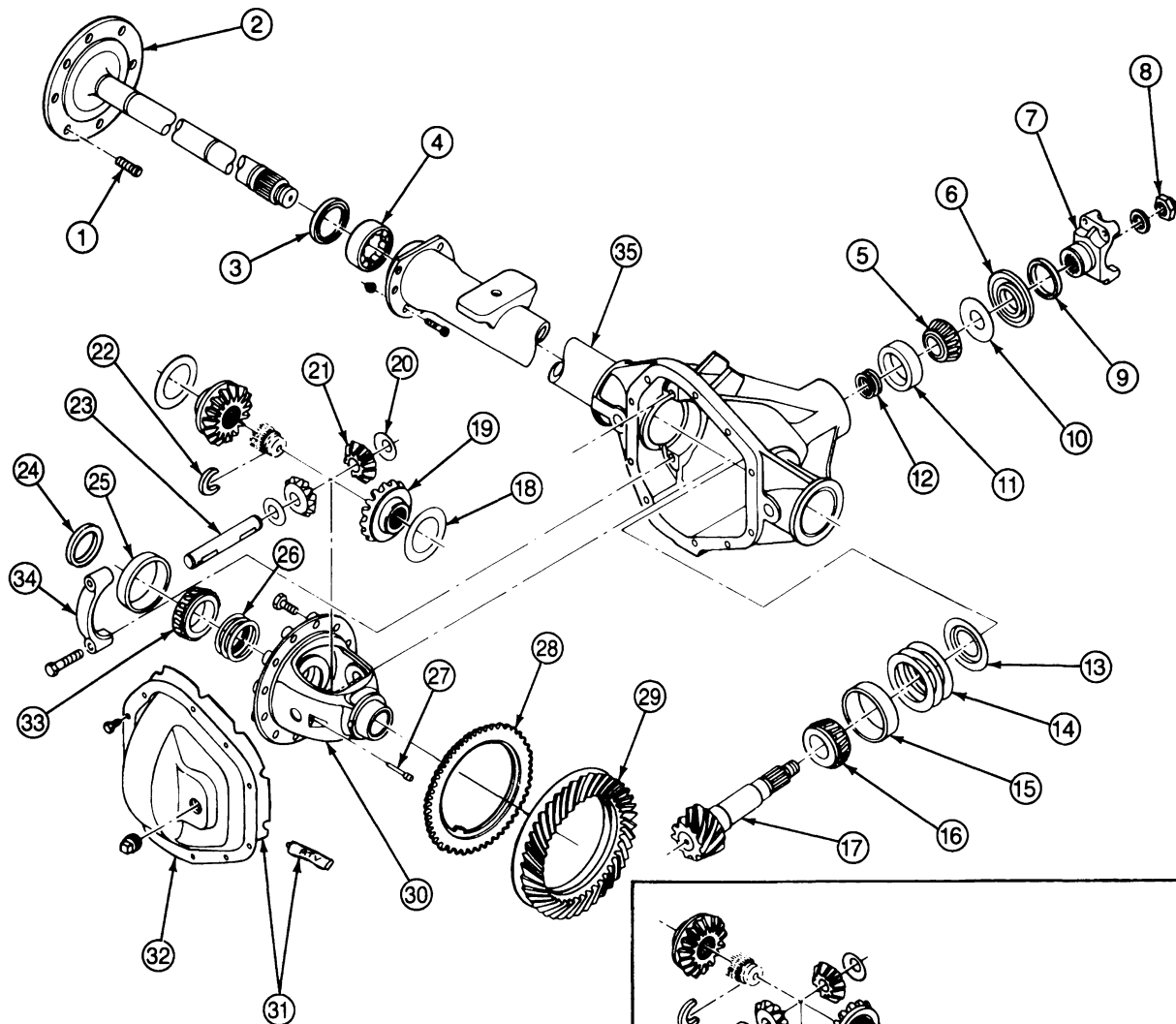
MODEL 60-1U (E-350 SRW) AND 70-2U (E-350 DRW)
FULL FLOATING AXLESNOTE: SHOCK ABSORBER MOUNTING
BRACKETS NOT SHOWN ON AXLES

MODEL 80 – FULL-FLOATING AXLE (F-SUPER DUTY)

E6668-F

DESCRIPTION AND OPERATION (Continued)

Model 60-1U Semi-Floating Axle



MODEL 60 TRAC-LOK LIMITED SLIP

E4831-G

Item	Part Number	Description
1	1107	Wheel Bolt
2	4234	Axle Shaft
3	1177	Seal
4	1225	Bearing

(Continued)

Item	Part Number	Description
5	4621	Outer Pinion Bearing
6	4676	Pinion Seal
7	4851	Yoke
8	—	Pinion Nut

(Continued)

DESCRIPTION AND OPERATION (Continued)

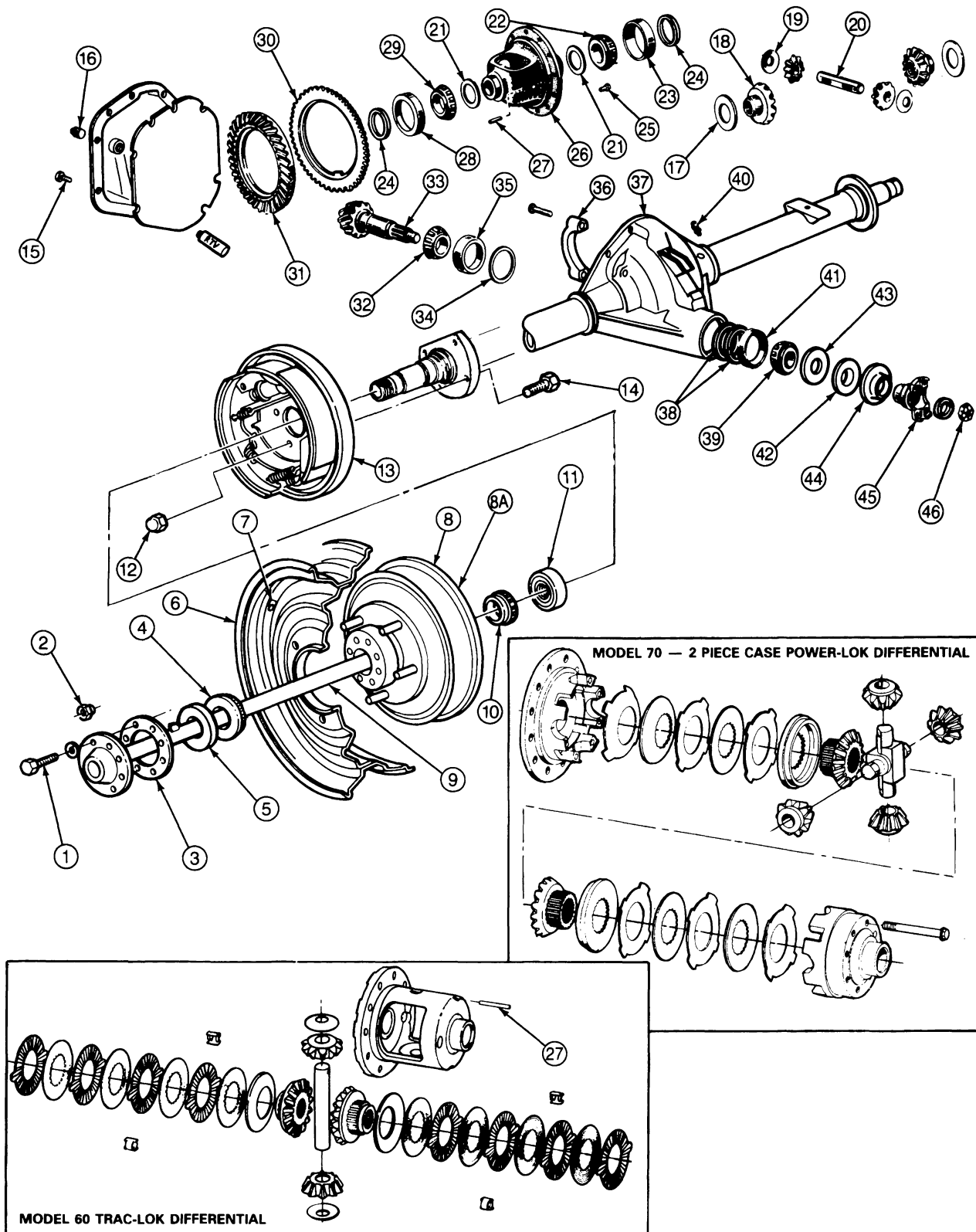
Item	Part Number	Description
9	4851	Dust Shield
10	4670	Oil Slinger
11	4616	Bearing Cup
12	—	Shims
13	—	Baffle
14	—	Shims
15	4628	Bearing Cup
16	4630	Inner Pinion Bearing
17	4209	Drive Pinion
18	4228	Washer
19	4236	Side Gear
20	4230	Thrust Washer
21	4215	Pinion Gear

(Continued)

Item	Part Number	Description
22	—	C-Clip
23	4211	Differential Pinion Shaft
24	—	Outboard Spacer
25	4222	Bearing Cup
26	—	Shims
27	—	Lockscrew
28	4B409	Speed Sensor Ring
29	4209	Ring Gear
30	4204	Case
31	—	Silicone Rubber Sealant, E7TZ-19562-A
32	4033	Cover
33	4221	Bearing
34	4010	Bearing Cap
35	4010	Housing

DESCRIPTION AND OPERATION (Continued)

Model 60-1U and 70-2U Full-Floating Axle



E1694-V

DESCRIPTION AND OPERATION (Continued)

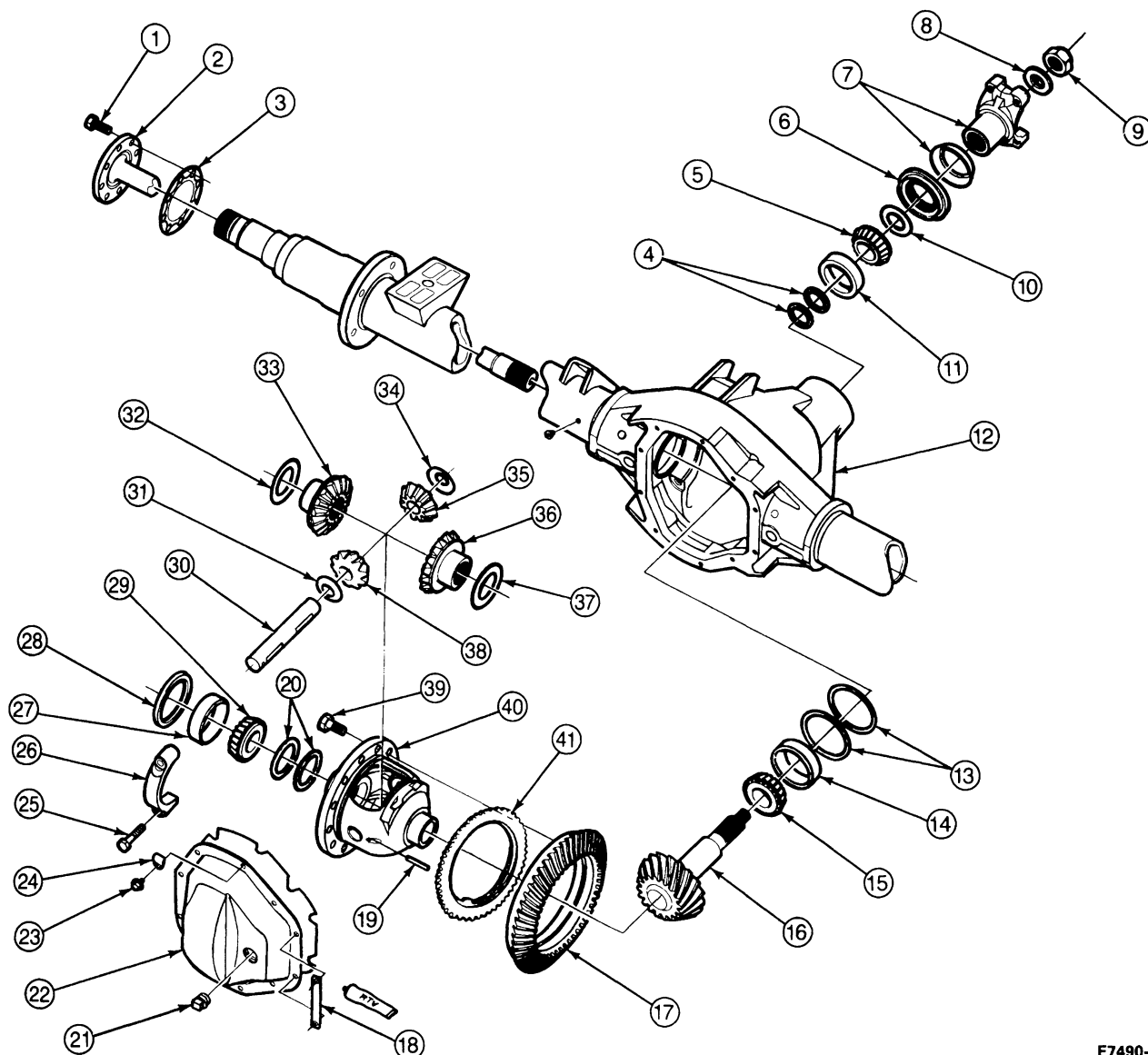
Item	Part Number	Description
1	304743	Bolt
2	351025	Nut
3	1001	Gasket
4	1240	Outer Cone and Roller Assembly
5	—	Hub Nut
6	—	Wheel Assembly
7	—	Valve Stem
8	1109	Hub Assembly
8A	1126	Drum
9	4234	Axle Shaft
10	1244	Inner Cone and Roller
11	1175	Oil Retainer Assembly
12	34447	Self Locking Nut
13	2209	Brake Assembly
14	2216	Bolt
15	4346	Bolt
16	353031	Filler Plug
17	4228	Washer
18	4236	Side Gear
19	4230	Thrust Washer
20	4211	Differential Pinion Shaft
21	4067	Shims

(Continued)

Item	Part Number	Description
22	4222	Bearing
23	1244	Bearing Cup
24	—	Outboard Spacers
25	—	Bolt
26	4204	Case
27	4241	Lock Pin
28	—	Bearing Cup
29	1244	Differential Bearing
30	4B409	Sensor Ring
31	4209	Ring Gear
32	4630	Pinion Inner Bearing
33	4209	Drive Pinion
34	4109	Pinion Locating Shim
35	4616	Bearing Cup
36	4010	Bearing Cap
37	4010	Housing
38	—	Shims
39	4621	Pinion Outer Bearing
40	4338	Vent
41	4616	Outer Bearing Cup
42	4676	Seal
43	4670	Slinger
44	4851	Dust Shield
45	4851	Flange
46	354845	Locknut

DESCRIPTION AND OPERATION (Continued)

Model 80 Full-Floating Axle



E7490-F

Item	Part Number	Description
1	—	Bolt
2	4234	Axle Shaft
3	1001	Gasket
4	—	Shims
5	4621	Pinion Bearing
6	4676	Pinion Oil Seal
7	4851	Yoke and Dust Shield
8	—	Washer
9	354845	Locknut
10	—	Thrust Washer
11	4616	Bearing Cup
12	4010	Axle Housing
13	4109	Shims

(Continued)

Item	Part Number	Description
14	4616	Inner Bearing Cup
15	4630	Inner Bearing Cone
16	4209	Pinion
17	4209	Ring Gear
18	—	Identification Tag
19	—	Roll Pin
20	—	Shims
21	353051	Fill Plug
22	4033	Cover Plate
23	—	Screw
24	—	Brake Line Clip
25	—	Bearing Capscrew
26	4010	Bearing Cap

(Continued)

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
27	1244	Bearing Cup
28	—	Outboard Spacer
29	4222	Bearing Cone
30	4211	Pinion Mating Shaft
31	4230	Thrust Washer
32	4228	Thrust Washer
33	4236	Side Gear
34	4230	Thrust Washer

(Continued)

Item	Part Number	Description
35	4215	Mate Gear
36	4236	Side Gear
37	4228	Thrust Washer
38	4215	Mate Gear
39	—	Ring Gear Screw
40	—	Differential Case
41	4B409	Speed Sensor Ring (Not Used on Stripped Chassis Vehicles)

DIAGNOSIS AND TESTING

Refer to Section 05-00 and Section 00-04.

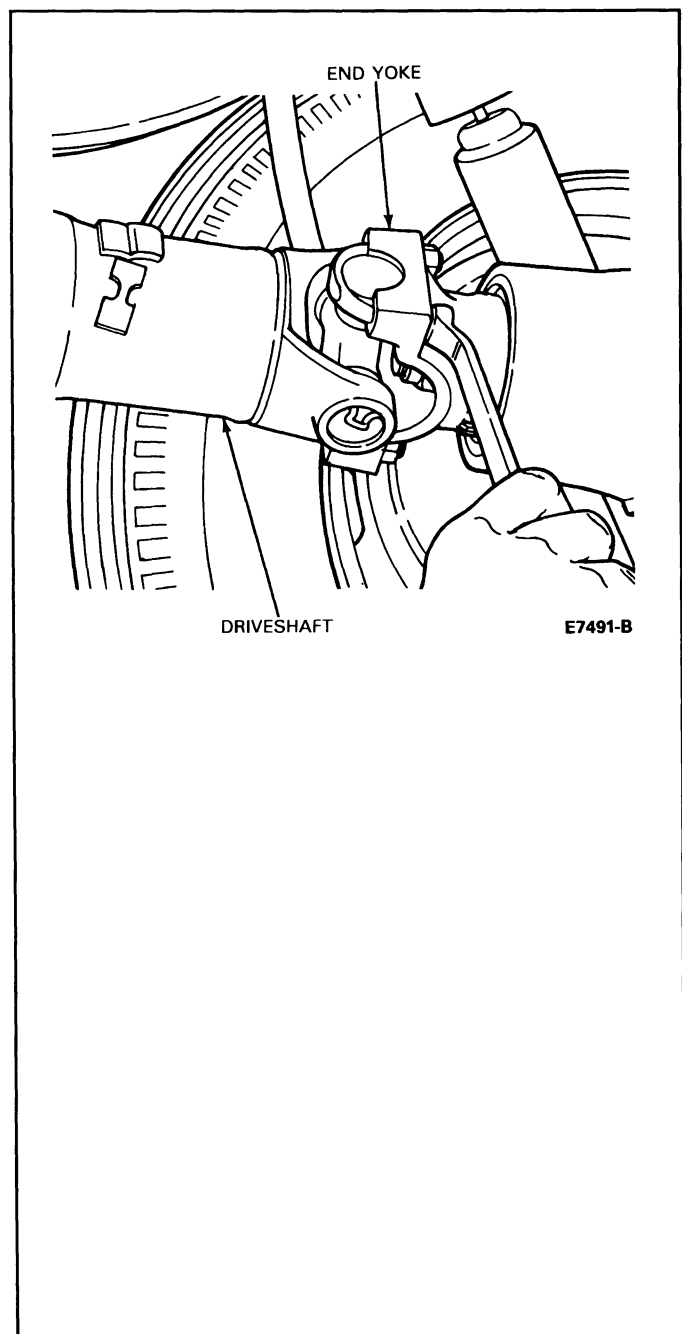
REMOVAL AND INSTALLATION**Drive Pinion Oil Seal****Removal**

The drive pinion oil seal can be replaced without removing the axle assembly from the vehicle.

1. Raise the vehicle on a hoist or raise the rear end of the vehicle with a jack. Install safety stands under the frame rails and lower the jack or hoist far enough to allow the axle to drop into the rebound position for working clearance.

NOTE: Note and mark driveshaft / axle yoke orientation so that it can be re-assembled in the same position to minimize driveline vibration.

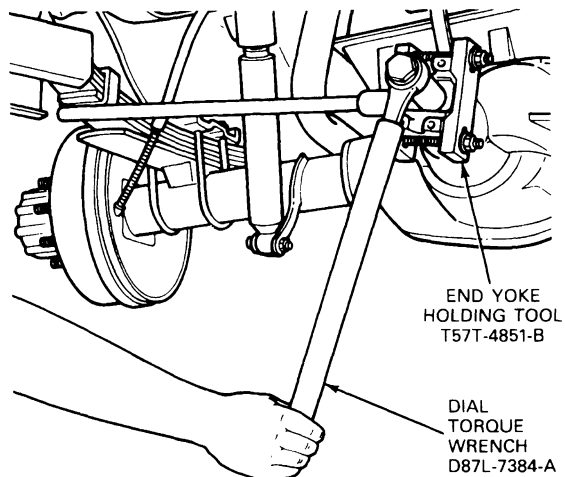
2. Remove the nuts and two U-bolts from the rear axle end yoke and disconnect the driveshaft from the rear axle end yoke. The Model 80 axle uses straps and bolts which are threaded into the end yoke. Wire the driveshaft to the frame.



REMOVAL AND INSTALLATION (Continued)

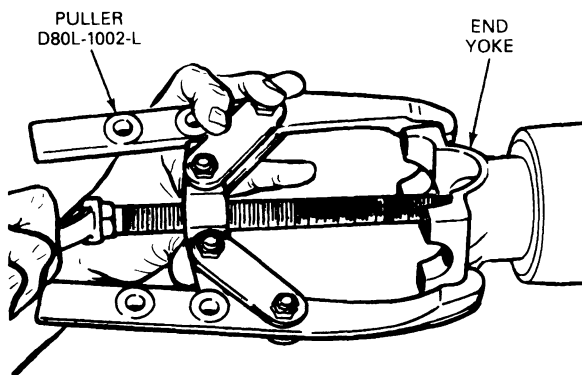
3. Using Companion Flange Remover T57T-4851-B to hold the end yoke, remove the pinion shaft nut with Tool D87L-7384-A or equivalent.

NOTE: The Model 80 pinion nut is tightened to 597-677 N·m (440-500 ft-lb).



E7495-D

4. Using Companion Flange Remover T65L-4851-B or 2-Jaw Puller D80L-1002-L, remove the end yoke.



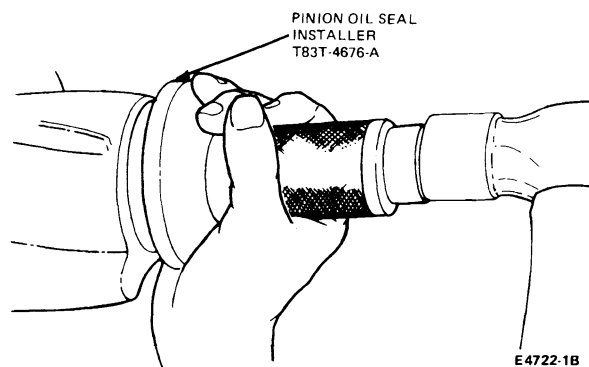
E7494-B

5. Using Seal Remover TOOL-1175-AC puller in combination with Slide Hammer T50T-100-A, remove the pinion oil seal.

Installation

1. Clean the pinion oil seal seat. Coat the sealing edge of the new seal with a small amount of Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent. Drive the seal into the housing using Tool T83T-4676-A for Econoline axles. Use Tool T88T-4676-A for F-Super Duty Axles.

CAUTION: Installation without the proper tool may result in early seal failure. If seal becomes cocked during installation, remove and install new one. Use care to assure the garter spring remains in place during assembly. If the spring is dislodged, the seal must be replaced.

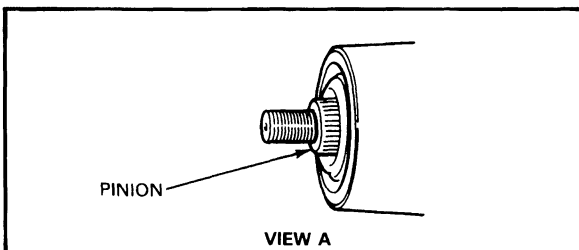
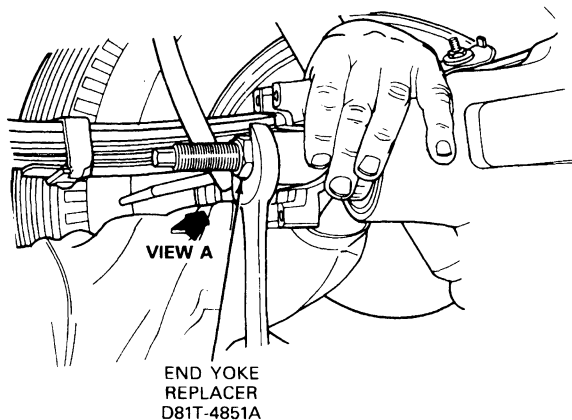


E4722-1B

REMOVAL AND INSTALLATION (Continued)

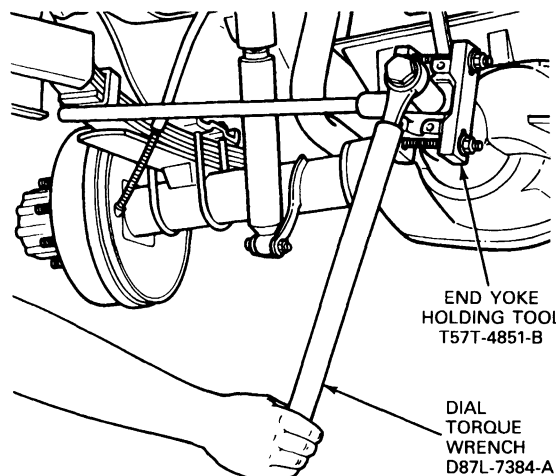
2. Coat the inside of the end yoke flange with a small quantity of Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent and install the flange on the pinion shaft using Tool D81T-4858-A or equivalent.

NOTE: The end yoke must never be hammered on or installed with power tools.



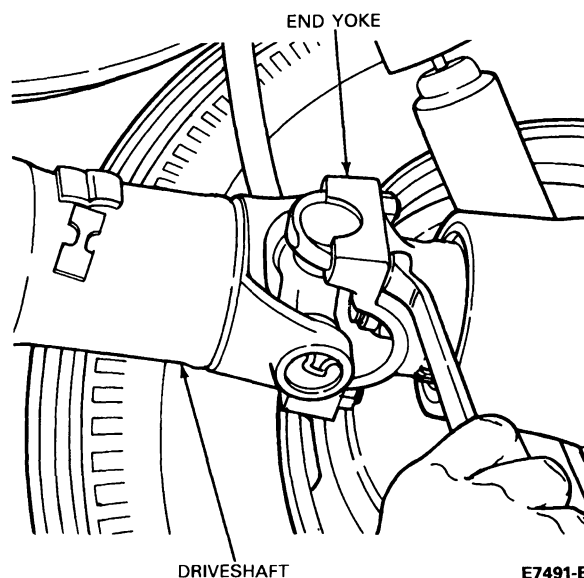
E7492-B

3. Install the pinion attaching nut on the pinion stem and tighten to specifications listed at the end of this section. Hold the end yoke with Companion Flange Holding Tool T57T-4851-B while tightening the nut with Dial Torque Wrench D87L-7384-A or equivalents.



E7495-D

4. Connect the driveshaft to the axle end yoke as originally oriented. Secure with nuts and U-bolts or straps and bolts (F-Super Duty threaded flange) and tighten to specifications listed at the end of this section.



E7491-B

5. Raise the vehicle, remove the safety stands and then lower the vehicle to road position. Check the level of axle lubricant and add the specified lubricant as necessary.

REMOVAL AND INSTALLATION (Continued)**Rear Axle****Removal**

NOTE: Axle shafts, wheel hubs, wheel hub bearings and the wheel hub grease seals can be replaced without removing the differential assembly from the axle housing or the rear axle assembly from the vehicle.

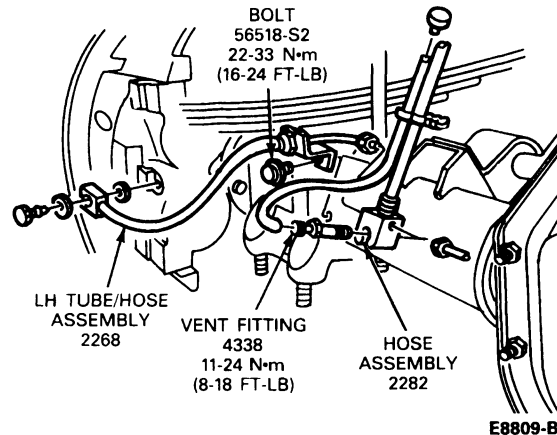
The axle shafts, wheel hubs, bearings and grease seals may be replaced, lubricated or adjusted as outlined in Section 05-02E.

1. Loosen the wheel stud nuts and the axle shaft to hub retaining bolts.
2. Disconnect the rear shock absorbers from the rear axle, and unclamp the rear stabilizer bar if so equipped. Refer to Section 04-02. Then raise the rear end of the vehicle frame until the weight is off the rear springs. Place safety stands under the frame in this position.
3. Disconnect the flexible hydraulic brake line at the frame.
4. Disconnect the parking brake cable (if so equipped) at the equalizer, and remove the cables from the cable support brackets. Refer to Section 06-05.
5. Disconnect the driveshaft from the rear U-joint flange. Disconnect anti-lock wiring from axle sensor and height sensing linkage, if so equipped. Refer to Section 06-09.
6. Remove the nuts from the rear spring clips (U-bolts), and remove the spring seat caps.
7. Roll the axle from under the vehicle, and drain the lubricant. Remove the wheels. Mount the axle in a work stand. To remove axle shafts, hubs and drums or hub and rotor assemblies refer to Section 05-02E.

Installation

1. Install inner grease seal after applying a coating of Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-BA) or an equivalent lubricant to the lip surface. Refer to Section 05-02E for hub and bearing installation (use new hub to axle shaft gaskets).
2. Clean and remove any metallic debris in the hub bolt holes.
3. Inspect for cracked material around the holes, depth of the threaded hole (minimum 1.0 inch), and oversized threaded holes, and replace hub if any of these three conditions are present.
4. Install the axle shafts through housing ends so that they will spline to the differential side gears.
5. Install **new** shaft retaining bolts (with Loctite®-type adhesive) and lockwashers every time the bolts are removed.
6. After installing the rear wheels, roll the axle assembly under the vehicle.

7. Install the rear spring clips (U-bolts) and spring seat caps. On Econoline, tighten the nuts to 150-217 N·m (110-160 ft·lb). Tighten F-Super Duty nuts to 267-360 N·m (200-270 ft·lb).
8. Connect the rear shock absorbers, and install the stabilizer bar in position on F-Super Duty.
9. Connect the driveshaft to the rear axle end yoke. Refer to Section 05-01 for installation instructions and torque specifications.
10. Connect and adjust the parking brake cables (if so equipped). Refer to Section 06-05.
11. Connect the hydraulic brake hose and bleed the brakes. The axle vent hose is part of the brake hose assembly and uses a special "flow" bolt to secure the hose block assembly to the axle.
12. Fill the axle with the proper grade and specified amount of axle lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent.
NOTE: This is a different lube than that used in Ford axles.
13. Lower the vehicle to the floor.

**Rear Axle Shaft, Semi-Floating Axle****Model 60-1U, E-250****Removal**

1. Lift vehicle and install safety stands.
2. Remove wheel and brake drum.
3. Drain lubricant from the axle. Remove cover plate to drain lubricant. Clean the gasket material from the cover and axle housing.
4. Remove the differential pinion mate shaft lock screw as shown in the illustration.

NOTE: It is possible for Dana semi-float axles to be equipped with lock screw coated with either a Loctite® or torque prevailing threads. The two types of lock screw may be identified as follows.

- the Loctite® (or equivalent) treated lock screw has a 5/32-inch hexagram socket head.

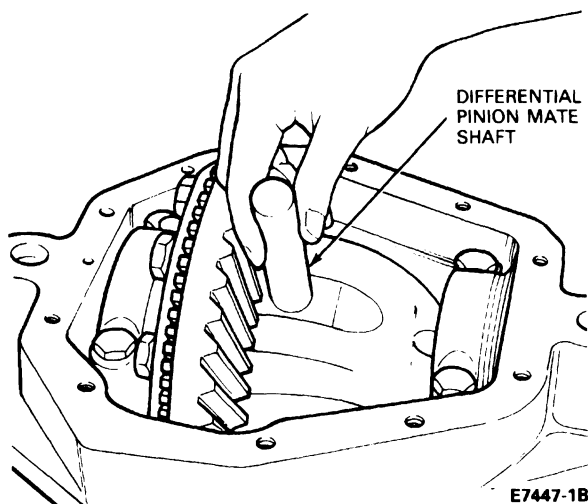
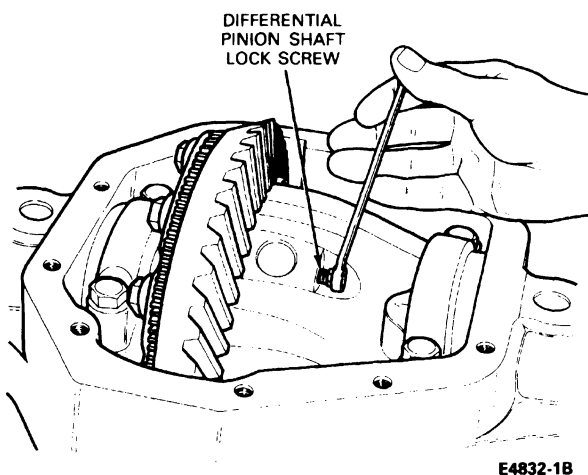
REMOVAL AND INSTALLATION (Continued)

Loctite® (or equivalent) treated lockscrew must not be re-used under any circumstances.

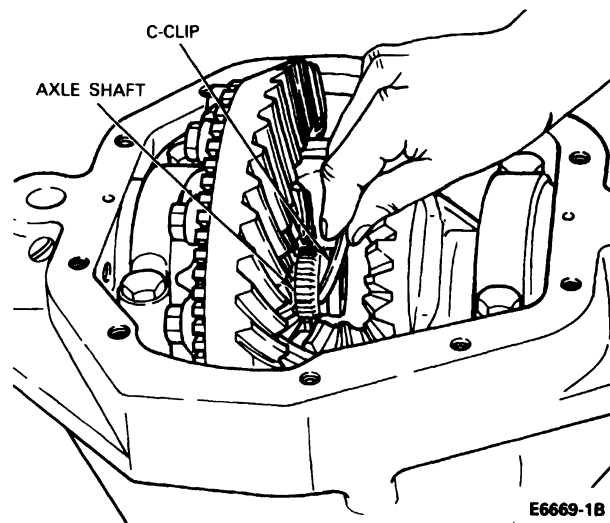
- the torque prevailing lockscrew has a 12-point drive head.

If the axle is equipped with the torque prevailing lockscrew, it may be re-used up to four times (four removals and installations). When in doubt about the number of times the torque prevailing lockscrew has been reused, replace the lockscrew.

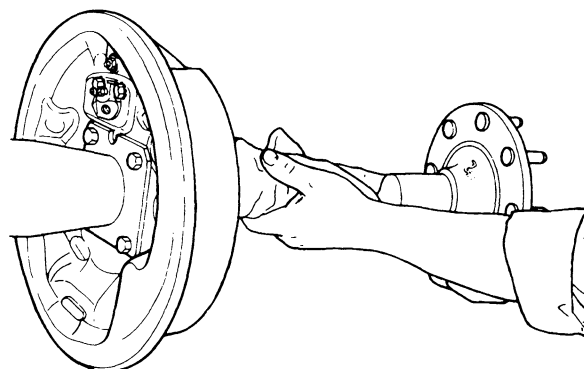
5. Lift out the differential pinion mate shaft as shown. Shaft is a slip-fit design and may be removed by hand.



6. Push the flanged end of axle shaft toward the center of the vehicle and remove the C-clip from button end of shaft as shown in the illustration.



7. Pull the axle shaft from the axle tube, being careful not to damage oil seals.



NOTE: When removing axle shafts, do not rotate differential side gears. Rotating side gears causes the pinion mate gears and thrust washers to turn to the differential case opening and fall out.

NOTE: In semi-floating axles, after the axle shafts have been removed, assemble the pinion mate shaft and lockscrew back in the differential case. Use old lockscrew and assemble finger-tight to prevent the side gear and mate gears from rotating and dropping out of the differential case.

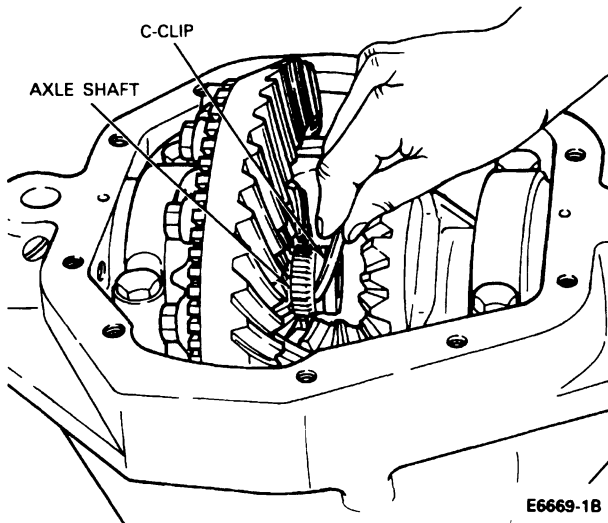
Installation

1. Push axle shaft into axle tube, making sure splined shaft end engages side gears.

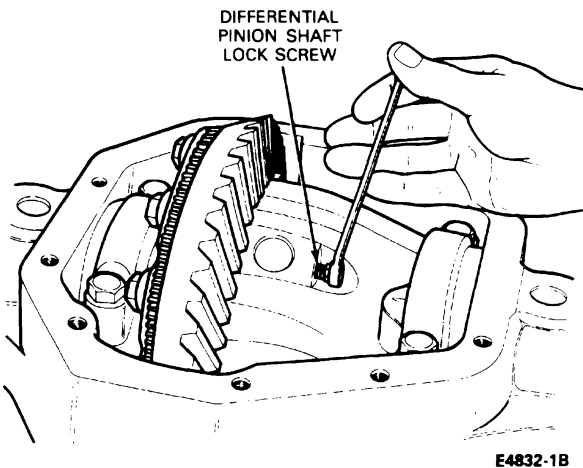
NOTE: Be careful not to damage oil seals and bearings.

REMOVAL AND INSTALLATION (Continued)

2. Push the flanged end of axle shaft toward center of axle and install C-clip. Pull flanged end outward until C-clip locks into side gear.



3. Install pinion mate shaft. Be sure lock screw hole of the shaft is lined up with the lock screw hole in case. Correctly position pinion gear side washers.
4. Install the new lock screw. Align the hole in the differential cross-shaft with the screw hole in the case. Make sure threads in the differential case and on lock screw are free of dirt and oil. Tighten lock screw to 27-34 N·m (20-25 ft·lb).



5. Add RTV or an equivalent sealer to the cover plate. Install cover plate. Do not use an acetic acid-based RTV.

A flat mounting surface cover plate is used on all Dana design axles. This cover plate requires the use of a silicone rubber sealer material, Silicone Rubber E7TZ-19562-A (ESL-M4G273A) or equivalent, rather than a gasket.

The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

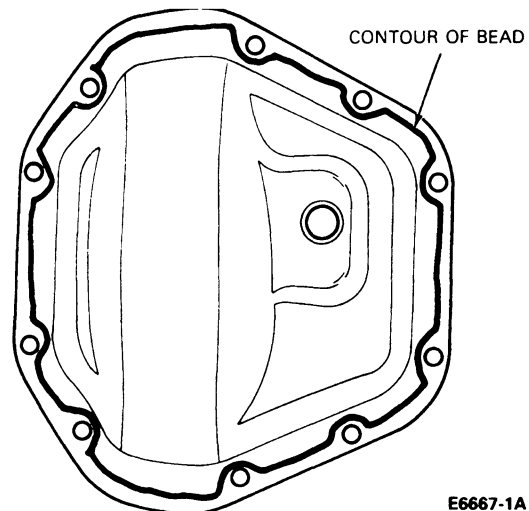
CAUTION: Clean both flat surfaces with a suitable solvent to remove all traces of oil film. Sealant material must meet specifications of ESL-M4G273-A, B, ASTM1, GE503, Z1, Z2, Z3 sealant or equivalent.

Apply Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent to cover plate surface. Sealer bead should be 3-6mm (1/8-1/4 inch) wide on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.

6. Assemble two cover screws into cover at 8 o'clock and 2 o'clock positions. Use these two holes to guide cover plate into position on the carrier.
7. Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft·lb).

Allow one hour cure time before filling carrier with the proper amount of specified lubricant and operating vehicle.



8. Fill the axle housing with the specified amount of axle lubricant C6AZ-19580-E (ESW-M2C 105-A).
NOTE: This lube is different than that used in Ford axles.
9. Install brake drum in position on axle shaft flange.
10. Install wheel and tire assembly in position to axle shaft flange. Tighten nuts to 190 N·m (140 ft·lbs).
11. Lower vehicle and road test.

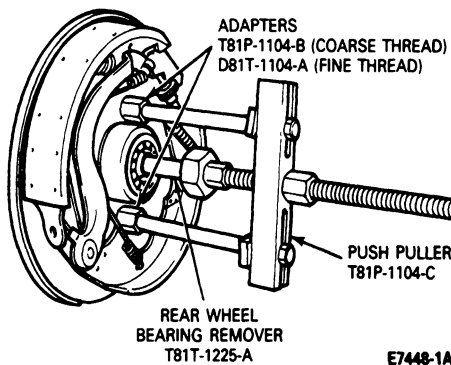
REMOVAL AND INSTALLATION (Continued)**Rear Axle Shaft, Full-Floating Axle**

For rear axle shaft removal and installation on Model 60-1U, 70-2U and 80, E-350 and F-Super Duty vehicles, refer to Section 05-02E.

**Oil Seal and Wheel Bearing, Semi-Floating Axle
Model 60-1U, E-250**
Removal

1. Remove axle shaft as described in this section.
2. Remove the oil seal from the axle tube. Discard the seal.
3. Pull the bearing from the axle tube using Push Puller T81P-1104-C, Adapters T81P-1104-B (coarse thread) or D81T-1104-A (fine thread) and Rear Wheel Bearing Remover T81T-1225-A, as shown.

CAUTION: Wear safety glasses when removing the bearing in the event the bearing flies apart during removal.



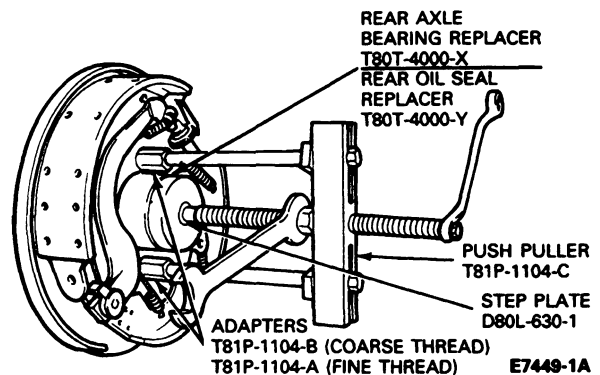
4. Use a standard metal cleaning solvent to clean out the bearing bore in the housing. Wipe this area clean, making sure it is free from dirt or any other contamination that might be present.
- NOTE:** The bearing bore must be free from nicks and burrs. Wipe the bore with emery cloth to assure a smooth surface. Clean bore out with a standard metal cleaning solvent. If bore has burrs or spalled areas and a new bearing is installed, it may lead to early fatiguing.

Installation

1. Coat the bearing with differential lube for easier assembly and to prevent possible scoring of the tube bore.
 2. Install bearing with identification numbers on bearing facing out. Use Push Puller T81P-1104-C, Adapters T81P-1104-B or D81T-1104-A, Step Plate D80L-630-1 and Rear Axle Bearing Replacer T80T-4000-X.
- NOTE:** During bearing installation, make sure the bearing is not cocked in the bore.

3. Install a new oil seal in the bore using Push Puller T81P-1104-C, Adapters T81P-1104-B or D81T-1104-A, Step Plate D80L-630-1 and Rear Oil Seal Replacer T80T-4000-Y, as shown. An alternate method of installing the seal is to drive the seal into place with Rear Oil Seal Replacer T80T-4000-Y and Driver Handle T80T-4000-W.

NOTE: Make sure the seal is not cocked in the bore during installation.



4. Lubricate cavity between seal lips and bearing with Premium Long-Life Grease XG-1-C, -K or equivalent.
5. Install axle shafts as described in this section.

**Oil Seal and Wheel Bearing, Full-Floating Axle
Models 60-1U, 70-2U and 80**
Removal and Installation

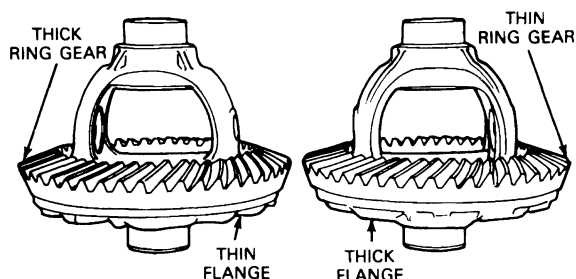
Refer to Section 05-02E for removal and installation procedures.

DISASSEMBLY AND ASSEMBLY

NOTE: When changing ratios on the Model 60 and Model 70 Series rear axles, it may be necessary to change the differential case along with the ring gear and drive pinion.

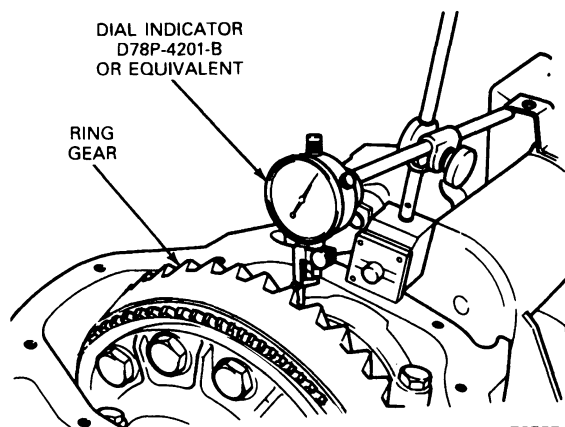
DISASSEMBLY AND ASSEMBLY (Continued)

In the 60-1U and 70 Series axles, ratios 3.54 to 1 up to 4.10 to 1 incorporate a thick differential case flange and a thin ring gear. Ratios 4.56 to 1 and up incorporate a thin differential case flange and a thick ring gear.



NOTE: SPEED SENSOR RING PRESSED ON DIFFERENTIAL CASE FLANGE NOT SHOWN.

E8551-B



E8555-B

Inspection Before Disassembly

Inspect differential case assembly and drive pinion prior to removal from the axle assembly. These inspections can find the cause of the concern and determine the resolution.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to check for any roughness, indicating damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.
4. Set up dial indicator Tool D78P-4201-B and check ring gear and pinion backlash and ring gear backface runout.

Check ring gear and pinion backlash in three equally spaced points with dial indicator.

Backlash tolerance is 0.127-0.203mm (0.005-0.008 inch) and cannot vary more than 0.05mm (0.002 inch) between points checked.

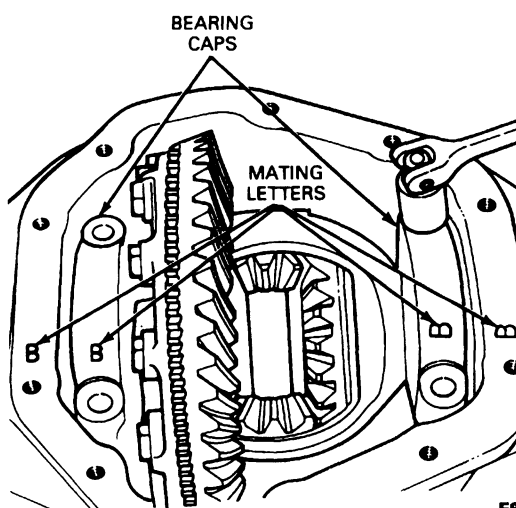
- High backlash is corrected by moving the ring gear toward the pinion.
- Low backlash is corrected by moving the ring gear away from the pinion.
- These corrections are made by switching shims from one side of the differential case to the other.

To check ring gear backface runout, mount Dial Indicator D78P-4201-B on the carrier so the tip of the dial indicator contacts the backface of the ring gear. Backface runout should be no more than 0.101mm (0.004 inch).

Disassembly

1. Remove the rear axle from the vehicle as outlined in Removal and Installation.
2. Remove cover plate screws and cover plate. Tip carrier to allow lube to drain completely. Clean the cover face of the carrier, making sure it is free from any nicks. Remove old RTV gasket material.
3. Remove bearing caps.

NOTE: Mating letters are stamped on caps and carrier. Matching letters is important at time of assembly. Letters are in vertical and horizontal positions.

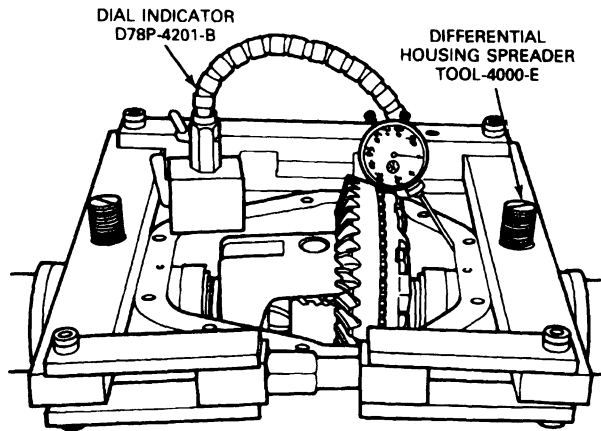


E8552-1A

CAUTION: Before removing differential case and ring gear, pull axle shafts out far enough for clearance to remove differential. Refer to section of manual covering the type of axle assembly being serviced.

DISASSEMBLY AND ASSEMBLY (Continued)

4. Place Differential Housing Spreader on the housing. Install Dial Indicator Tool D78P-4201-B on the carrier housing. Do not spread housing more than 0.38mm (0.015 inch).

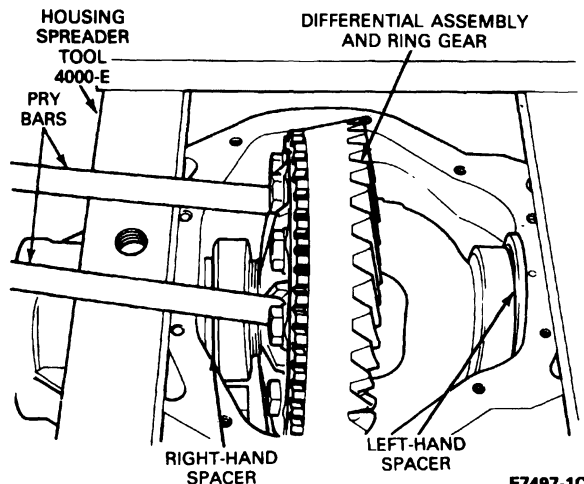


E7674-1C

5. Pry differential case from carrier with two pry bars. After differential case has been removed, remove spreader.

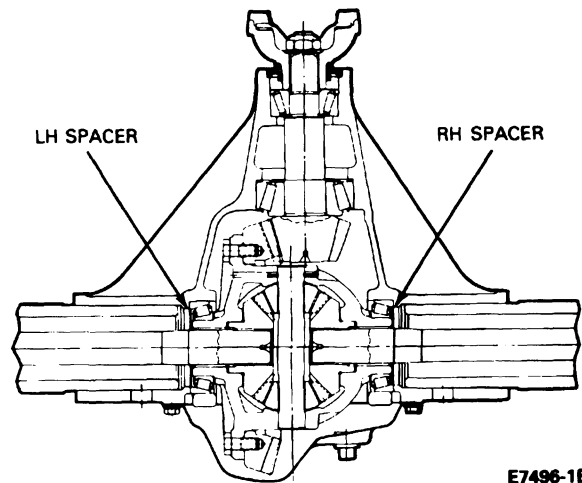
NOTE: Use caution to avoid damage to ring and pinion.

Mark or tag bearing cups indicating from which side they were removed.



E7497-1C

Dana Model 60, 70 and 80 rear axles incorporate spacers installed outboard of each differential bearing cup. Remove both spacers and tag each indicating the side each was removed from. Inspect both spacers for damage, bent or grooved conditions. Replace if required.

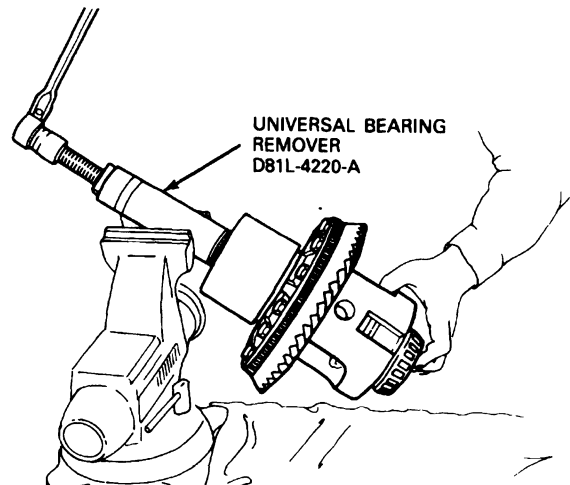


E7496-1B

6. Remove differential bearings with special tool Universal Bearing Remover D81L-4220-A. Place the tool in a vise when removing bearing. Wire shims, bearing cup, bearing cone, and outboard spacer together. Identify from which side they were removed (ring gear side or opposite side). If shims are damaged, replace with new ones at time of assembly.

NOTE: Shims are available in thicknesses of .08, .13, .25 and .76 mm (.003, .005, .010 and .030 inch).

7. Reposition case in puller and remove other bearing cone as described above. Replace bearings whenever removed from the carrier.



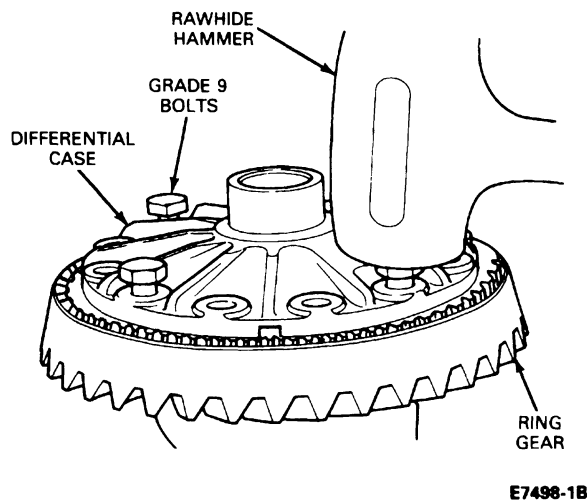
E8553-1A

DISASSEMBLY AND ASSEMBLY (Continued)

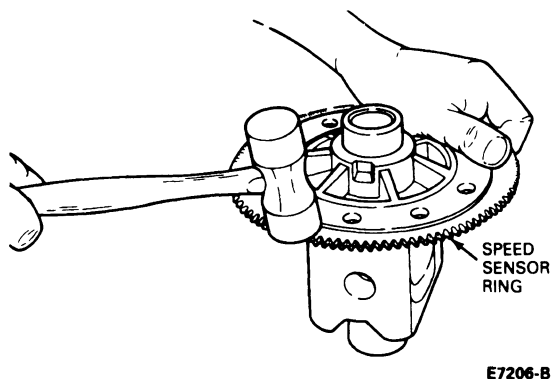
8. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked. Place case in vise. Remove ring gear bolts. Leave four bolts loosely assembled 90 degrees apart. Tap each bolt head alternately with a rawhide hammer to loosen the ring gear. Remove bolts and ring gear.

NOTE: Whenever removing the ring gear bolts, always replace with new bolts upon assembly. Use grade 9 bolts for service replacement for all Dana axles.

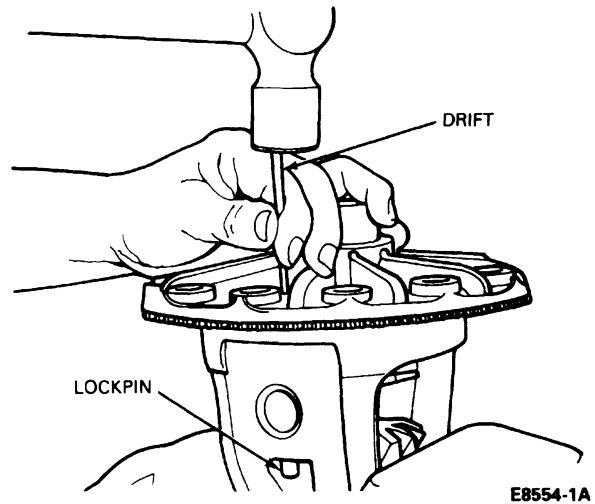
CAUTION: Use care to not damage sensor ring when removing ring gear. If the sensor ring is removed, it must be replaced with a new one.



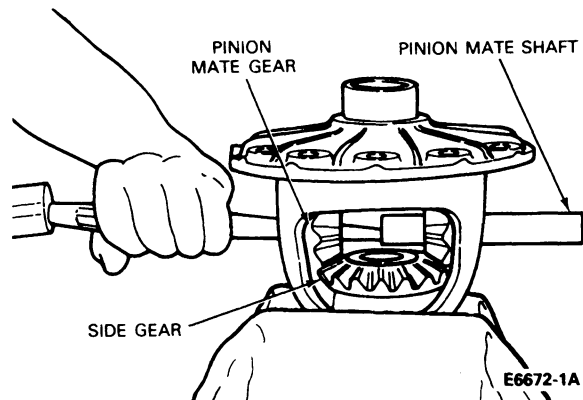
9. If required, remove the sensor ring with a soft-faced hammer. Discard the sensor ring.



10. Replace case in vise. Use a small drift to drive out lockpin which secures the pinion mate shaft.



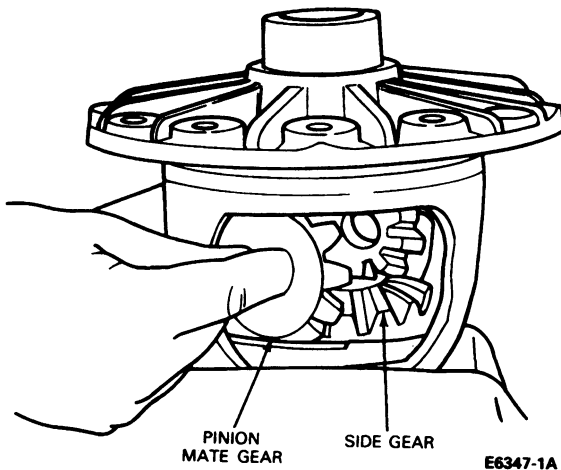
11. Remove pinion mate shaft with drift as shown.



12. To remove side gears and pinion mate gears, rotate the side gears. The pinion mate gears will turn to the opening of the case. Remove pinion mate gears and spherical washers behind the gears. Lift out side gears and thrust washers.

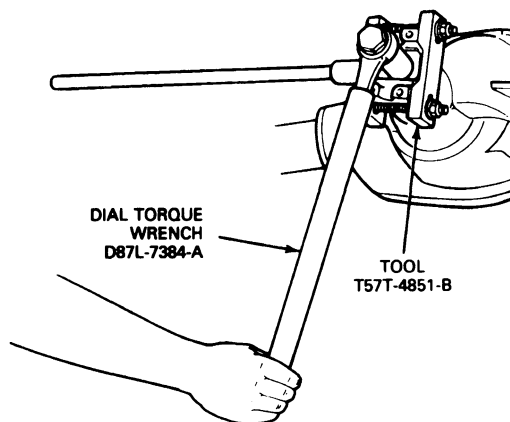
DISASSEMBLY AND ASSEMBLY (Continued)

13. Inspect all parts, including the machined surfaces of the case itself. If excessive wear is visible on all parts, it is suggested that the complete differential assembly be replaced. If any one of the gears is to be replaced. REPLACE AS A SET.

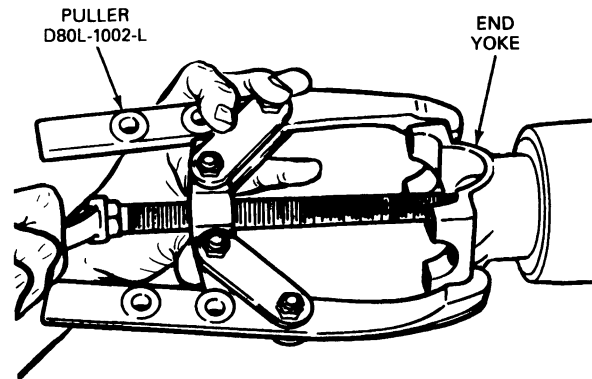


14. Turn nose of carrier in a horizontal position, remove pinion nut with tool D87L-7384-A. Hold pinion flange with Tool T57T-4851-B Companion Flange Holding Tool and remove pinion nut and washer.

NOTE: Pinion nut for Model 80 axle requires 596-678 N·m (440-500 ft-lb) of torque to remove.

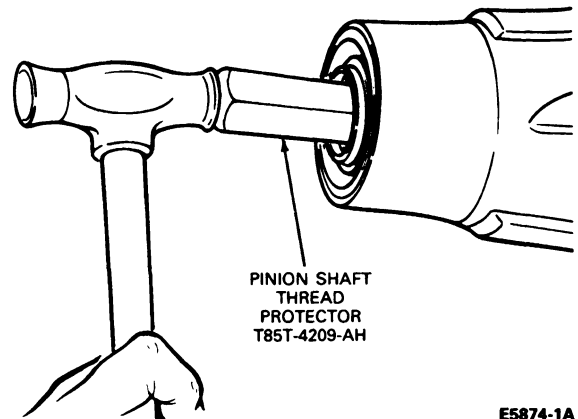


15. Remove end yoke with Puller Tool D80L-1002-L. If the end yoke shows wear in the area of the seal contact, replace.



16. Remove pinion by tapping with a rawhide hammer. Catch the pinion with your hand to prevent from falling and being damaged.

CAUTION: Handle pinion gear carefully to prevent injury.



NOTE: On the spline end of the pinion, there are bearing preload shims. These shims may stick to the pinion or bearing or even fall out. These shims are to be collected and kept together for reassembly. Try not to damage shims. If shims are damaged, replace with new ones. Shims are available in the following thicknesses:

PINION PRELOAD SHIMS

Models 60 and 70		Model 80	
mm	Inches	mm	Inches
.25	.010	.36	.014
.36	.014	.38	.015
.38	.015	.41	.016
.41	.016	.46	.018
.46	.018	.51	.020
.51	.020	.53	.021
.53	.021	.56	.022

(Continued)

DISASSEMBLY AND ASSEMBLY (Continued)**PINION PRELOAD SHIMS (Cont'd)**

Models 60 and 70		Model 80	
mm	Inches	mm	Inches
.56	.022	.58	.023
.58	.023	.76	.030
.76	.030	—	—

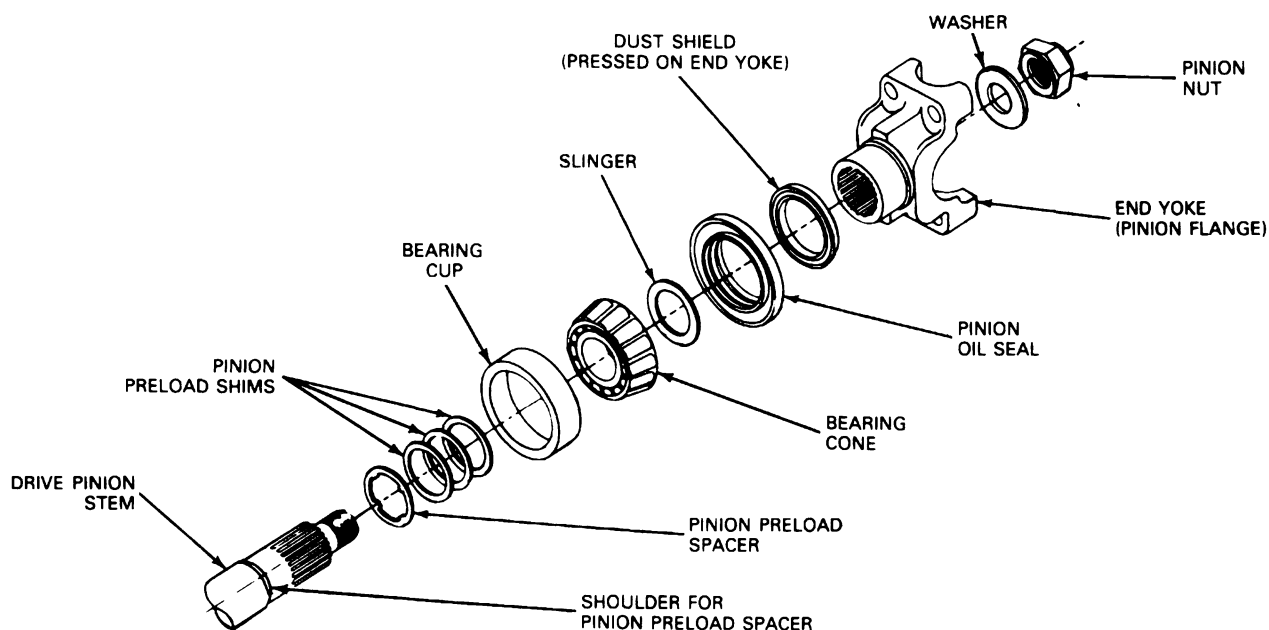
Model 70 axles may also include a pinion bearing preload spacer with the inner pinion bearing preload shims.

Drive Pinion Assembly Sequence

The illustration shows the assembly sequence for the drive pinion preload spacer, included in the service kit, must be used with the drive pinion kit.

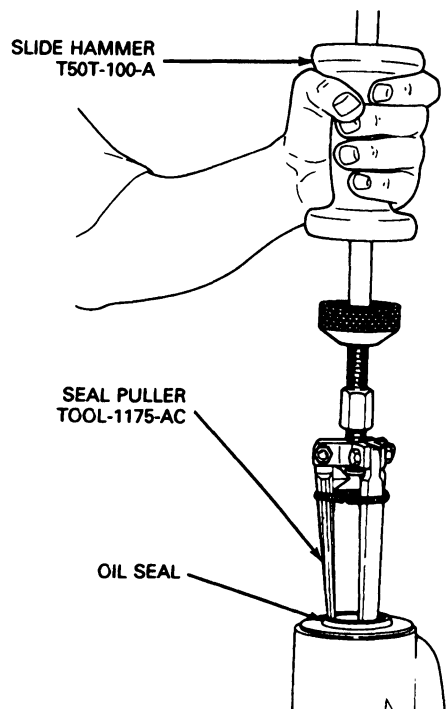
The drive pinion preload spacer and preload shims assembly sequence must be followed. If sequence is not followed and components are improperly assembled, it may cause unit failure.

Axle assemblies manufactured without and prior to the use of the pinion preload spacer may be serviced with this drive pinion and preload spacer.

**E7499-2B**

DISASSEMBLY AND ASSEMBLY (Continued)

17. Pull out pinion seal with Puller T77F-1102-A, Bearing Cup Puller and Slide Hammer T50T-100-A. Discard seal. **REPLACE WITH NEW ONE AT TIME OF ASSEMBLY.** Remove bearing cone and outer oil slinger.



E4834-1B

18. Turn nose of carrier down. Remove outer pinion bearing cup with Driver Handle D81L-4000-A and the correct size bearing cup remover as shown in the following illustration.

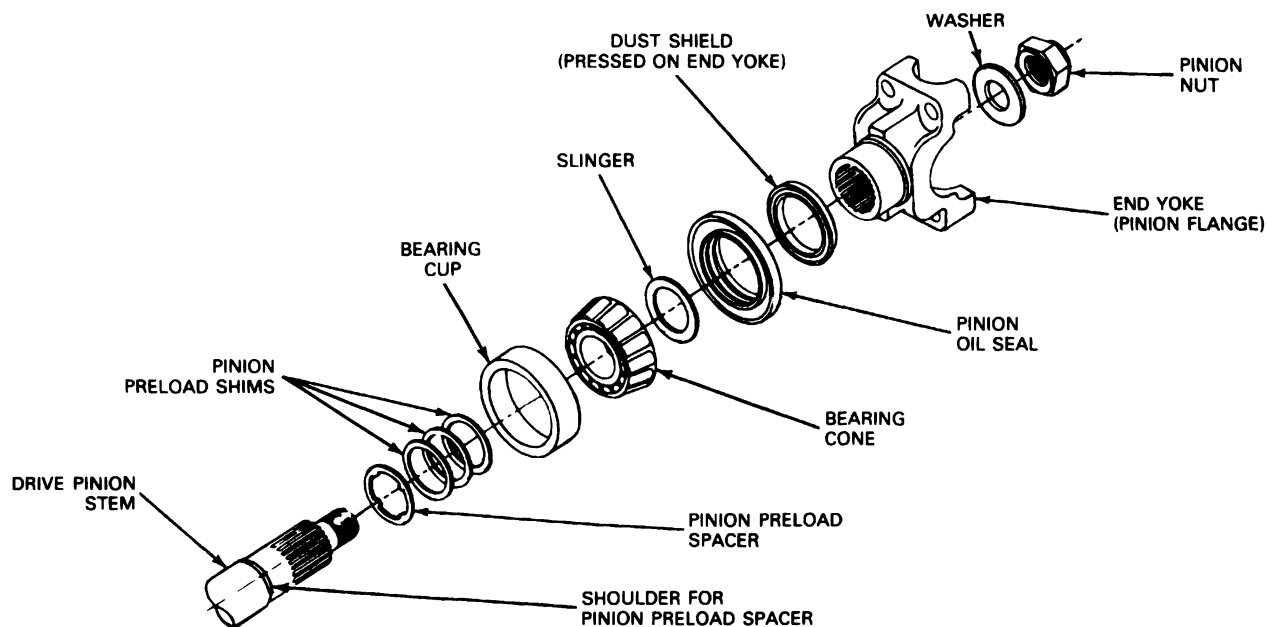
CAUTION: Do not nick carrier bore.

NOTE: The front and rear carrier section may vary in pinion bore depth due to the need for either a baffle or slinger or both.

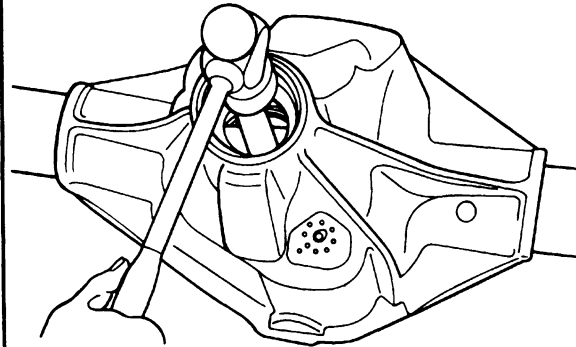
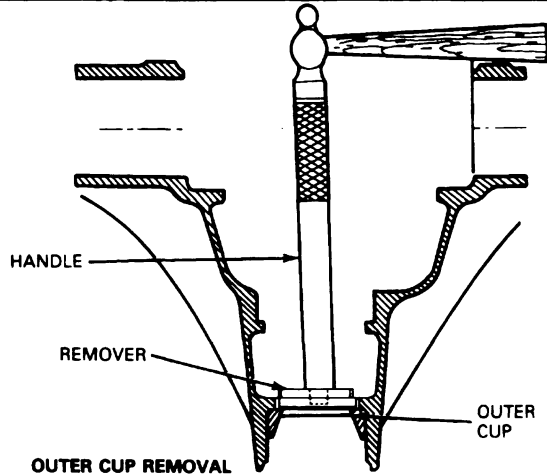
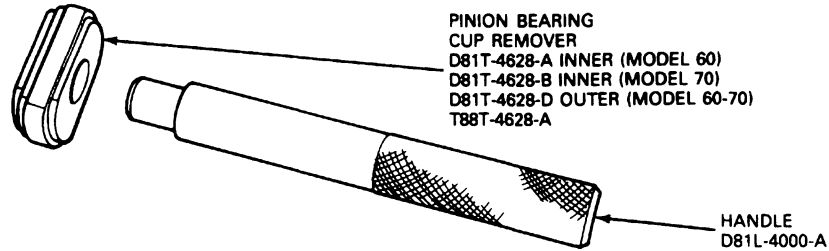
The baffle serves the same purpose as a dam, to maintain pinion bearings with lubricant.

The slinger serves the purpose of assisting the lube to flow up through the oil channels to lubricate the pinion bearings. If used, they are part of the pinion setting adjustment.

19. Remove the inner bearing cup with Driver Handle D81L-4000-A and the correct size bearing cup remover as shown in the following illustration.

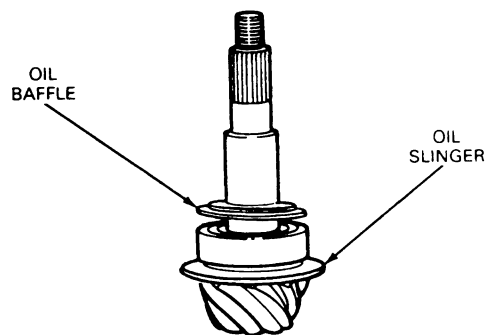
Inner and Outer Bearing Cup Removal

E7499-2B

DISASSEMBLY AND ASSEMBLY (Continued)**Inner and Outer Bearing Cup Removal**

E4835-2G

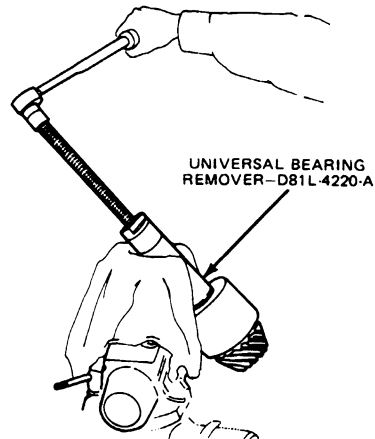
NOTE: Shims are located between the bearing cup and carrier bore and may also include an oil baffle. If shims and baffles are bent or nicked, replace at time of assembly. Wire shim stacks together and measure each. If stack has to be replaced, replace with same thickness shim pack.



E7115-1A

20. Remove bearing from pinion with Universal Bearing Remover D81L-4220-A.

NOTE: Both baffle and slinger are part of the pinion adjustment shims and are to be kept intact for assembly.



E4847-1A

Inspection After Disassembly

1. Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air.
2. Oil the bearings immediately to prevent rusting.
3. Inspect the parts for any major damage.
4. Clean the inside of the housing before rebuilding.

DISASSEMBLY AND ASSEMBLY (Continued)

5. When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly.

Inspection procedures for individual parts are outlined as follows:

Bearing Cups

Check bearing cups for deep scores, galling, or spalling. If a 0.0381mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup must be re-seated.

Cone and Roller Assemblies

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

Pinion Flange (End Yoke)

Be sure that the flange lugs have not been damaged in removing the driveshaft or in removing the flange from the pinion. The end of the flange that contacts the bearing cone as well as the nut counterbore and seal surface must be smooth and free of nicks.

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Sensor Ring

Examine sensor ring teeth. Replace if any are broken or missing.

Carrier Housing

Make sure that the differential and pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed.

CAUTION: The bearing assemblies will fail if they do not seat firmly against the shoulders.

Check the fit (free rotation) of the differential side gears in their counterbores.

Assembly**Differential Case**

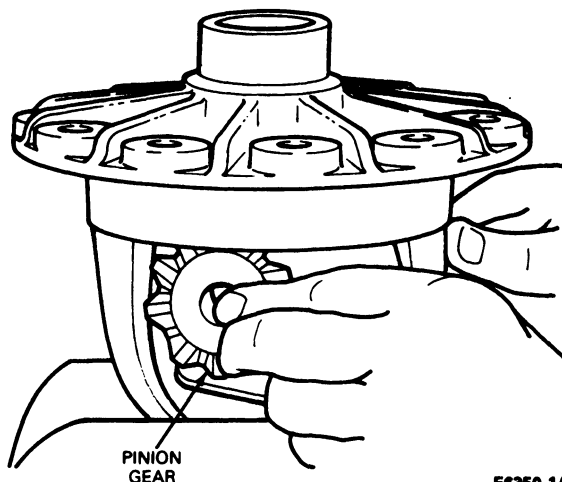
1. Place differential case in vise. Apply Premium Long-Life Grease XG-1-C or -K C1AZ-19590-BA (ESA-M1C75-B) or equivalent to new side gear thrust washers and to hubs and thrust face of the new side gears.

2. Install both side gears. Apply grease to the new pinion mate spherical washers and the new pinion mate gears.

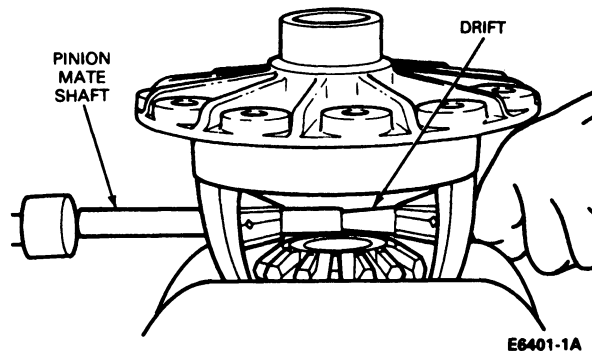
3. Assemble both side gears and thrust washers, hold in place with hand, then assemble the pinion mate gears and washers to hold the side gears in place.

NOTE: An easy way to assemble the side gears and pinion mate gears is to have all parts lubricated with Rear Axle Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent before assembly.

4. Rotate the side gears until the holes of the washers and pinion gears line up with the holes of the case. If the gears cannot be rotated by hand, install one of the axle shafts into the side gear spline and use a pipe wrench to turn the shaft.



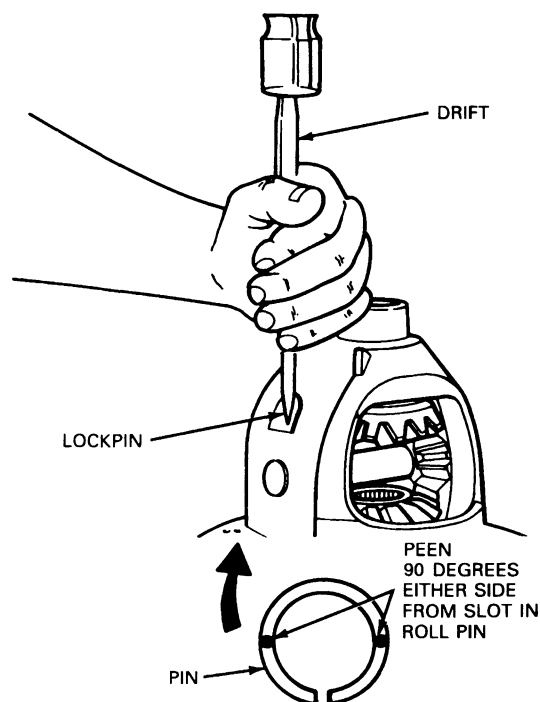
5. Use a drift to line up the holes with those of the differential case.
6. Assemble pinion mate shaft, drive on shaft to remove drift. Align lockpin hole of the shaft with the lockpin hole of the case.



DISASSEMBLY AND ASSEMBLY (Continued)

7. Assemble lockpin. Peen metal of case over pin in two places 180 degrees apart to lock in place. Note the location of the slot in the lockpin and peen 90 degrees away.

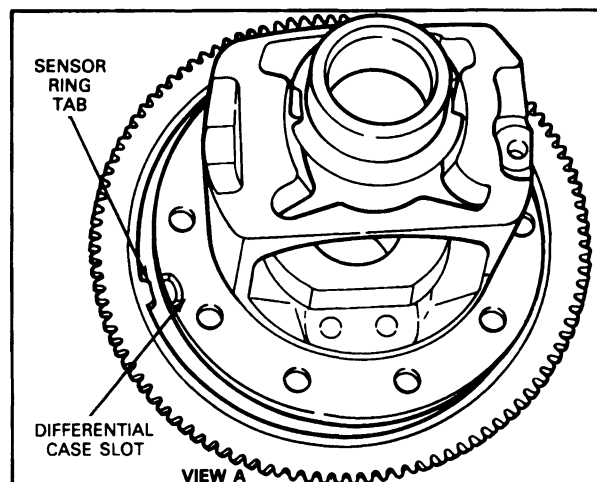
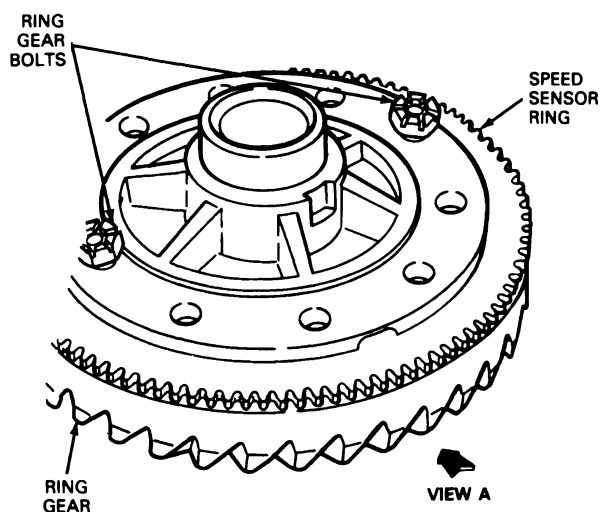
NOTE: The semi-float shaft riding bearing design uses a lockpin that is assembled using a 12-point socket wrench. Use a new lockpin and assemble finger tight only. This procedure is necessary to prevent differential side gears and differential pinion mate gears from rotating in the case and dropping out when servicing the carrier section. Install a new lockpin after assembling the axle shafts.



E6402-C

8. Align tab in sensor ring with slot in differential case. Start two ring gear bolts through the case into the ring gear to make sure case and ring gear bolt hole align.

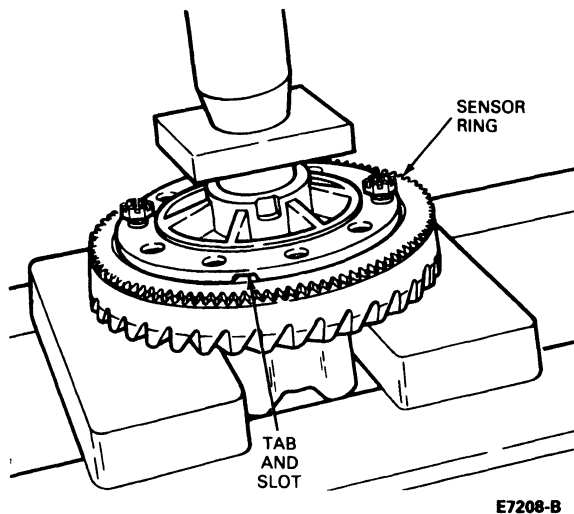
CAUTION: Tab on sensor ring must be aligned with slot in differential case.



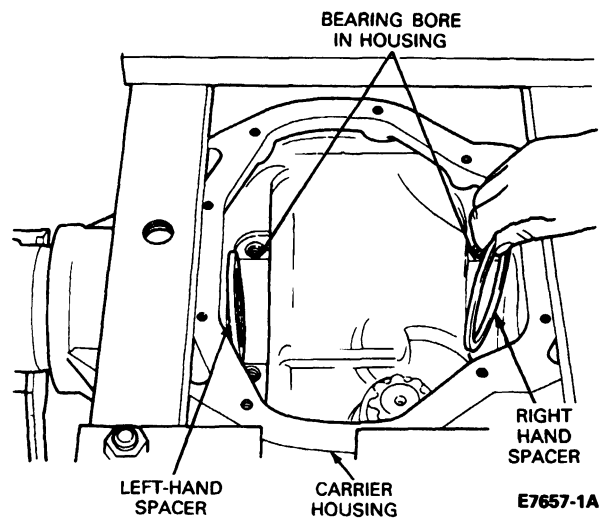
E7207-B

DISASSEMBLY AND ASSEMBLY (Continued)

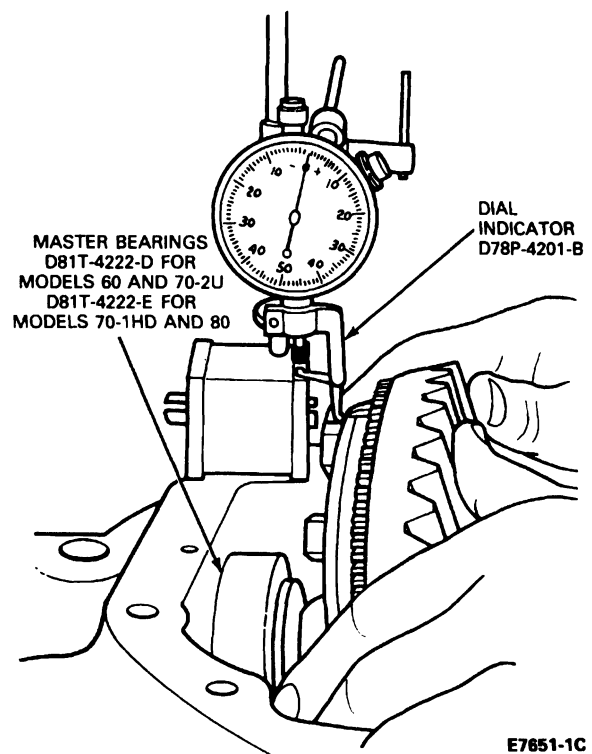
9. Press the sensor ring and ring gear on the differential case. The ring gear acts as a pilot for the sensor ring. Apply Thread Lock and Sealer EOAZ-19554-AA (ESE-M4G204-A) or equivalent to new ring gear bolts.



10. Make sure flange face of the case is free of nicks or burrs. Assemble ring gear to case. Line up holes of the ring gear with those of the case.
11. Draw up gear bolts alternately and evenly.
- Tighten ring gear bolts to 136-163 N·m (100-120 ft·lb) for grade 8 bolts.
 - Tighten grade 9 bolts 169-183 N·m (125-135 ft·lb) for Model 60, 61 and 70 axles.
 - Tighten Model 80 ring gear bolts to 285-312 N·m (210-230 ft·lb).
12. Install Master Differential Bearings Tool D81T-4222-D for Model 60 and 70-2U axles. Use Tool D81T-4222-E or equivalent for 70-HD and Model 80 axles onto the differential case.
13. Remove all nicks, burrs, dirt, etc., from hubs to allow bearings to rotate freely.
14. Install outboard differential spacers into carrier. Assemble differential case into carrier (less pinion).
15. Mount dial indicator with a magnetic base Tool D78P-4201-B or equivalent as shown. Locate tip of indicator on flat surface of one of the ring gear screw spot faces.
16. Force differential assembly as far as possible in the direction toward the indicator. With force still applied, set indicator at zero (0).



NOTE: Dial indicator should have a minimum travel capability of 5.08mm (0.200 inch).



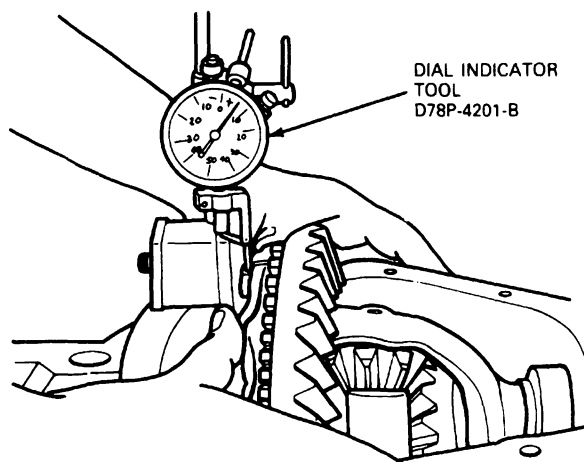
17. Force the differential assembly as far as it will go in the opposite direction.

NOTE: Repeat these steps until you have obtained the same reading. Record the reading of the indicator. This will be the total amount of shims required (less preload) and will be calculated later during assembly.

DISASSEMBLY AND ASSEMBLY (Continued)

18. After making sure the readings are correct, remove indicator and differential assembly from housing. **DO NOT REMOVE MASTER BEARINGS FROM DIFFERENTIAL CASE AT THIS TIME.**

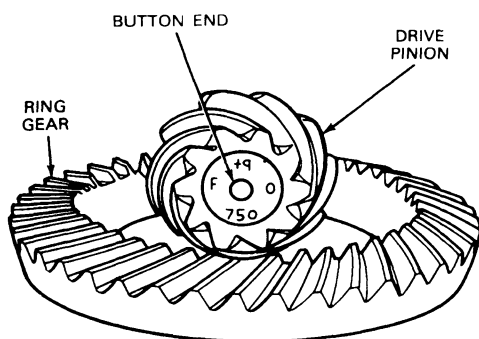
This reading is the Total Differential Case End Play which will be needed in Step 9 of Assembly of Differential into Housing later in this section.



E7652-1B

19. Ring gears and pinions are supplied in matched sets only. Matching numbers on both the pinion and ring gear are etched for verification. If a new gearset is being used, verify the numbers of each pinion and ring gear before proceeding with assembly. The end of the pinion with the etched figures shown is known as the "button" end.

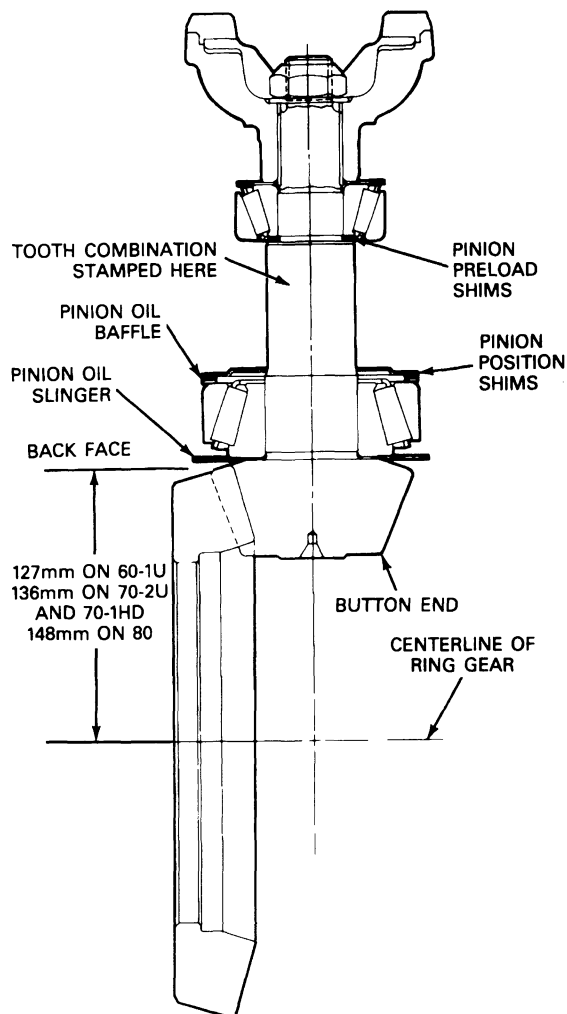
Use the gear contact pattern method to make sure the final pinion position is valid.



E8556-B

On the button end of each pinion, there is etched a plus (+) number, a minus (-) number, or a zero (0) number which indicates the best running position for each particular gear set. This dimension is controlled by the shimming behind the inner pinion bearing cup (the backface).

The distance from the centerline of the ring gear to the backface of the pinion for Model 60-1U is 127mm (5.000 inch), for Model 70-2U the distance is 136mm (5.375 inch) and for Model 80 is 148mm (5.812 inch).



E8230-C

For example, if a pinion is etched $m+8 (+3)$, this pinion would require .08mm (.003 inch) less shims than a pinion etched "0". This means by removing shims, the mounting distance of the pinion is increased, which is just what an $m+8 (+3)$ indicates. Or if a pinion is etched $m-8 (-3)$, we would want to add .08mm (.003 inch) more shims than would be required if the pinion were etched "0". By adding .08mm (.003 inch) shims, the mounting distance of the pinion was decreased, which is just what an $m-8 (-3)$ indicated.

If the old ring and pinion set is to be reused, measure the old shim pack and build a new shim pack to this same dimension. If a baffle is used in the axle assembly, it is considered as part of the shim pack.

DISASSEMBLY AND ASSEMBLY (Continued)

To change the pinion adjustment, shims are available in thicknesses of .08, .13 and .25 mm (.003, .005 and .010 inch).

NOTE: If baffle or slinger is bent or mutilated, it should be replaced.

20. Measure each shim separately with a micrometer and add together to get the total shim pack thickness from the original build up.

If a new gear set is being used, notice the (+) or (-) etching on both the old and new pinion and adjust the thickness of the new shim pack to compensate for the difference of these two figures.

For example, if the old pinion reads m+5 (+2) and the new pinion is m-5 (-2), add .10mm (.004 inch) shims to the original shim pack.

Old Pinion Marking	New Pinion Marking (English)								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

TE4091A

Old Pinion Marking	New Pinion Marking (Metric)								
	-10	-8	-5	-3	0	+3	+5	+8	+10
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	-.03
+5	+.15	+.13	+.10	+.08	+.05	+.03	0	-.03	-.05
+3	+.13	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08
0	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10
-3	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13
-5	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15
-8	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18
-10	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18	-.20

TE4092A

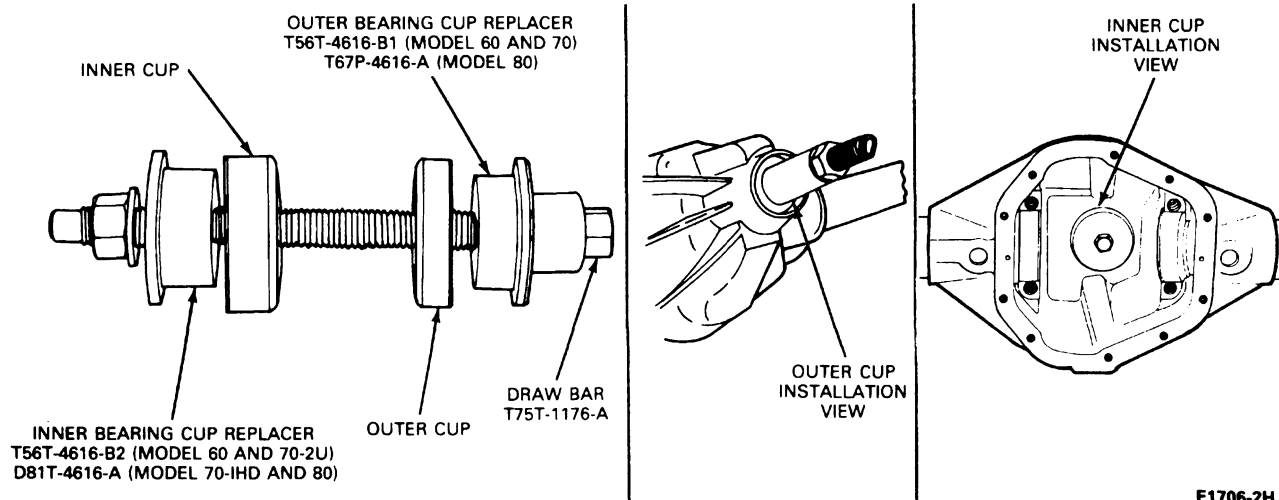
Pinion Bearing Cup Installation

1. Place the inner and outer bearing cups into the carrier bore.
2. Place the Inner Bearing Cup Replacer Tool on the inner bearing cup. For Model 60 and 70-2U axles, use T56T-4616-B2. For Model 70-1HD and 80 axles, use D81T-4616-A or equivalent.

3. Place the Outer Bearing Cup Replacer Tool on the outer bearing cup. For Model 60 and 70 use T56T-4616-B1. For Model 80 axles, use T67P-4616-A.

DISASSEMBLY AND ASSEMBLY (Continued)

4. Install the Threaded Drawbar T75T-1176-A into the replacer tools and tighten the drawbar to install the cups into the carrier bore.

**Pinion Position Shim Selection**

1. Refer to the following tool usage chart for the correct tools for the particular axles.

NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium India oilstone to make sure there are no erroneous readings.

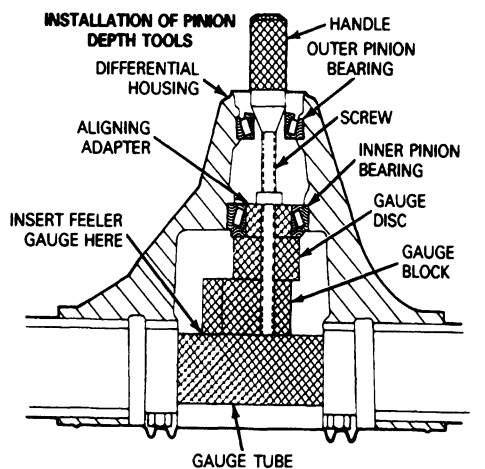
Description	Number	Model 60	Model 70-1HD	Model 70-2U	Model 80
Handle	T76P-4020-A11	X	X	X	T88T-4020-B
Screw	T80T-4020-F43	X	X	X	X
Gauge Block	T80T-4020-F42	X	X	X	X
Aligning Adapter	T76P-4020-A3	X	—	—	D80T-4020-R60
Aligning Adapter	T80T-4020-F48	—	X	X	—
Gauge Disc	T78P-4020-A15	X	—	—	T88T-4020-A
Gauge Disc	D80T-4020-F45	—	X	X	—
Gauge Tube	D80T-4020-F48	X	—	X	D81T-4020-F51
Final Check Gauge Block (Not Required with Gear Contact Pattern Method)	D81T-4020-F54	X	—	—	—
Final Check Gauge Block (Not Required with Gear Contact Pattern Method)	D81T-4020-F55	—	X	X	D81T-4020-F56

2. Place a new inner pinion bearing cone over the proper aligning adapter and insert into the axle carrier bore.

DISASSEMBLY AND ASSEMBLY (Continued)

3. Place the outer pinion bearing cone (new or used if in good condition) into the bearing cup and assemble the handle onto the screw and hand tighten.

Note the 3/8-inch square drive in the handle to be used for obtaining the proper pinion bearing preload and tighten to preload of 2.26-4.53 N·m (20-40 in-lb).



E7653-1A

4. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten to 109-147 N·m (80-90 ft-lb).
5. Using a feeler gauge tool or shims, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge directly along the gauge block so a correct reading can be made.

NOTE: The feeler gauge fit between the gauge tube and the gauge block should be a slight drag-type feeling.

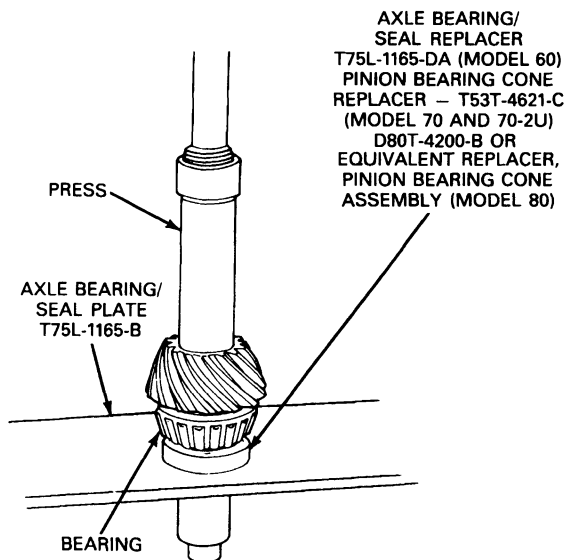
6. Make sure the shims or feeler gauges are free of dirt to prevent an incorrect reading.
7. After the correct feeler gauge feel is obtained, check the reading. This is the thickness of shim(s) required providing that, upon inspection of the service pinion gear, there are no markings.

NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained in Step 4.

If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained in Step 4.

In addition you must use the exact same new inner pinion bearing used in the previous steps.

8. Remove the inner pinion bearing cup and install the correct thickness of shims in the carrier bore. Re-install the bearing cup and baffle (if used). Refer to Step 2, Pinion Bearing Cup Installation, if a slinger is used between the pinion gear head and inner pinion bearing cone. Assemble onto the pinion shaft and press on the cone with T53T-4621-C for Model 70, T75L-1165-DA for Model 60 and D80T-4200-B or equivalent for Model 80.



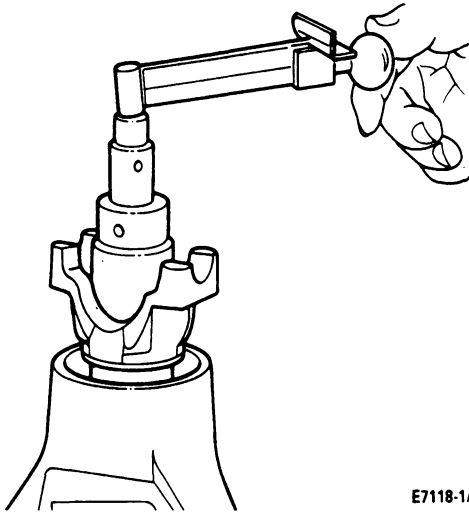
E4851-F

NOTE: If a baffle or slinger is used, replace with a new one upon assembly and measure as part of the shim stack.

9. After following these procedures, continue to build the remaining components with proper pinion and differential bearing preload torques and ring gear backlash.
10. Assemble preload shims onto pinion and install pinion gear into carrier housing. Assemble outer bearing cone and roller assembly onto pinion.
11. Assemble end yoke, washer and new pinion nut on the pinion shaft. Tighten nut to 325-406 N·m (240-300 ft-lb) for Model 60 and 70 Axles. For Model 80 axles tighten nut to 596-677 N·m (440-500 ft-lb).

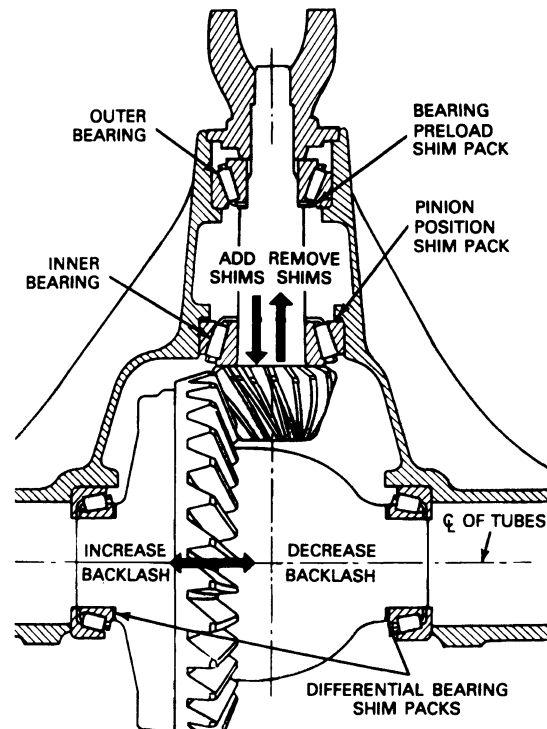
DISASSEMBLY AND ASSEMBLY (Continued)

12. Using an inch-pound torque wrench, rotate pinion. Torque to rotate pinion should read between 2.26-4.53 N-m (20-40 in-lb). To increase preload, remove shims from the outer pinion bearing preload shim pack. To decrease preload, add shims.



E7118-1A

The direction pointing toward the end yoke indicates that by removing pinion position shims, the distance from the centerline of the tubes to pinion backface is increased, giving a plus reading. The pinion bearing preload shim pack does not affect the pinion depth setting. However, if pinion position is changed, the pinion preload will change and may require adjustment to bring torque-to-rotation within specification. Arrows on the ring gear illustrate the method to increase or decrease backlash and differential bearing preload.

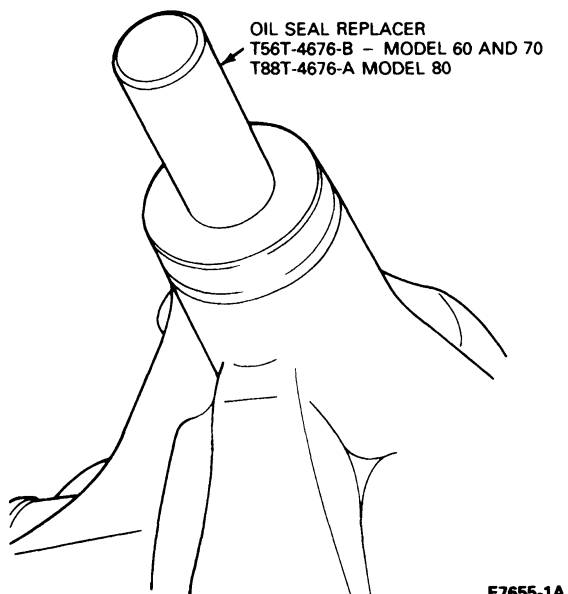


E1729-F

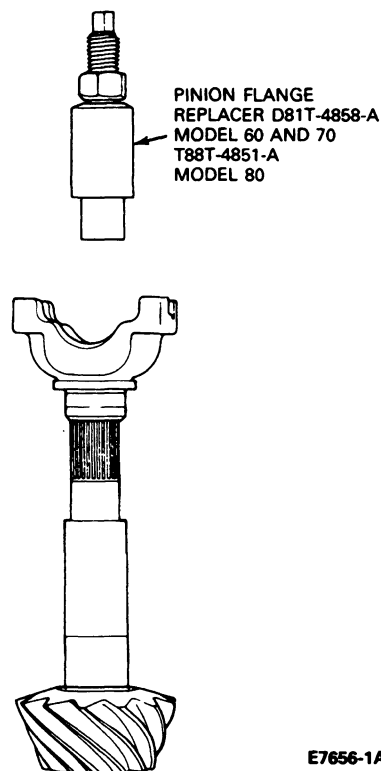
13. With the drive pinion at the correct preload as determined in Step 12, remove the pinion nut, washer and yoke with Holding Tool T57T-485 1-B and Yoke Remover T65L-485 1-B for Model 60, 70 and 80 axles.

DISASSEMBLY AND ASSEMBLY (Continued)

14. Coat the oil seal with grease. Install the drive pinion oil seal with Oil Seal Replacer T56T-4676-B (Model 60 and 70). For Model 80 axle use Pinion Seal Replacer T88T-4676-A. After installation, make sure the garter spring did not pop out. If the garter spring pops out, remove and replace seal.

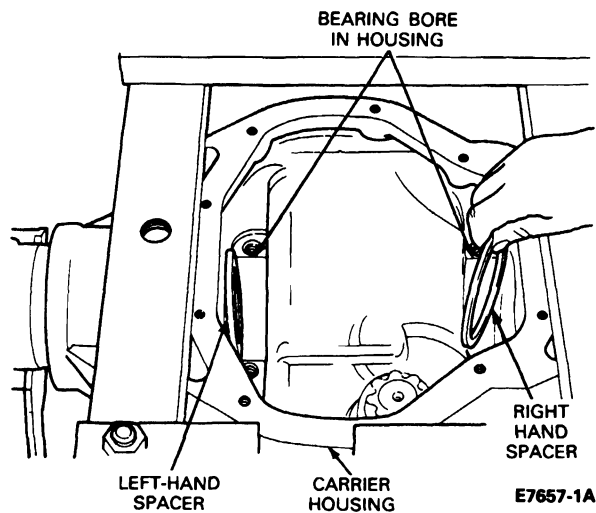


15. Install the yoke with Pinion Flange Replacer D81T-4858-A or equivalent for Model 60 and 70 axles to draw the drive pinion up to engage the nut.
16. Install the washer and nut and tighten nut to 339-366 N·m (250-270 ft·lb). For Model 80 axles, tighten to 596-677 N·m (440-500 ft·lb). Use Pinion Flange Replacing Tool T88T-4851-A.
- NOTE:** It is recommended that a new pinion and new pinion nut be used whenever the end yoke is removed.



Assembly of Differential Into Housing Ring Gear and Pinion Backlash

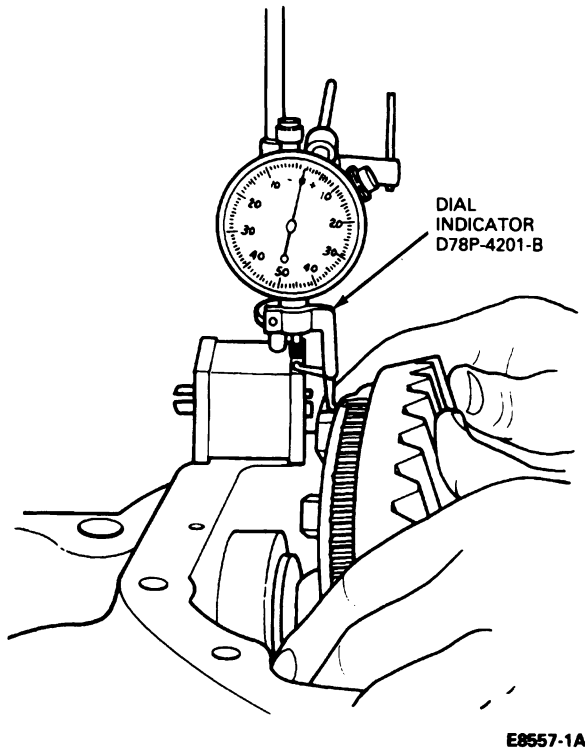
1. Place differential assembly into housing. Differential master bearings should still be assembled to case. Install outboard spacers in same side as removed from, when making overall measurement.



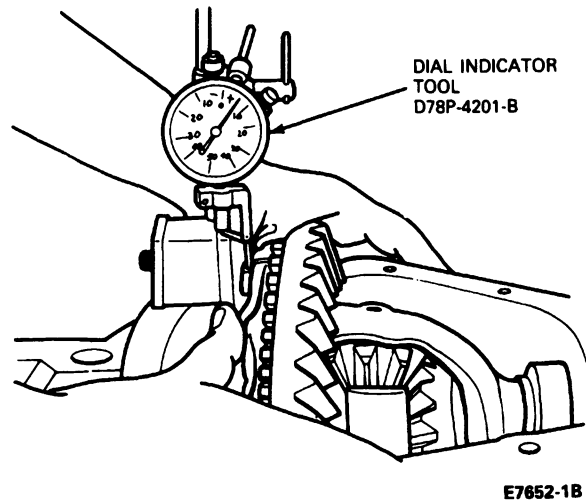
2. Set up dial indicator as shown. Locate dial indicator on a flat surface of one of the ring gear screws.

DISASSEMBLY AND ASSEMBLY (Continued)

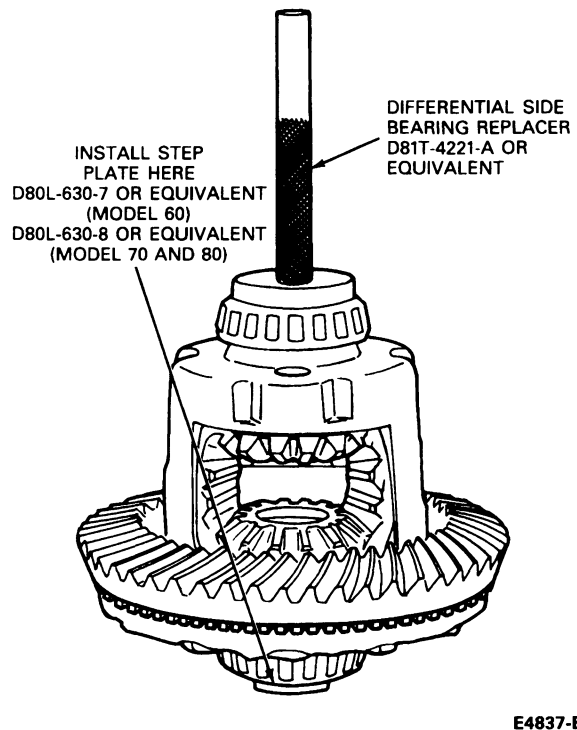
3. Force the differential case assembly (ring gear) away from the pinion gear. With force still applied to the differential case, set indicator at zero "0".



4. Force the differential case assembly (ring gear) into mesh with the pinion gear to obtain an indicator reading.
- NOTE: Repeat until the same reading is obtained each time. This reading will be the necessary amount of shims required between the differential case and differential bearings on the ring gear side.
5. Remove indicator and differential case from the carrier.
6. Remove master bearings from differential case.
7. As determined in Steps 3 and 4, place the required amount of shims on the ring gear hub of the differential case. For example, if the reading was 1.14mm (0.045 inch), place 1.14mm (0.045 inch) of shims on the hub of the ring gear side of the differential case.



8. Install the bearing cone on the ring gear side of the differential case. Drive the bearing onto the hub using Differential Side Bearing Replacer D81T-4221-A or equivalent.



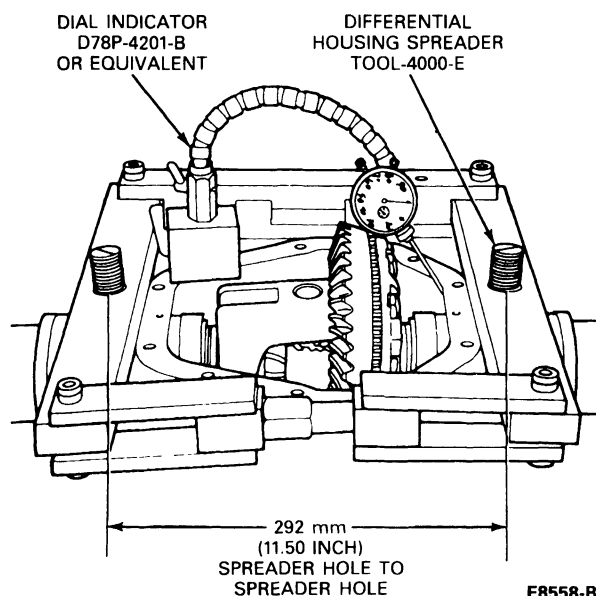
DISASSEMBLY AND ASSEMBLY (Continued)

9. To determine the correct amount of shims to be placed on the hub of the drive pinion side of the differential case, subtract the reading obtained in Steps 3 and 4 from the Total Differential Case End Play. Total Case End Play was determined under Steps 9 and 10 of Differential Case Assembly. When this amount is determined, add 0.36mm (0.015 inch) to the amount for a Model 60, or 0.25mm (0.010 inch) for Models 70 and 80. This is the required amount of shims to be placed on the hub of the drive pinion side of the differential case.

For example, Total Differential Case End Play on a Model 60 was 2.30mm (0.091 inch). The reading in Step 3 was 1.14mm (0.045 inch), and when subtracted from 2.30mm (0.091 inch) gives 1.16mm (0.046 inch). 0.36mm (0.015 inch) is added to give 1.52mm (0.061 inch) amount of shims to be placed on the hub of the drive pinion side of the differential case.

10. Required amount of shims on the hub of the drive pinion side of the differential case.
11. Install the bearing cone on the hub of the drive pinion side of the differential case. Place Step Plate D80L-630-7 for Model 60 axles and D80L-630-8 on Model 70 and 80 axles on the ring gear side bearing to protect the bearing during installation of the drive pinion side bearing.
12. Place the bearing on the drive pinion side hub and drive on using Differential Side Bearing Replacer D81T-4221-A or equivalent.
13. Install Spreader TOOL-4000-E and Indicator D78P-4201-B to carrier. Do not spread carrier over 0.38mm (0.015 inch). Remove indicator.

CAUTION: Do not spread carrier over 0.38mm (0.015 inch).



E8558-B

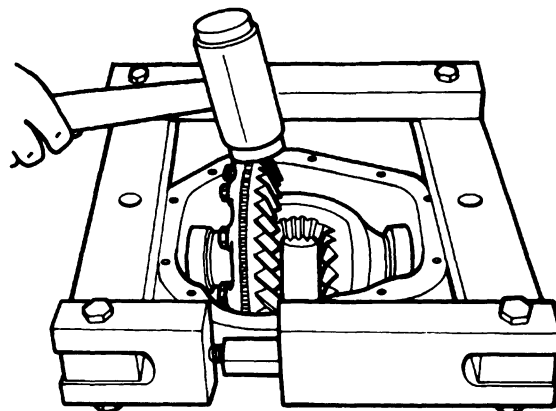
Final Assembly of Differential into Housing

1. Assemble differential bearing cups to differential bearing cones. Install differential assembly into carrier.

Use a rawhide hammer to seat differential assembly into crossbore of carrier.

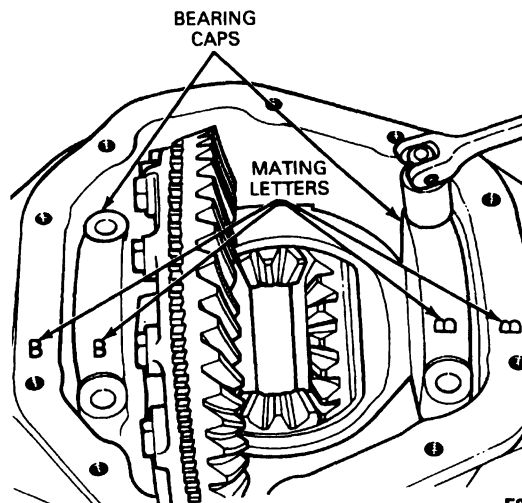
NOTE: Care should be taken to avoid nicking the teeth of the ring gear, sensor ring, and pinion during assembly.

Remove the spreader from the carrier.



E6409-1B

2. Install bearing caps. Align the letters stamped on the caps with those on the carriers. Tighten bearing cap screws to 108-122 N·m (80-90 ft·lb).



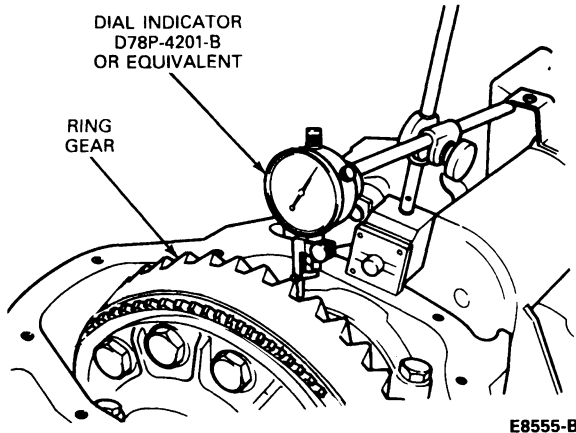
E8552-1A

3. Check ring gear and pinion backlash in three equally spaced points with dial indicator. Backlash tolerance is 0.13-0.203mm (0.005-0.008 inch) and cannot vary more than 0.05mm (0.002 inch) between points checked. High backlash is corrected by moving the ring gear closer to the pinion.

DISASSEMBLY AND ASSEMBLY (Continued)

Low backlash is corrected by moving ring gear away from the pinion.

These corrections are made by switching shims from one side of the differential case to the other.



4. To confirm total preload, recheck torque to rotate with an inch-pound wrench as shown. The reading should be higher than the initial reading (taken without the differential case installed as outlined under Pinion Position Shim Selection, Step 12). by the following amount if new bearings have been installed as recommended:

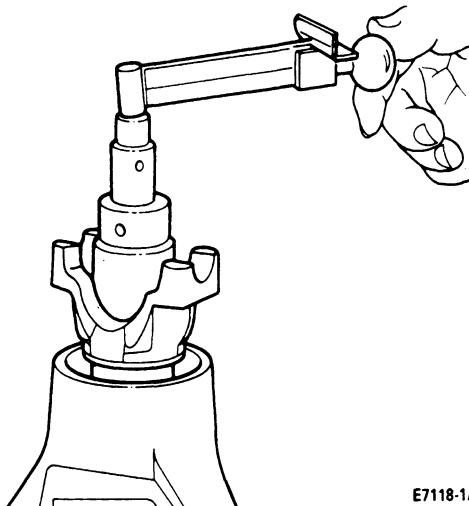
3.54 & 3.73 ratios = 7-9 in-lb

4.10 & 4.56 ratios = 6-8 in-lb

4.63 & 5.13 ratios = 6-8 in-lb

If total preload is too high, remove an equal amount of shims from each differential case hub.

If total preload is too low, add an equal amount of shims to each differential case hub.



5. To verify the final pinion position, refer to Ring Gear and Pinion Tooth Pattern Interpretation in this section.

6. Install new cover gasket and install cover plate. Tighten screws to 41-54 N·m (30-40 ft-lb) as detailed below.

Figure shows the flat mounting surface cover plate on Dana design axles. This cover plate requires the use of a silicone rubber sealer material such as Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent rather than a gasket.

The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

CAUTION: Clean both flat surfaces with a suitable solvent to remove all traces of oil film.

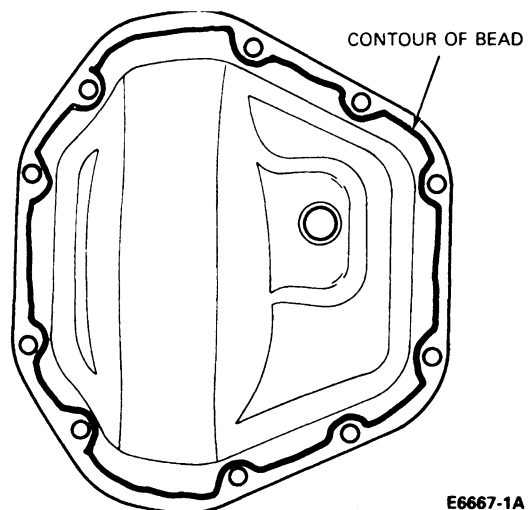
Sealant material must meet specifications of ESL-M4G273-A, ASTM1, GE503, Z1, Z2 and Z3 sealant or equivalent.

Apply Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent to cover plate surface. Lay sealer bead 3.18-6.35mm (1/8 to 1/4 inch) wide on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.

7. Assemble two cover screws into cover at 8 o'clock and 2 o'clock position. Use these two holes to guide cover plate into position on the carrier.
8. Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lb).

ALLOW ONE HOUR CURE TIME BEFORE FILLING CARRIER WITH THE PROPER AMOUNT OF SPECIFIED LUBRICANT. Refer to the Specifications portion of this section.



9. Install axle shafts as outlined under axle shaft removal in Section 05-02E.

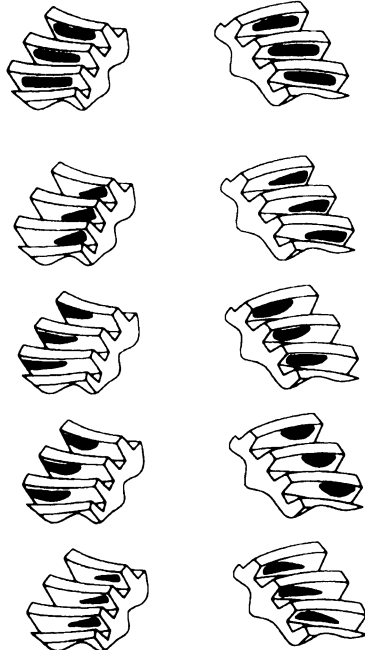
DISASSEMBLY AND ASSEMBLY (Continued)

10. Fill axle housing with specified amount of Rear Axle Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent rear axle lubricant.

Ring Gear and Pinion Tooth Pattern Interpretation**Gear Tooth Contact Pattern Check**

- To check the gear tooth contact, paint the gear teeth with the special marking compound.
NOTE: A mixture that is too wet will run and smear, too dry a mixture cannot be pressed out from between the teeth.
- Rotate the ring gear (use a box wrench on the ring gear attaching bolts as a lever) several complete revolutions in both directions or until a clear tooth contact pattern is obtained.

- Certain types of gear tooth contact patterns on the ring gear indicate incorrect adjustment. Incorrect adjustment can be corrected by readjusting the ring gear and/or the pinion.
- The illustration shows acceptable tooth patterns for all axles. In general, desirable tooth patterns should have the following characteristics:
 - The drive pattern should be fairly well centered on the tooth.
 - The coast pattern should be fairly well centered on the tooth.
 - Some clearance between the pattern and the top of the tooth is desirable.
 - There should be no hard lines where the pressure is high.

Ring Gear Pattern Interpretation**PATTERN INTERPRETATION
(RING GEAR)****DRIVE SIDE****COAST SIDE****HEEL****TOE****TOE****HEEL**

NORMAL OR DESIRABLE PATTERN. THE DRIVE PATTERN SHOULD BE CENTERED ON THE TOOTH. THE COAST PATTERN SHOULD BE CENTERED ON THE TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD BE SOME CLEARANCE BETWEEN THE PATTERN AND THE TOP OF THE TOOTH.

BACKLASH CORRECT. THINNER PINION POSITION SHIM REQUIRED.

BACKLASH CORRECT. THICKER PINION POSITION SHIM REQUIRED.

PINION POSITION SHIM CORRECT. DECREASE BACKLASH.

PINION POSITION SHIM CORRECT. INCREASE BACKLASH.

E8232-B

DISASSEMBLY AND ASSEMBLY (Continued)

5. Pattern Movements Summarized

- a. Decreasing backlash moves the ring gear closer to the pinion.

Drive pattern (convex side of gear) moves slightly lower and toward the toe.

Coast pattern (concave side of gear) moves lower and toward the toe.

- b. Increasing backlash moves the ring gear away from the pinion.

Drive pattern moves slightly higher and toward the heel.

Coast pattern moves higher and toward the heel.

- c. Thicker pinion position shim with the backlash constant moves the pinion closer to the ring gear.

Drive pattern moves deeper on the tooth (flank contact) and slightly toward the toe.

Coast pattern moves deeper on the tooth and toward the heel.

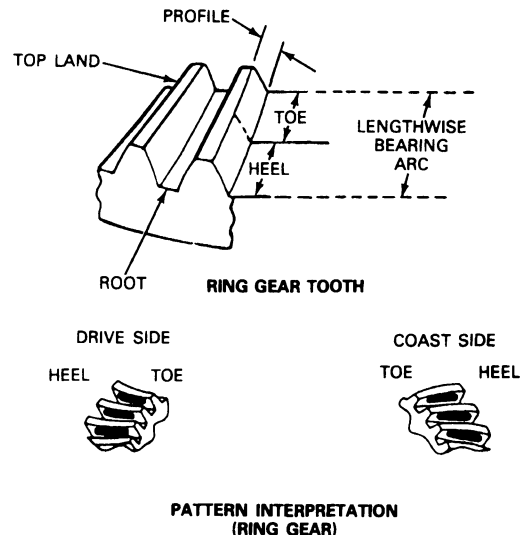
- d. Thinner pinion position shim with the backlash constant moves the pinion further from the ring gear.

Drive pattern moves toward the top of the tooth (face contact) and toward the heel.

Coast pattern moves toward the top of the tooth and slightly toward the toe.

6. An individual gear set need not conform exactly to the ideal pattern to be acceptable. Any combination of drive and coast patterns shown is acceptable.

7. Since each gear set rolls a characteristic pattern, the patterns shown are considered acceptable and should be used as a guide. The drive pattern is rolled on the convex side of the tooth, and the coast pattern is rolled on the concave side.



NORMAL OR DESIRABLE PATTERN. THE DRIVE PATTERN SHOULD BE CENTERED ON THE TOOTH. THE COAST PATTERN SHOULD BE CENTERED ON THE TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD BE SOME CLEARANCE BETWEEN THE PATTERN AND THE TOP OF THE TOOTH.

THE TOE OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE END TOWARDS THE CENTER. THE HEEL OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE OUTER END. THE TOP LAND OF A GEAR TOOTH IS THE SURFACE OF THE TOP OF THE TOOTH.

E8196-1A

The movement of tooth contact patterns with changes in shimming can be summarized as follows:

- Thinner shim, with the backlash set to specification, moves the pinion farther from the ring gear.
- Thicker shim, with the backlash set to specification, moves the pinion closer to the ring gear.

NOTE: When making pinion position changes, shims should be changed in the range of .05mm (.002 inch) to .10mm (.004 inch) until correct pattern has been obtained.

8. If the pinion positioning shims are correct:

- Decreasing backlash moves the ring gear closer to the pinion. Drive pattern (convex side of gear) moves slightly lower and toward the toe. Coast pattern (concave side of gear) moves lower and toward the toe.
- Increasing backlash moves the ring gear away from the pinion. Drive pattern moves slightly higher and toward the heel. Coast pattern moves higher and towards the heel.

NOTE: If the patterns are not correct, make the changes as indicated. The differential case and drive pinion will have to be removed from the carrier housing to change a shim.

DISASSEMBLY AND ASSEMBLY (Continued)

9. Check ring gear backlash by installing a dial indicator on the carrier housing. Check ring gear and pinion backlash at three equally spaced points on the ring gear. Backlash tolerance is 0.23mm (0.005-0.009 inch) and cannot vary more than 0.08mm (0.003 inch) between the three points. If backlash is high, the ring gear must be moved closer to the pinion, by moving shims to the ring gear side to the opposite side. If backlash is low, the ring gear must be moved away from the pinion by moving shims from the ring gear side to the opposite side.

ADJUSTMENTS

For adjustments refer to the specific adjustments in this section under Disassembly and Assembly and Section 05-00.

Refer to Section 05-02E for rear wheel bearing adjustment procedures and rear hub specific adjustments.

Refer to Section 06-03 for rear disc brake assembly and / or disassembly procedures for F-Super Duty vehicle Model 80 rear axle usage.

SPECIFICATIONS**LUBRICANT CAPACITIES**

Axle Model	Ford Specification	Approximate Capacities		
		U.S. Pts.	Imperial Pts.	Liters
60-1U	ESW-M2C105-A (C6AZ-19580-E)	6.3	5.2	3.0
70-2U	ESW-M2C105-A (C6AZ-19580-E)	6.6	5.5	3.1
70-HD	ESW-M2C105-A (C6AZ-19580-E)	7.4	6.1	3.5
80	ESW-M2C105-A (C6AZ-19580-E)	8.5	6.8	4.0

NOTE: Use additive friction modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent for complete refill of Dana limited-slip axles. Add 0.2 liter (8 oz.) for E250-350 complete refill.

TE4098A

DANA AXLE ADJUSTMENTS

Description	Specification	Description	Specification
Backlash Between Ring Gear and Pinion	0.13-0.20mm (0.005-0.008 Inch)	Pinion Bearing Preload (with new bearings)	2.26-4.53 N-m (20-40 In-Lbs)
Backlash Maximum Variation Between Teeth	0.05mm (0.002 Inch)	Total (pinion plus differential) Preload with new bearings	Add 6-9 In-Lbs, depending on ratio, to pinion preload.

TE7675A

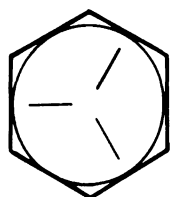
SPECIFICATIONS (Continued)

DANA AXLE TORQUE LIMITS

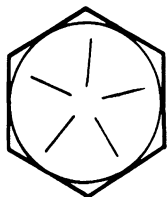
Description	Axle Model					
	60		70		80	
	Ft-Lbs	N-m	Ft-Lbs	N-m	Ft-Lbs	N-m
Pinion Shaft Nut	250-270	339-366	250-270	339-366	440-500	596-677
Differential Bearing Cap Bolts	80-90	109-147	80-90	109-147	80-90	109-147
Ring Gear Attaching Bolts	Grade 8	100-120	136-163	100-120	136-163	—
	Grade 9	125-135	169-183	125-135	169-183	272-330
Oil Filler Plug – 1/4 Inch Recess Drive	15-25	20-33	15-25	20-33	15-25	20-33
U-Joint Bolts	15-20	21-27	15-20	21-27	—	—
Cover to Housing Bolts	30-40	41-54	30-40	41-54	30-40	41-54

WARNING

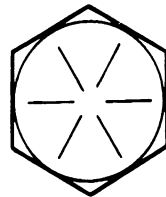
IF FASTENERS OF A LOWER GRADE OR CLASS ARE TORQUED TO THE REQUIREMENTS OF A HIGHER GRADE OR CLASS FASTENER, IT MAY RESULT IN COMPONENT FAILURE. (E.G. GRADE 5 FASTENER TORQUED TO THE REQUIREMENTS OF A GRADE 8 FASTENER.)



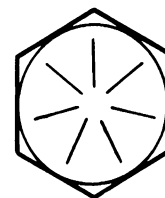
GRADE 5



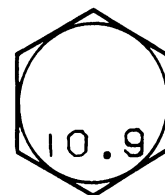
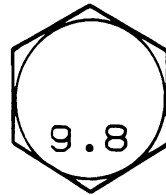
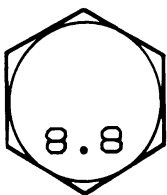
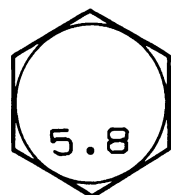
GRADE 7



GRADE 8

GRADE 9
(High Strength Applications)

Customary (Inch) Bolts-identification marks correspond to bolt strength-increasing numbers represent increasing strength.




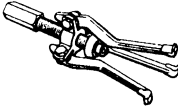
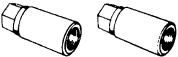
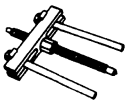



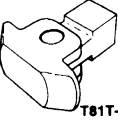


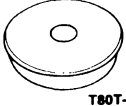
Metric Bolts-identification class numbers correspond to bolt strength-increasing numbers represent increasing strength.

Inch grade fasteners can be identified by the radial lines embossed upon the head of the fastener and will correspond to the fastener strength by two-lines less than actual grade (i.e., grade 8 fastener will display 6 radial lines on the head).


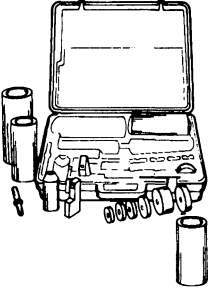
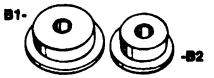



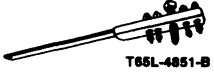

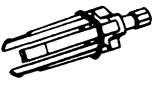
Metric fastener strength can be identified with the class identification embossed on the head of each fastener. Increasing numbers represent increasing strength.

CE7751-D

SPECIAL SERVICE TOOLS

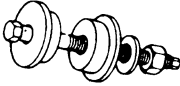

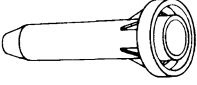



Tool Number/ Description	Illustration
T50T-100-A Impact Slide Hammer — 2-1/2 Lbs. (Oil Seal Removal)	 T50T-100-A
T77F-1102-A Bearing Cup Puller (Oil Seal Removal)	 T77F-1102-A
T81P-1104-B Adapter — Coarse Thread (Wheel Bearing Removal)	 T81P-1104-B
T81P-1104-C Push Puller (Wheel Bearing Removal)	 T81P-1104-C
T75L-1165-B Axle Bearing / Seal Plate (Drive Pinion Bearing Installation)	 T75L-1165-B
T75L-1165-DA Axle Bearing / Seal Replacer (Drive Pinion Bearing Installation — Model 60)	 T75L-1165-DA
T75T-1176-A Threaded Drawbar	 T75T-1176-A
T81T-1225-A Rear Wheel Bearing Remover	 T81T-1225-A
TOOL-4000-E Housing Spreader (Differential Case Removal and Installation)	 TOOL-4000-E
T80T-4000-W Driver Handle (Bearing Cup Removal and Installation)	 T80T-4000-W
T80T-4000-X Rear Axle Seal Wheel Bearing Replacer	 T80T-4000-X

(Continued)

Tool Number/ Description	Illustration
T80T-4000-Y Rear Oil Seal Replacer	 T80T-4000-Y
T80T-4020-A Pinion Depth Gauge (Axle Adjustments — Model 60 and 70)	 T80T-4020-A
T56T-4616-B Pinion Bearing Cup Replacer	 T56T-4616-B
T53T-4621-C Pinion Bearing Cone Replacer	 T53T-4621-C
T56T-4676-B Oil Seal Replacer	 T56T-4676-B
T57T-4851-B Companion Flange Holding Tool (Yoke Removal and Installation)	 T57T-4851-B
T65L-4851-B Companion Flange Remover (Yoke Removal — Model 60-70-80)	 T65L-4851-B
T85T-4209-AH Pinion Shaft Thread Protector	 T85T-4209-AH
TOOL-1175-AC Oil Seal Remover	 TOOL-1175-AC

(Continued)

SPECIAL SERVICE TOOLS (Continued)

Tool Number/ Description	Illustration
T67P-4616-A Bearing Cup Replacer	 T67P-4616-A
T88T-4628-A Bearing Cup Remover	 T88T-4628-A
T88T-4676-A Oil Seal Replacer	 T88T-4676-A
T83T-4676-A Oil Seal Replacer	 T83T-4676-A
T88T-4851-A Pinion Flange Replacer (Model 80)	 T88T-4851-A
T85T-4851-AH Pinion Flange Replacer (Model 60-70)	 T85T-4851-AH

Tool Number	Description
D80L-630-1	Step Plate (Wheel Bearing Installation)
D80L-630-7	Step Plate (Differential Side Bearing Installation — Model 60)
D80L-630-8	Step Plate (Differential Side Bearing Installation — Model 70-80)

(Continued)

Tool Number	Description
D81T-1104-A	Adapter — Fine Thread (Wheel Bearing Removal)
D81L-4000-A	Drive Handle (Bearing Cup Removal)
D80T-4020-F48	Aligning Adapter (Axle Adjustments — Model 60-70)
D78P-4201-B	Dial Indicator, Magnetic Base (Axle Adjustments)
D81L-4220-A	Universal Bearing Puller
D81T-4221-A	Differential Bearing Cone Replacer (Differential Side Bearing Installation — Model 60-70)
D81T-4222-D	Master Bearings (Axle Adjustments — Model 60 and 70-2U)
D81T-4616-A	Bearing Cup Replacer
D81T-4628-A	Bearing Cup Remover
D81T-4628-B	Bearing Cup Remover
D81T-4628-D	Bearing Cup Remover
D81T-4628-X	Pinion Bearing Cup Remover Set (Model 60 and 70 — Model 60-70)
D81T-4858-A	Companion Flange Replacer (Yoke Removal — Model 60-70)
D80L-1002-L	2-Jaw Puller (Pinion Flange Removal)
D87L-7384-A	Dial Torque Wrench (Pinion Nut)
D81T-4020-F51	Gauge Tube (Axle Adjustment Model 70HD-80)
D81T-4020-F54	Gauge Block (Axle Adjustment Model 60)
D81T-4020-F55	Gauge Block (Axle Adjustment Model 70)
D81T-4020-F56	Gauge Block (Axle Adjustment Model 70HD-80)
D80T-4200-B	Bearing Cone Replacer (Pinion Bearing Model 80)
D81T-4222-E	Master Bearing-Diff. Case (Axle Adjustment Model 70HD-80)

SECTION 05-02E Wheel Hubs and Bearings, Rear, Dana Full-Floating Axle

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS.....	05-02E-9	SPECIAL SERVICE TOOLS / EQUIPMENT	05-02E-10
DESCRIPTION AND OPERATION	05-02E-1	SPECIFICATIONS.....	05-02E-9
DISASSEMBLY AND ASSEMBLY		VEHICLE APPLICATION	05-02E-1
Bearings, Cups and Seals, E-350.....	05-02E-2		
Bearings, Cups and Seals, F-Super Duty and F-Super Duty Commercial and Motorhome Chassis Vehicles	05-02E-6		

VEHICLE APPLICATION

E-350, F-Super Duty and F-Super Duty Commercial
and Motorhome Chassis Vehicles

DESCRIPTION AND OPERATION

On E-350 full-floating rear axle wheel hubs with tapered roller bearings, a seal is installed behind the inner bearing to keep the wheel bearing lubricant from the brake lining and brake drum. The Econoline full-floating axles have drums mounted outboard of the hub, permitting drum removal for brake inspection without the need to remove the hub. The F-Super Duty axle is disc brake-equipped and contains larger tapered roller bearings and a unique inner seal and shaft-hub gasket.

The wheel bearings are packed with a lithium base grease, Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent, to provide initial lubrication until axle lubricant flows into the wheel hubs and bearings during vehicle operation. On these axles, the wheel hub is vented through the axle housing vent hose in the left axle tube.

Vehicles equipped with dual rear wheel (DRW) axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lugnuts.

WARNING: ON REAR AXLES WITH DUAL REAR WHEELS, DO NOT ATTEMPT TO USE PRE-1985 LUGNUTS (CONE-SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUGNUTS. PAST MODEL LUGNUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE-SHAPED LUGNUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUGNUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

DISASSEMBLY AND ASSEMBLY

NOTE: For disassembly and assembly procedures for wheel hubs and bearings on Ford full-floating axles, refer to Section 05-02A.

DISASSEMBLY AND ASSEMBLY (Continued)

Bearings, Cups and Seals, E-350

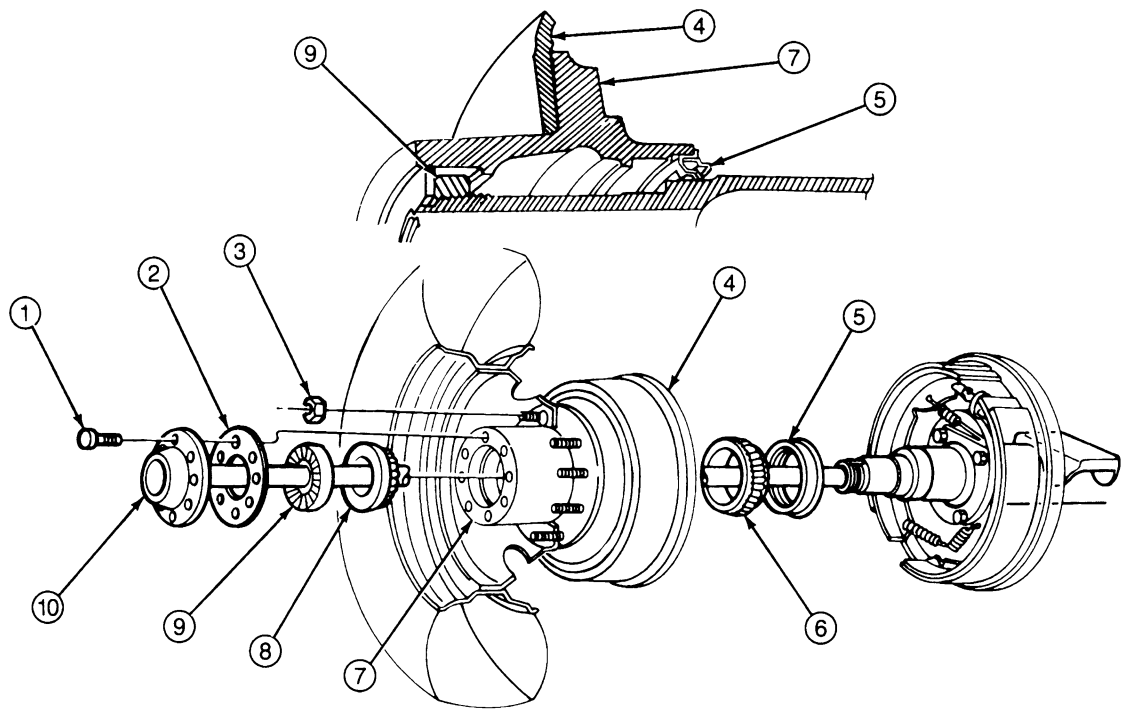
Vehicles equipped with dual rear wheel (DRW) axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lugnuts.

WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUGNUTS (CONE-SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUGNUTS. IF SO USED, PRE-1985 LUGNUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE-SHAPED LUGNUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUGNUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

Single Rear Wheel, E-350

Disassembly

1. Set the parking brake and loosen the axle shaft attaching bolts.

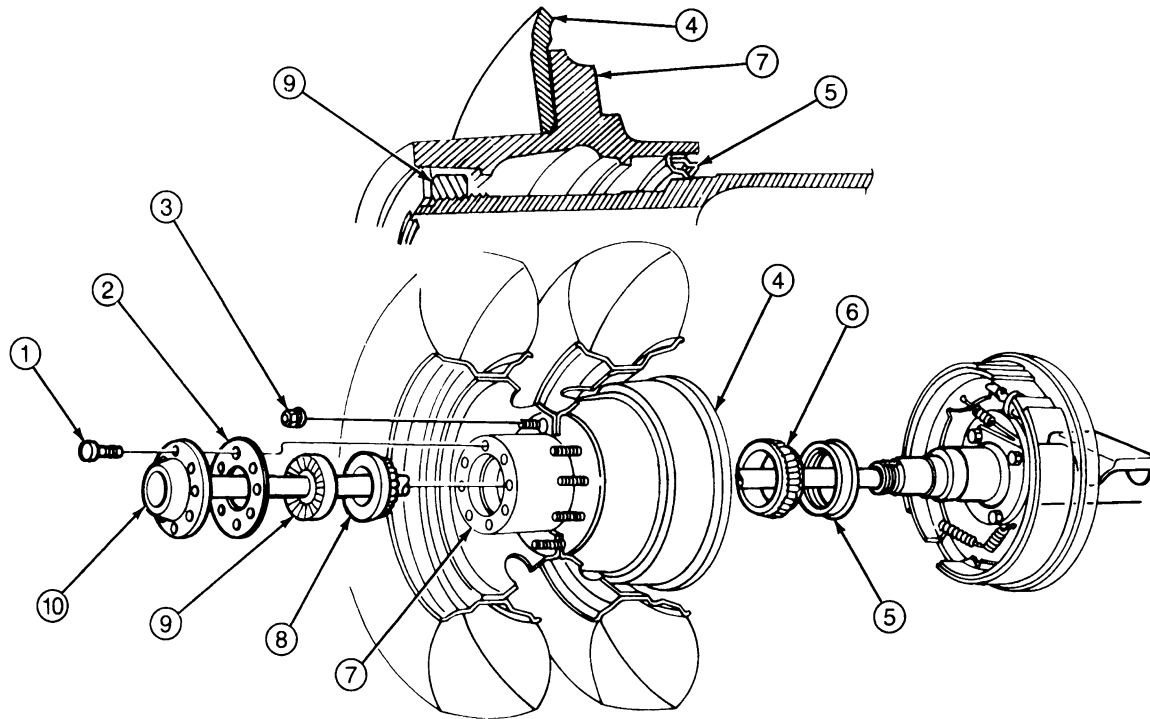


F8249-A

Item	Description
1	Axle Shaft Bolt
2	Gasket
3	Lugnut
4	Drum

(Continued)

Item	Description
5	Seal
6	Cone and Roller Bearing
7	Hub
8	Cone and Roller Bearing
9	Hub Nut
10	Axle Shaft

DISASSEMBLY AND ASSEMBLY (Continued)**Dual Rear Wheel, E-350**

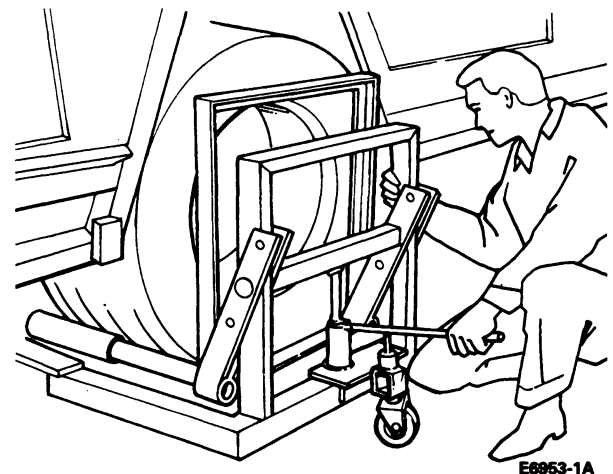
F8250-A

Item	Description
1	Axle Shaft Bolt
2	Gasket
3	Integral Two-Piece Swiveling Lugnut
4	Drum

(Continued)

Item	Description
5	Seal
6	Bearing
7	Hub
8	Bearing
9	Hub Nut
10	Axle Shaft

2. Raise the rear wheels off the floor and place safety stands under the rear axle housing so axle is parallel with the floor. Release parking brake and back off the rear brake adjustment, if necessary.
3. Remove the axle shaft attaching bolts and discard them.
4. Using a heavy duty wheel dolly such as Rotunda model 014-00030 or equivalent, raise the wheel to the point that all weight is removed from the wheel bearings.

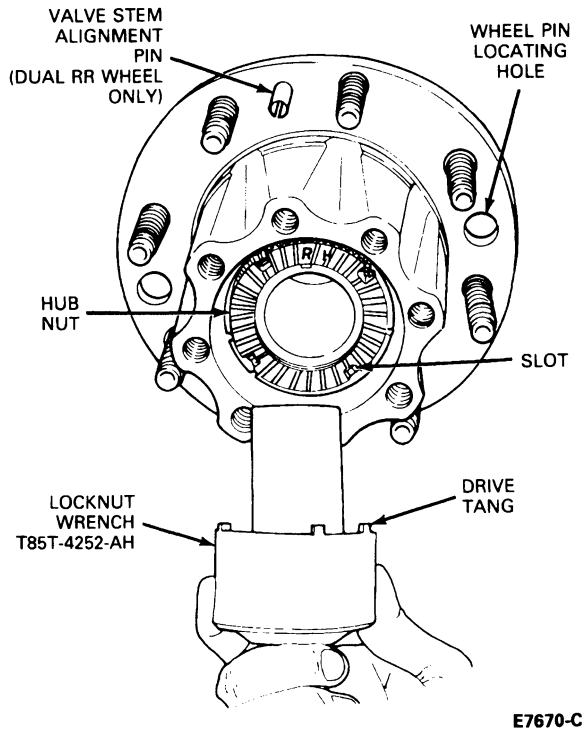


E6953-1A

5. Remove brake drum. If so equipped, push-on sheet metal drum retainer nuts may be discarded.
6. Remove the axle shaft and discard the gasket.

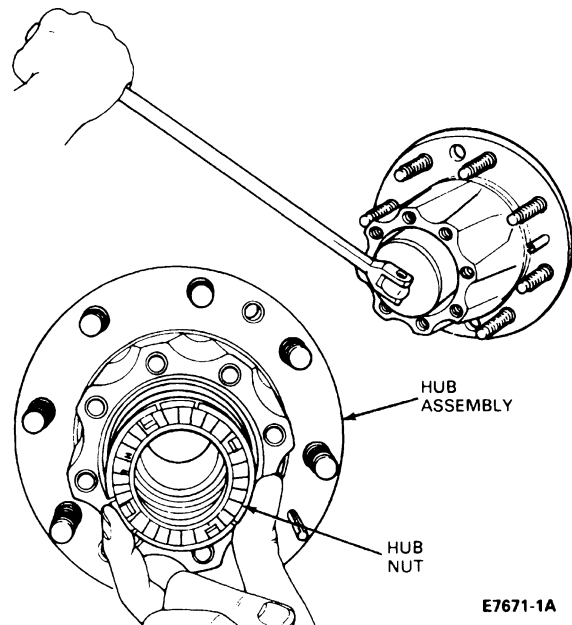
DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove the wheel bearing hub nuts using Locknut Wrench T85T-4252-AH so the drive tangs of the tool engage the four slots in the hub nut.

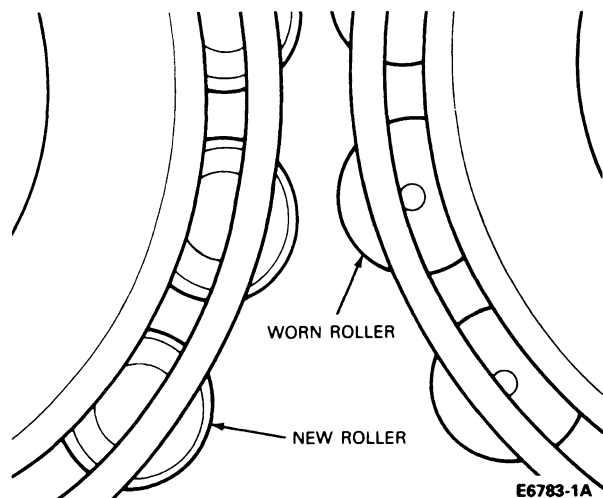


8. Remove the outer bearing cone, pull the wheel assembly straight out and away from the axle. If it had not been done in Step 4, remove hub assembly and set aside.

NOTE: The hub nuts are right-hand thread on both spindles. Each hub nut is stamped RH to identify thread direction. Do not use power impact tools when performing operations on the hub nuts.

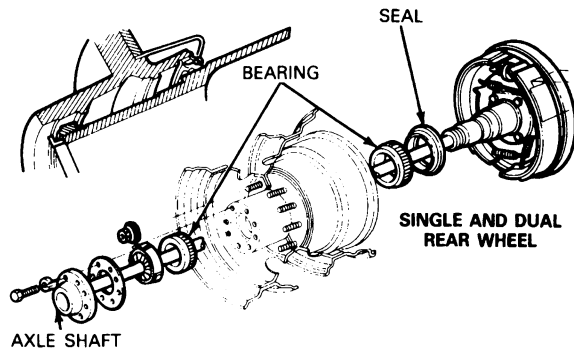


9. Thoroughly clean the spindle of the axle housing.
10. Carefully remove inner seal from hub assembly with screwdriver, avoiding damage to the bearing or hub bore. Discard the seal.
11. Clean all old grease and axle lubricant out of the wheel hub.
12. Inspect the bearing races and rollers for pitting, galling or erratic wear patterns. Inspect the rollers for end wear.

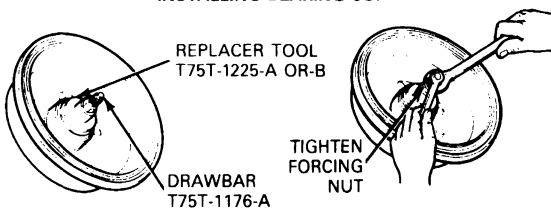


DISASSEMBLY AND ASSEMBLY (Continued)

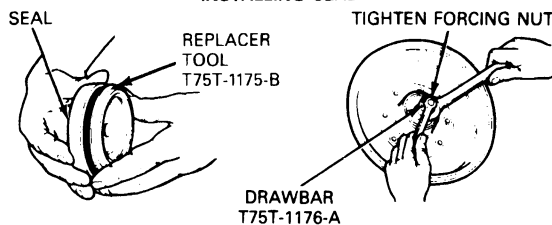
13. Remove the bearing cups by driving them out with a brass drift. Inspect the cups for galling or excessive wear. If either component (cup or cone and roller) of the tapered roller bearing is not usable, replace both components. Install the new cups with Bearing Cup Replacer T75T-1225-A or -B and Threaded Drawbar T75T-1176-A.



INSTALLING BEARING CUP



INSTALLING SEAL

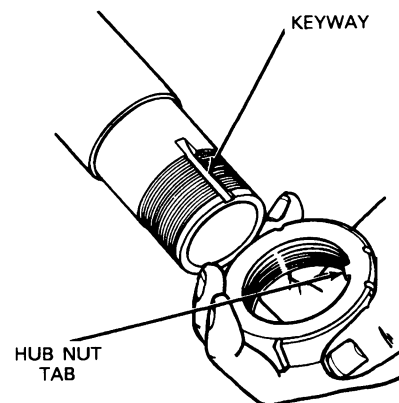


F2367-L

Assembly

1. Check for proper seating of the new bearing cups by trying to insert a 0.038mm (0.0015-inch) feeler gauge between the cups and the wheel hub. The gauge should not enter beneath the cup. Check several places to make sure the cups are squarely seated.
2. Pack each bearing cone and roller assembly with a lithium base grease, Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Use a bearing packing tool such as Rotunda 108-00078 or equivalent.

3. Place the inner bearing cone and roller assembly in the wheel hub. Install a new hub inner seal with Seal Replacer Tool T75T-1175-B and Threaded Drawbar T75T-1176-A.
4. Position the hub assembly at the axle housing. Wrap the threads of the spindle with electrician's tape. **Carefully slide the hub assembly straight (to avoid seal damage) onto the axle housing spindle.** Remove the electrician's tape.
5. Install outer wheel bearing cone and roller.
- NOTE: Properly locate hub tab in keyway prior to thread engagement.
6. Slide washer onto spindle, engaging keyway with the hub nut tab as shown.



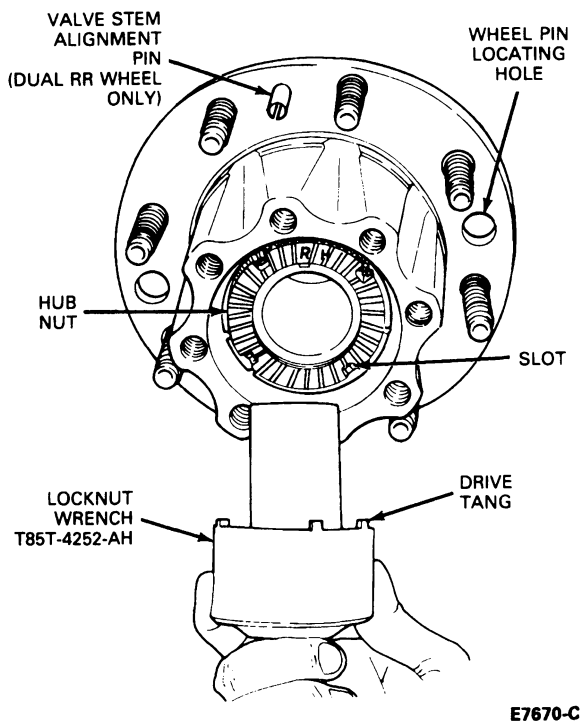
E7672-D

7. Install a Locknut Tool T85T-4252-AH into four hub nut slots. Tighten hub to 88-102 N-m (65-75 ft-lb). Rotate hub occasionally while tightening to set bearings.
- NOTE: Hub will ratchet as torque is applied.
8. After tightening to 88-102 N-m (65-75 ft-lb), ratchet back 90 degrees, then tighten to 20-27 N-m (15-20 ft-lb).

NOTE: This procedure is intended to provide no side-to-side end play of the hub and wheel bearings. This may be verified with a dial indicator magnetically mounted to the spindle end with the indicator on the outboard surface of the hub.

DISASSEMBLY AND ASSEMBLY (Continued)

9. Prior to reinstallation of the axle shaft, clean and remove any metallic debris in the hub bolt holes.



E7670-C

10. Replace hub if any of the following conditions exist:

- cracked material around holes
- depth of holes (minimum 25.4mm [1-inch])
- oversized threaded holes

11. Install the axle shaft and new axle flange gasket, and new axle shaft retaining bolts. Coat the bolt thread with a suitable thread adhesive if none is present. Tighten the bolts until they seat.

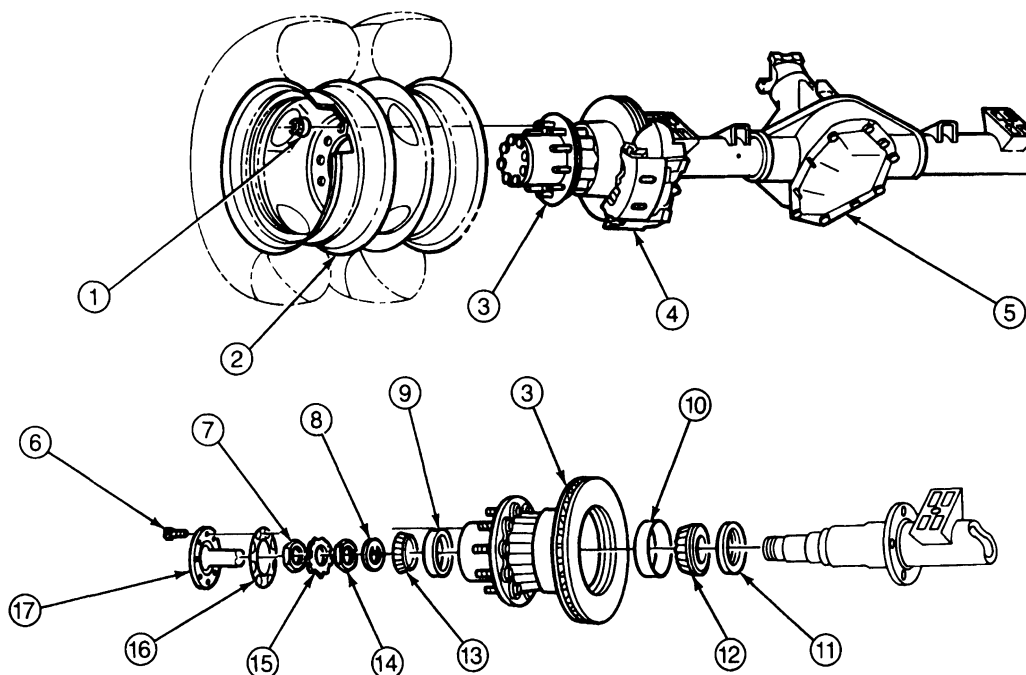
12. Install the brake drum.
 13. Install the wheel and tire assembly.
 14. Lower vehicle after removing safety stands.
 15. Adjust the brakes.
 16. Tighten wheel lugnuts to specification.
 17. Tighten axle shaft retaining bolts to 88-115 N·m (65-85 ft·lb).

Bearings, Cups and Seals, F-Super Duty and F-Super Duty Commercial and Motorhome Chassis Vehicles**Disassembly**

1. Set the parking brake and loosen the axle shaft attaching bolts.
2. Raise the rear wheels off the floor and place safety stands under the rear axle housing. Release the parking brake.
3. Remove the axle shaft attaching bolts and discard them.
4. Using a heavy duty wheel dolly such as Rotunda Model 014-00030 or equivalent, raise the wheel to the point that all weight is removed from the wheel bearings. If a dolly is unavailable, remove the wheel and tire assembly.
5. Remove the axle shaft and discard the gasket.
6. Remove the caliper as outlined in Section 06-03.
7. Straighten tab of lockwasher from slot in outer nut and remove outer retainer nut using Front Wheel Bearing Spanner D78T-1197-A or equivalent.
8. Straighten lockwasher tab bent over inner retainer nut and remove lockwasher.

DISASSEMBLY AND ASSEMBLY (Continued)

F-Super Duty and F-Super Duty Commercial and Motorhome Chassis



F5648-D

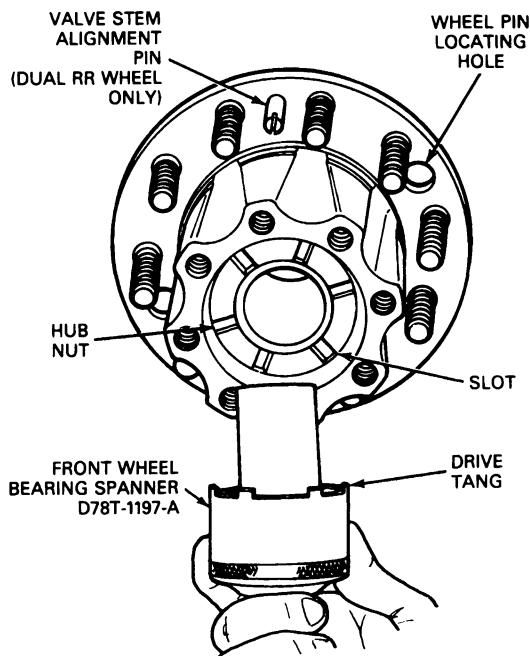
Item	Description
1	Integral Two-Piece Swiveling Lugnut
2	Dual Rear Wheels
3	Hub and Rotor Assembly
4	Rear Disc Brake
5	Dana Full-Floating Axle-Model 80
6	Axle Shaft Bolt 127-171 N·m (94-126 ft-lbs)
7	Outer Locknut

(Continued)

Item	Description
8	Inner Washer
9	Outer Bearing Cup
10	Inner Bearing Cup
11	Inner Hub Seal
12	Inner Bearing Cone
13	Outer Bearing Cone
14	Inner Locknut
15	Lockwasher
16	Gasket
17	Axle Shaft

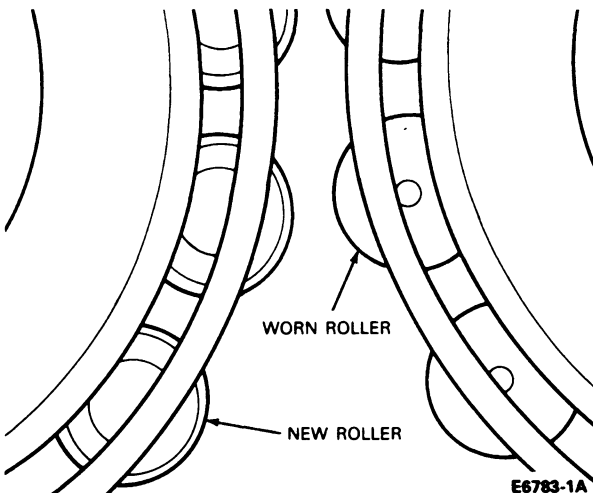
DISASSEMBLY AND ASSEMBLY (Continued)

9. Remove inner retainer nut using front wheel bearing spanner and remove flatwasher.



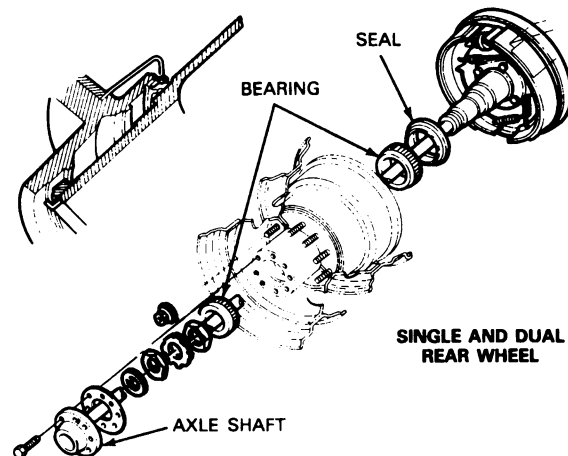
E8807-A

10. Remove the outer bearing cone. Pull the wheel assembly straight out and away from the axle. If it had not been done in Step 4, remove hub assembly and set aside.
11. Thoroughly clean the spindle of the axle housing.
12. Carefully remove the inner seal from the hub assembly with a screwdriver, avoiding damage to the bearing or hub bore. Discard the seal.
13. Clean all old grease and axle lubricant out of the wheel hub.
14. Inspect the bearing races and rollers for pitting, galling or erratic wear patterns. Inspect the rollers for end wear.



E6783-1A

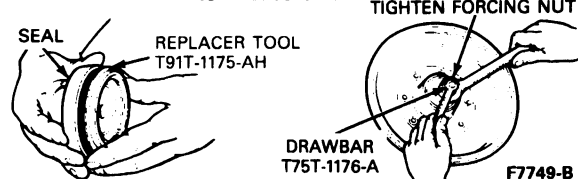
15. Remove the inner bearing cup with Hub Inner Bearing Cup Remover T88T-1175-B. Remove the outer bearing cup with Hub Outer Bearing Cup Replacer T88T-1175-A. Inspect the bearing races and rollers for pitting, galling or excessive wear. If either component (cup or cone and roller) of the tapered roller bearing is not usable, replace both components.
16. Install the new cups with Hub Outer Bearing Cup Replacer T88T-1175-C and Threaded Drawbar T75T-1176-A.



INSTALLING BEARING CUP



INSTALLING SEAL



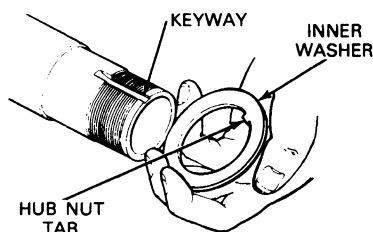
F7749-B

Assembly

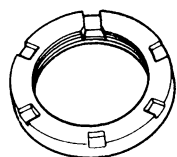
1. Check for proper seating of the new bearing cups by trying to insert a 0.038mm (0.0015-inch) feeler gauge between the cups and the wheel hub. The gauge should not enter beneath the cup. Check in several places to be sure the cups are squarely seated.
2. Pack each bearing cone and roller assembly with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Use a bearing packing tool such as Rotunda 108-00078 or equivalent.
3. Place the inner bearing cone and roller assembly in the hub. Install a new inner seal with Rear Hub Seal Replacer T91T-1175-AH and Threaded Drawbar T75T-1176-A.

DISASSEMBLY AND ASSEMBLY (Continued)

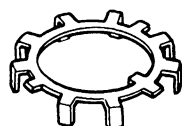
4. Position the hub and rotor assembly at the axle housing. Wrap the threads of the spindle with electrician's tape. Carefully slide the hub and rotor assembly over the axle housing spindle. Remove the electrician's tape.
5. Install the outer wheel bearing cone and roller. Slide the inner washer onto the spindle, engaging the keyway with the tab on the washer as shown.



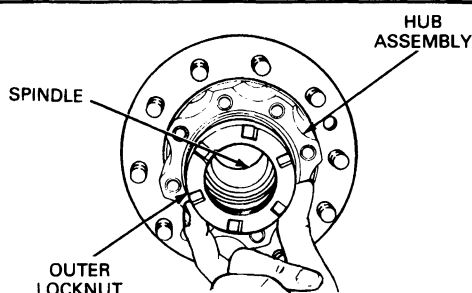
RIGHT HAND THREAD
(INSTALL CLOCKWISE)



INNER LOCKNUT



LOCKWASHER



E8808-B

6. Install the inner locknut with front wheel bearing spanner to 68-82 N·m (50-60 ft-lb) to seat the bearings. Back off the locknut 90 degrees, then retighten to 41-54 N·m (30-40 ft-lb) while rotating the hub and rotor. This provides the proper bearing preload.
7. Back off the inner locknut again, 135-150 degrees. Install the lockwasher with the flat side inboard, noting the relative position of the flat tabs to the six slots in the inner nut. Tighten the inner nut until one of the tabs aligns with a slot, bend tab a minimum of 30 degrees to fully engage the slot.

8. Install the outer locknut and tighten to 88 N·m (65 ft-lb), then additionally until one of the eight L-shaped tabs from the lockwasher aligns with one of the six slots on the outer locknut.
9. Use a magnetic dial indicator mounted to the end of the spindle to measure the end play of the hub and rotor, which is to be .025-.25 mm (0.001-0.010 inch). Bend the L tab of the lockwasher a minimum of 60 degrees over the outer nut to fully engage the slot.
10. Prior to installation of the axle shaft, clean and remove any debris in the hub bolt holes.
11. Inspect axle shaft for:
 - cracked material around the holes
 - depth of holes (40mm [1.57 inches])
 - threaded for 25mm (1 inch)
 - oversized holes
 Replace the hub if any of these conditions are present.
12. Install the axle shaft, new gasket, and new bolts. Coat the bolt threads with a suitable thread adhesive and install the bolts until they seat.
13. Install the wheel and tire assemblies.
14. Remove safety stands and lower the vehicle to the floor.
15. Tighten the wheel lugnuts to specifications.
16. Tighten the axle shaft hub retaining bolts to 127-171 N·m (94-126 ft-lb).

ADJUSTMENTS

For rear wheel bearing adjustments refer to Bearings, Cups and Seals under Disassembly and Assembly in this section.

NOTE: For adjustment procedures for wheel hubs and bearings on Ford full-floating axles, refer to Section 05-02A.

SPECIFICATIONS**WHEEL TORQUE SPECIFICATIONS, FULL-FLOATING REAR AXLES**

Description	N·m	Lb·Ft
E-250-350 — Single Rear Wheel Vehicles (8-Lug Wheel — 9/16-18)	190	140
E-350 — Dual Rear Wheel Vehicles With Integral Two-Piece Swiveling Lugnuts (8-Lug Wheel — 9/16-18)	190	140
F-Super Duty Series Dual Rear Wheel Vehicles with Integral Two-Piece Swiveling Lugnuts (10-Lug Wheel — 9/16-18)	190	140

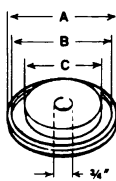

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SPECIFICATIONS (Continued)**WHEEL TORQUE SPECIFICATIONS, FULL-FLOATING
REAR AXLES (Cont'd)**

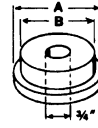




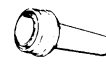
Description	N-m	Lb-Ft
E-350 Hub Nut	88-102	67-75
(To set bearings, back off the hub nut 90 degrees, retighten)	20-27	15-20
Axle Shaft Retaining Bolts	88-115	65-85
F-Super Duty and F-Super Duty Commercial and Motorhome Inner Locknut	68-82	50-60
(To set bearings, back off the locknut 90 degrees, retighten)	41-54	30-40
Outer Locknut	88	65
Axle Shaft Hub Retaining Bolts	127-171	94-126

NOTE: Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts.

SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number / Description	Illustration
T75T-1175-A or -B Seal Replacer (Use with Threaded Drawbar)	 T75T-1175-A
T75T-1176-A Threaded Drawbar	 T75T-1176-A

(Continued)

Tool Number / Description	Illustration
T75T-1225-A or -B Bearing Cup Replacer (Use with Threaded Drawbar)	 T75T-1225-A
T85T-4252-AH Locknut Wrench	 T85T-4252-AH
T88T-1175-A Hub Outer Bearing Cup Remover (F-Super Duty Series Vehicles)	 T88T-1175-A
T88T-1175-B Hub Inner Bearing Cup Remover	 T88T-1175-B
T88T-1175-C Hub Outer Bearing Cup Replacer	 T88T-1175-C
T91T-1175-AH Rear Hub Seal Replacer	 T91T-1175-AH

ROTUNDA EQUIPMENT

Tool Number	Description
014-00030	Heavy Duty Wheel Dolly

SECTION 05-02F Differential, Dana Limited-Slip

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION AND OPERATION	05-02F-1	DISASSEMBLY AND ASSEMBLY (Cont'd.)	
DIAGNOSIS AND TESTING	05-02F-3	Differential Case, Model 70 Four-Pinion	
DISASSEMBLY AND ASSEMBLY		Powr-Lok®	05-02F-7
Dana Limited-Slip Axles	05-02F-4	REMOVAL AND INSTALLATION	05-02F-4
Differential Case, Model 44 IFS, 44 IFS-HD,		SPECIAL SERVICE TOOLS	05-02F-12
60-1U Two-Pinion Dana Trac-Lok®	05-02F-4	SPECIFICATIONS	05-02F-11
		VEHICLE APPLICATION	05-02F-1

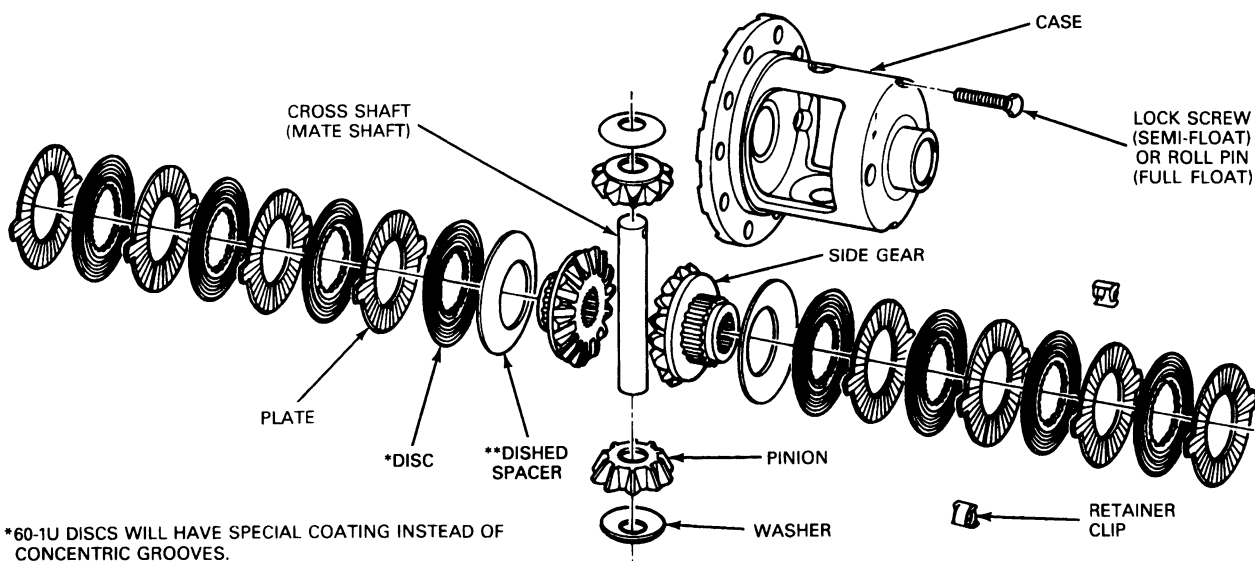
VEHICLE APPLICATION

E-250-350 Rear Axle, F-150-250-350 4x4 and
Bronco Front Axle Vehicles

DESCRIPTION AND OPERATION

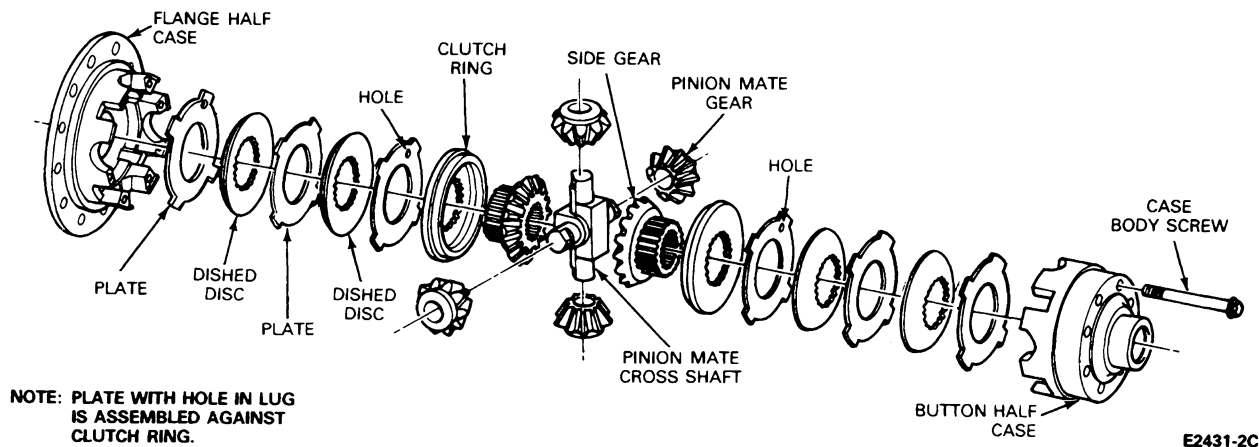
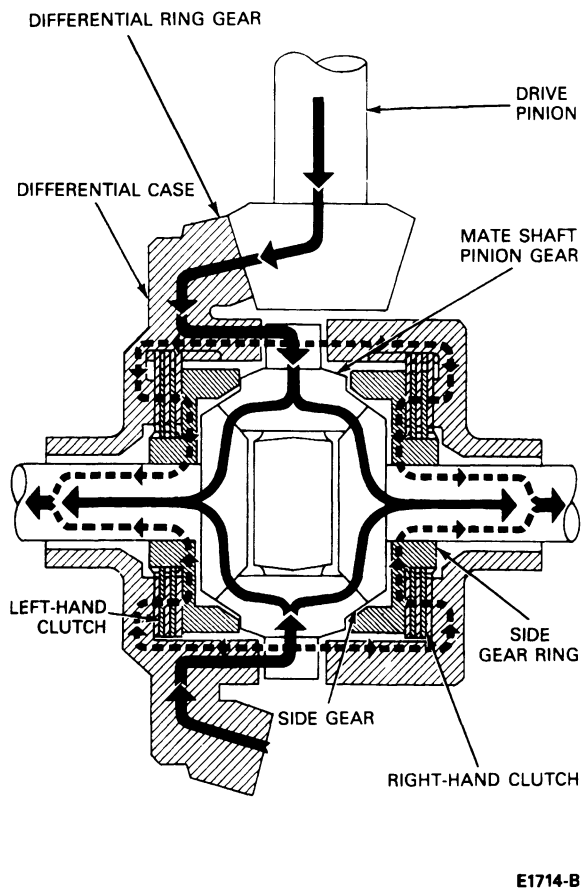
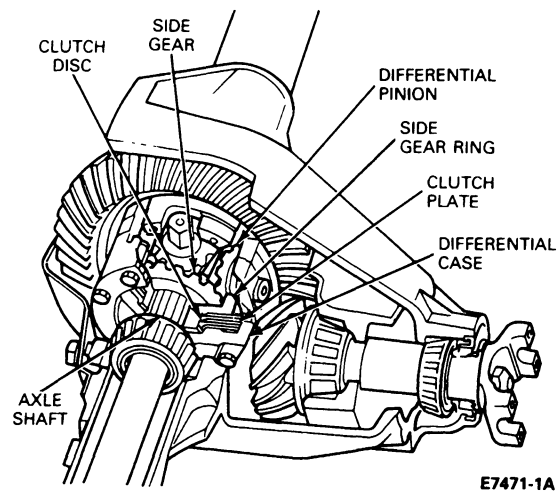
The limited-slip Dana Trac-Lok® Model 44 IFS, Model 44 IFS-HD and Model 60-1U two pinion axle and the four pinion Dana Powr-Lok® Model 70 have a power flow identical to a conventional rear axle, plus a more direct power flow which automatically takes effect as driving conditions demand. This more direct power flow is from the differential case to each axle shaft through clutches.

Two Pinion Limited-Slip Differential, Model 44 IFS Trac-Lok® Shown



E2428-H

DESCRIPTION AND OPERATION (Continued)

Powr-Lok® Differential (Model 70), Exploded View, Design with Special Surface Coating on Plates, Two Dished Discs, and Flat Plates**Limited-Slip Differential Power Flow with Both Wheels Driving****Limited-Slip Differential, Model 70-2U and 70-1HD Powr-Lok®**

The limited-slip differential is similar to a conventional differential, except part of the torque from the ring gear is transmitted through clutch packs between the side gears and differential case. The multiple-disc clutches are engaged by a preload from dished springs and separating forces from the side gears. This occurs as torque is applied through the ring gear.

NOTE: Model 60 clutch packs have **discs** with a special surface coating in place of the concentric grooves. Model 70 clutch packs have **plates** with special surface coating in place of radial grooves. Discs and plates of this design should be soaked for twenty minutes prior to assembly in Additive Friction Modifier C8AZ-19B546-A (EST-M2C 118-A) or equivalent.

DESCRIPTION AND OPERATION (Continued)

Each clutch plate and disc pack consists of steel plates, set between the case and the side gear ring. The dished spacer is locked to the differential case by the external lugs. The dished spacer, installed next to the case, is a Belleville spring plate. This plate is installed with the concave (dished) side against the case. The remaining clutch discs have internal spline teeth which lock to the splined hub on the side gear ring. Each clutch pack is premeasured for proper stack height.

NOTE: Do not separate packs and inter-mix the plates and discs from the packs.

The side gear ring is, in turn, splined to the axle shaft and acts as a pressure plate against the clutch pack. Since the side gear ring fits against the pinions on the cross-shaft (mate shaft), any outward force exerted by the mate shaft and its pinions will press the ring against the clutch pack, connecting the differential case directly to the axle shaft.

DIAGNOSIS AND TESTING

If noises or roughness such as chatter are present when turning corners, the probable cause is incorrect or contaminated lubricant.

Before any differential is removed and disassembled for chatter complaints, the correctness of lubricant should be determined.

If the fluid cannot be identified, it must be drained and refilled with proper quantity and grade of lubricant.

NOTE: Axle Lubricant F1TZ-19580-A (WSL-M2C191-A) or equivalent is recommended for use in all IFS model axles except Dana model 60.

Make sure axle has the specified quantity of Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent and 0.236L (8 ounces) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for rear axles and 0.059L (two ounces) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for front drive axles. Warm the axle up and recheck for chatter by making a minimum of ten figure-eight type turns.

If this is unsuccessful, a complete lubricant drain, flush and refill will usually correct chatter. The following procedure is recommended for flushing system of old lubricant.

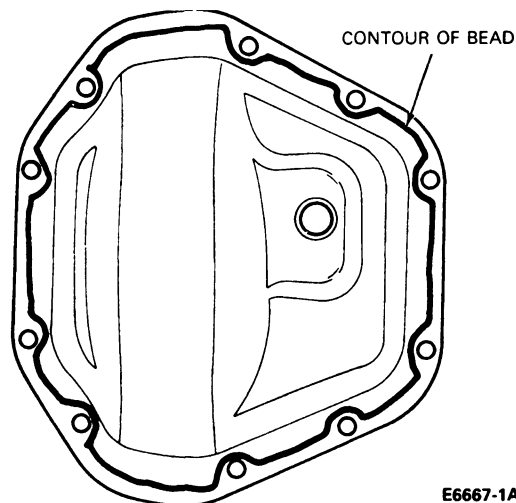
1. Warm the lubricant by vehicle road operation or five minutes of operation in gear with both rear or front wheels off the ground on a hoist.

CAUTION: Never place the transmission in gear with the engine running when only one wheel of a limited-slip differential equipped vehicle is raised. The vehicle might drive itself off the jack and cause damage or injury.

2. Drain lubricant while warm. Remove cover plate to drain completely. Remove all silicone rubber from surface of cover plate.

NOTE: The following illustration shows the flat mounting surface cover plate on Dana design axles. This cover plate requires the use of Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent rather than a gasket.

3. The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.
4. Apply Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent to cover plate surface. The sealer bead (3.18-6.35mm [1/8 to 1/4 inch] wide) is laid on the inside of the cover screw holes. Bead is not to pass through the holes or outside of the holes.



5. Assemble two cover screws into cover at 8 o'clock and 2 o'clock positions. Use these two holes to guide cover plate into position on the carrier.
 6. Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lb).
- Allow one hour cure time before filling carrier and operating vehicle.**
7. Refill axle with specified lubricant.
 8. Operate the vehicle for approximately 16 km (10 miles), making at least ten figure eight turns to flush the old lubricant out of the clutch packs.
 9. Repeat Steps 2 through 8, if required. Remove all existing silicone rubber from cover plate surface. Replace, refer to Step 4.
 10. It is possible that a slight chatter, requiring additional vehicle operation may remain after Step 8. If chatter still persists after 160 km (100 miles) of operation, or remains severe after Step 8, disassemble and repair. Refer to Model 70, Powr-Lok®, in this section for assembly.

For further diagnostic and testing procedures refer to Section 05-00.

REMOVAL AND INSTALLATION

For Dana Models 44-IFS, 44IFS-HD, 60, or 70 limited-slip differential rear axle removal and installation procedures, refer to Section 05-02G and Section 05-02C.

DISASSEMBLY AND ASSEMBLY

Dana Limited-Slip Axles

Service procedures for the Dana Models 60 and 70 rear axles and Model 44 front axles with limited-slip differentials are covered separately in this section.

The Dana limited-slip differential assembly is removed and installed in exactly the same manner as the conventional differential assembly. For these service procedures refer to Section 05-02G.

When axle lubricant has been drained for front or rear axle repair (limited-slip only), refill the axle with the specified quantity of Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent and add 0.236L (eight ounces) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for rear axles and 0.059L (2 ounces) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for front-drive axles.

NOTE: Axle Lubricant F1TZ-19580-A (WSL-M2C191-A) or equivalent is recommended for use in all IFS model axles except Dana model 60.

Differential Case, Model 44 IFS, 44 IFS-HD, 60-1U Two-Pinion Dana Trac-Lok®

Disassembly

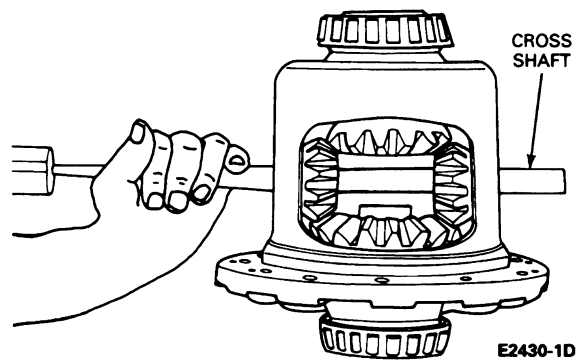
The differential bearings need not be removed to overhaul the limited-slip differential; however, the ring gear will have to be removed first.

To remove and install the side gears, washers and clutch packs during disassembly and assembly requires special procedures and tooling.

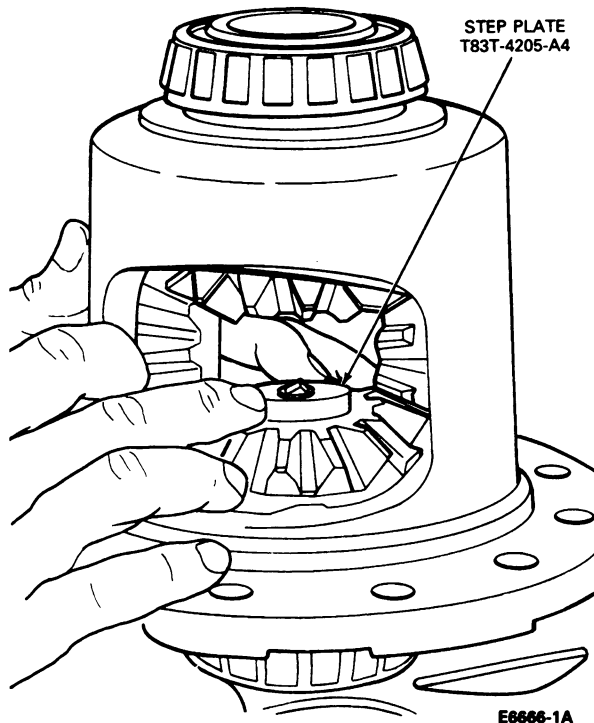
For Model 60, use Limited-Slip Differential Tool D83T-4205-A.

NOTE: An axle shaft placed in a vise, with the splines extending above the jaws of the vise not more than three inches, makes an excellent holding fixture after the case has been removed from the housing.

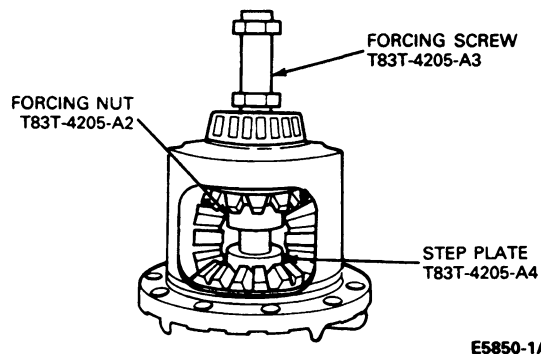
1. For Model 44 IFS and 60-1U full-float axles, use small drift to remove the roll pin retaining the cross-shaft. For Model 60-1U semi-float axles, a lock screw is used to secure the slip fit cross-shaft.
2. Remove the cross-shaft for the Model 44 IFS and 60-1U full-float axles with a hammer and drift. The Model 60-1U semi-float cross-shaft is a slip fit and may be lifted out without tools.



3. Position the Step Plate T83T-4205-A4 into the bottom side gear. Apply grease to the centering hole of the step plate.

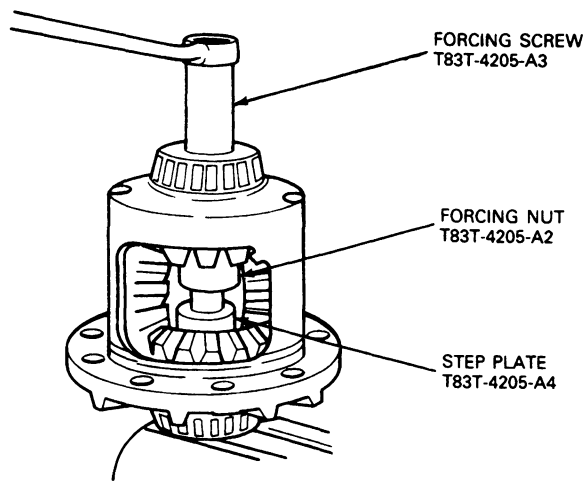


4. Install Forcing Nut T83T-4205-A2 and Forcing Screw T83T-4205-A3 into the differential case.



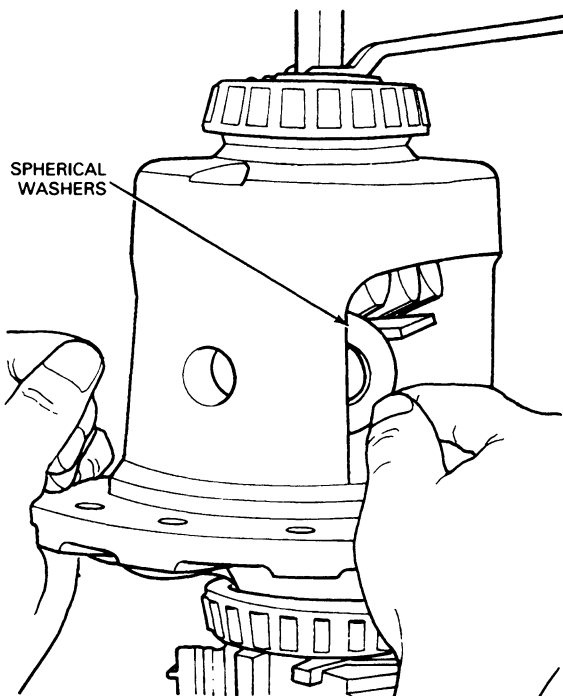
DISASSEMBLY AND ASSEMBLY (Continued)

5. Guide the forcing screw onto the step plate.



E5851-1A

6. Tighten the forcing screw to move the side gears away from the differential pinion gears and relieve the normal loaded condition.
7. Using a piece of 0.762mm (0.030 inch) thick shim or gauge stock, push out the differential spherical washers located behind the pinion mating gears.

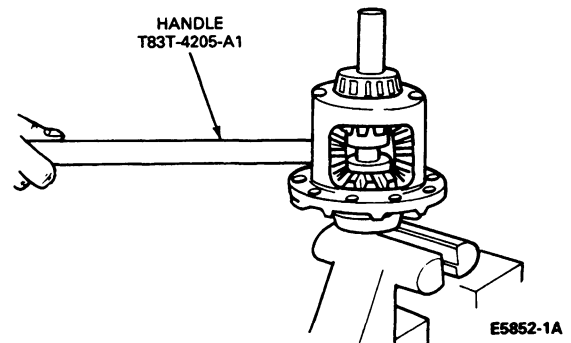


E7370-1A

8. Momentarily, loosen the forcing screw. This step is very important to relieve the pressure of the clutch pack.
9. Re-tighten the forcing screw until a very slight movement of the differential pinion gears is seen.

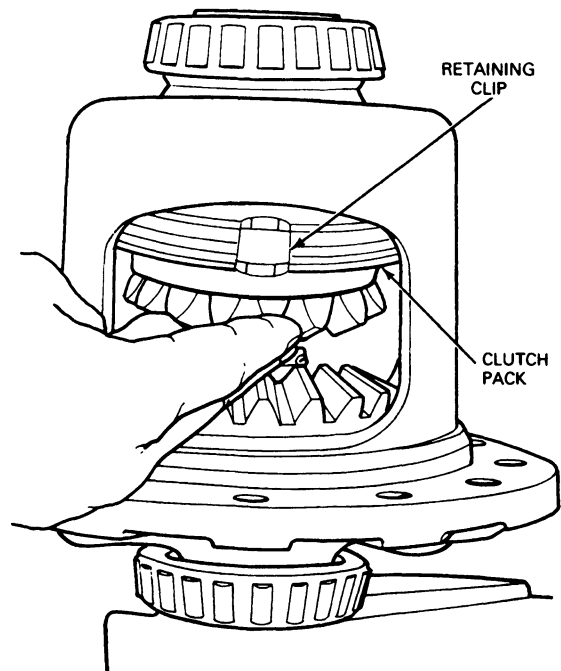
10. Insert Handle T83T-4205-A1 into the pinion mate shaft bore and rotate the case. Continue this until the differential pinion gears can be removed through the large openings in the case.

NOTE: When attempting to rotate the side gear, some tightening or loosening of the forcing screw will probably be required to permit gear movement.



E5852-1A

11. Retain the top side gear and clutch pack in the case by hand and remove the forcing screw.
12. Continue to hold the side gear and clutch pack and remove the gear rotating tool.
13. Remove the top side gear and clutch pack. Keep the stack of plates and discs in exact order.



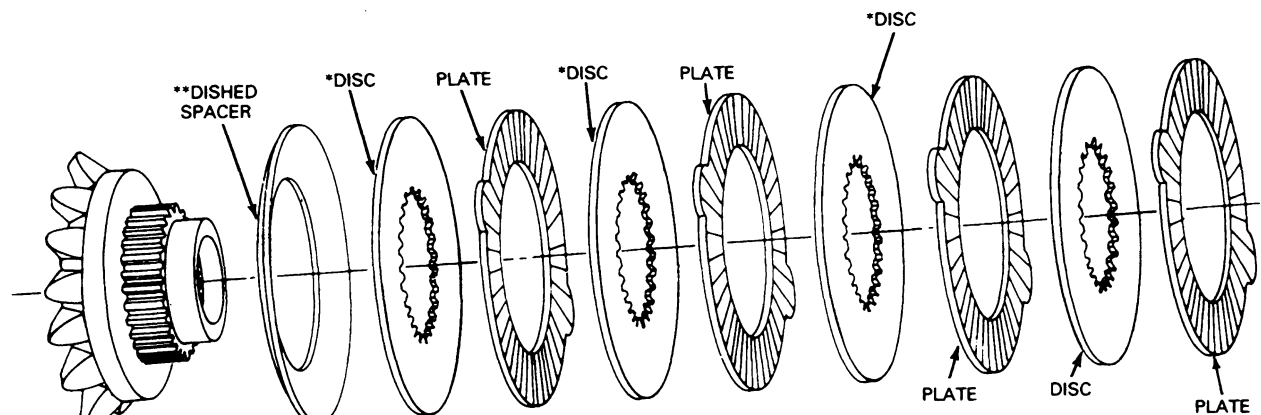
E7371-1A

14. Turn case so the flange, or ring gear side is up. Ease the step plate, side gear and clutch pack out of the case.

DISASSEMBLY AND ASSEMBLY (Continued)

15. Remove the retainer clips from both clutch packs to allow separation of the discs and plates for cleaning and inspection.

Dana Model 60 Trac-Lok® Clutch Pack



*DISCS HAVE SPECIAL COATING INSTEAD OF CONCENTRIC GROOVES.
**MAY HAVE EARS AS SHOWN ON PLATE.

E2272-2D

Assembly

Refer to illustrations used during disassembly for guidance in re-assembly operations.

1. Install the clutch packs, side gears and thrust washers. Assemble in exactly the same order.

NOTE: Always replace the entire kit of plates and discs even if only one component requires it.

2. Prelubricate the thrust face of the side gear and assemble the plates and discs to the side gear splines, prelubricating each part with Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent or with Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier lubricant, both stacks.

NOTE: Axle Lubricant F1TZ-19580-A (WSL-M2C191-A) or equivalent is recommended for use in all IFS model axles except Dana model 60.

CAUTION: The Model 60 discs of the newer coated design (without concentric grooves), must be soaked for twenty minutes in Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) before assembly.

3. Assemble the retainer clips to the ears of the plates. Make sure both clips are completely assembled or seated onto the ears of the plates.
4. Assemble the clutch pack and side gear into the case. Make sure the clutch pack stays assembled to the side gear splines, and the retainer clips are completely seated into the case pockets.

NOTE: To prevent the pack from falling out of the case, hold in place by hand while re-positioning the case on a bench.

5. Re-position the case on the bench. Assemble the step plate into the side gear. Apply a small amount of Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent into the centering hole of the step plate.

6. Assemble the other clutch pack and side gear. Make sure the clutch pack stays assembled to the side gear splines, and the retainer clips are completely seated into the case pockets.

7. Install Step Plate T83T-4205-A4 on top of the side gear.

8. Hold the side gear in position by hand. Insert Forcing Screw T83T-4205-A3 down through the top of the case, and thread Forcing Nut T83T-4205-A2 on the screw.

NOTE: The tip of the forcing screw must contact the step plate.

9. With tools assembled to the case, position the case onto the axle shaft (as a holding fixture) by aligning the splines of the side gear with those of the shaft.

10. Position both differential pinion gears opposite one another through the openings in the case. Align holes of the gears with each other. Hold the gears in place by hand.

11. Tighten the forcing screw so the side gears move away from the differential pinion gears and relieve the loaded condition.

12. While holding the differential pinion gears in place, insert the Handle T83T-4205-A1 into the pinion mate shaft hole in the differential case. Pull on the handle rotating case allowing the differential pinion gears to rotate and enter into the case.

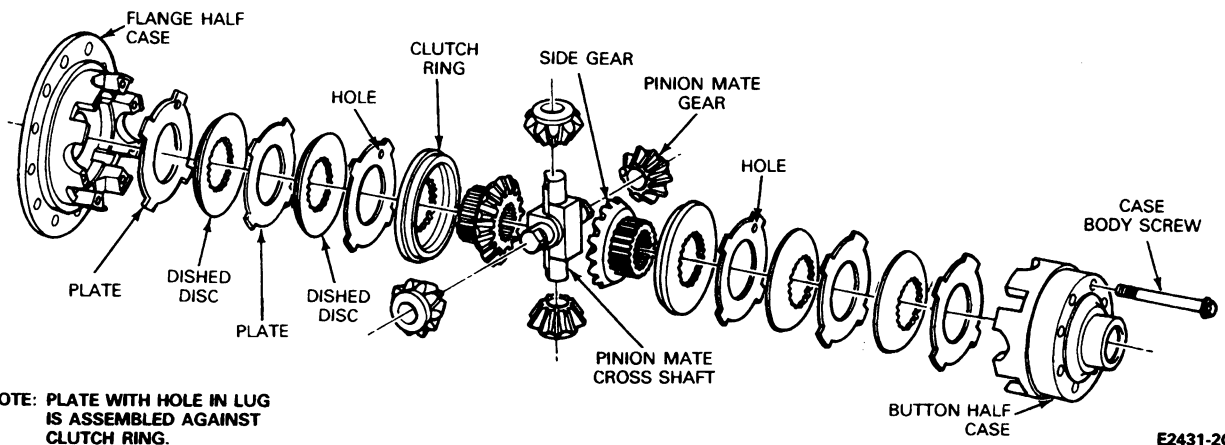
DISASSEMBLY AND ASSEMBLY (Continued)

13. Adjust the forcing screw by very slightly loosening or tightening until the required load is applied to allow the side gear and differential pinion gears to rotate.
14. Rotate the case until the holes of both differential pinion gears are aligned with those of the case.
Prelubricate both sides of the pinion spherical washers with the specified lubricant, Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent.
15. Apply torque to the forcing screw for clearance to assemble the spherical washers.
16. Assemble washers into the case. Use a very small screwdriver to push the washers into place.
NOTE: Be sure the holes of the washers and gears are lined up exactly with those of the case.
17. Remove the forcing screw, forcing nut, handle, and step plate.
18. Install the pinion shaft in the differential case. Install the cross-shaft locking pin.
19. Install the ring gear on the differential case. Tighten new attaching bolts to specification. Refer to Specifications in this section.

CAUTION: Do not over-tighten the forcing screw. Over-tightening the forcing screw may damage the clutch plate and disc assemblies.

Differential Case, Model 70 Four-Pinion Powr-Lok®
Disassembly

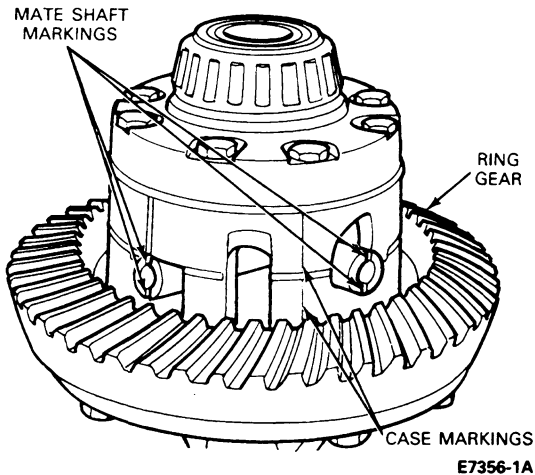
The differential bearings need not be removed to overhaul the limited-slip differential.

Dana Model 70 Powr-Lok® Differential


1. Mark the ring gear half and cover half of the differential case for re-assembly in the same positions.

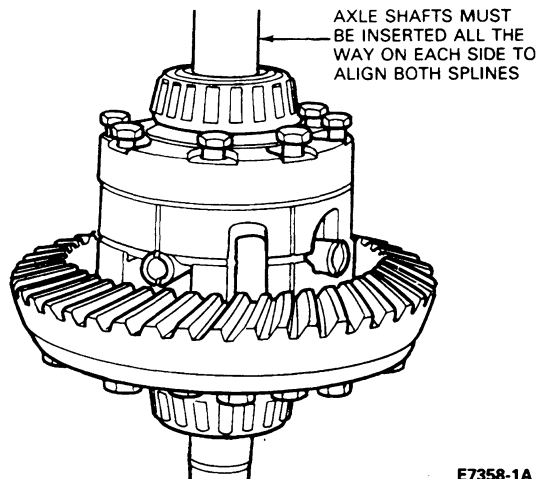
DISASSEMBLY AND ASSEMBLY (Continued)

2. Mark the pinion mate shafts and their corresponding ramps for re-assembly in the same positions.

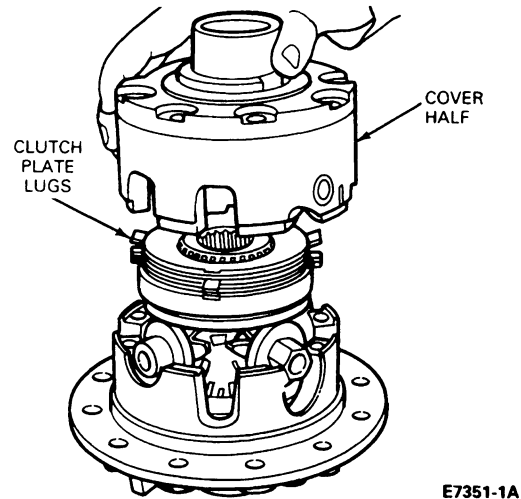


3. Clamp the differential assembly in a soft-jawed vise and loosen, do not remove the case bolts holding the halves together.

NOTE: Insert an axle shaft into the differential assembly to act as a holding tool to facilitate loosening the bolts.



4. Place the differential assembly on the bench with the ring half of the case down. Remove the case attaching bolts and cover half on Model 70 differentials.



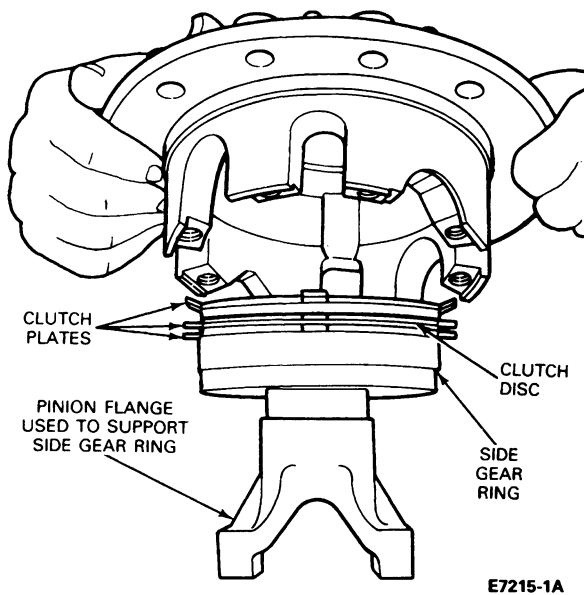
5. Remove the pinion mate gear, side gear ring, and clutch pack. Keep these parts with the cover half of the case to reinstall in original positions.
6. Remove the corresponding parts as in Step 5 from the drive gear half of the case.
7. Inspect the clutch plates and discs for cracks, excessive wear, and distortion. If one or more of the plates, or discs needs replacing, replace entire stack of clutch plates.
- Inspect all other parts and replace any worn or damaged part.
8. Inspect the pinion mate shaft surfaces and the ramp surfaces on the case for excessive wear or pitting.
9. Inspect the side gear and pinion gear teeth. Inspect the pinion gear races that bear on the side gear rings.

DISASSEMBLY AND ASSEMBLY (Continued)

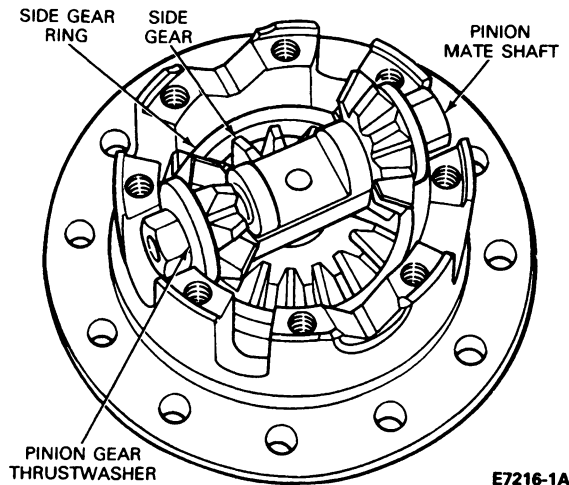
Assembly

1. Place the side gear ring from the flange half of the case on a pinion flange approximately four inches above the bench. Coat the clutch plates with axle lubricant, Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or an acceptable alternate such as Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A).

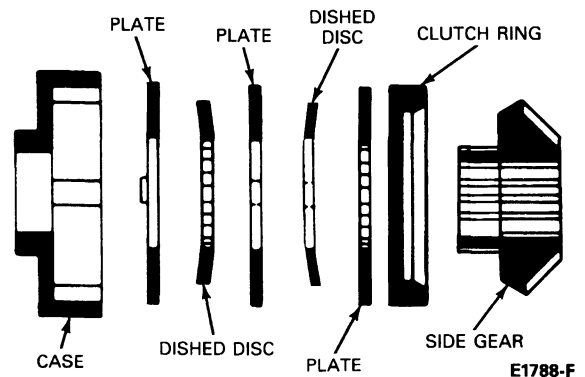
CAUTION: The plates of the new design (without radial grooves) must be soaked for twenty minutes in Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) before assembly.



2. Assemble the parts in order according to the illustration that accompanies Step 9 in this procedure.
3. Place the ring gear half of the case over the clutch pack and side gear ring. Install clutch plate lugs into case slots. Check the case bottoms on the clutch pack.
4. Grasp the flange and the case to hold the assembly together, then turn the case half upside down.
5. Place the side gear into clutch ring.
6. Place the mate shaft and pinions on the side gear ring. Align the mate shaft and case markings.



7. Install the cover half mate shaft and pinions. Align the paint markings.
8. Place the side gear on the pinions, then place the side gear ring on the side gear and pinions.
9. Assemble the clutch pack on the side gear according to the arrangement shown. Align the clutch plate lugs, and install into case.



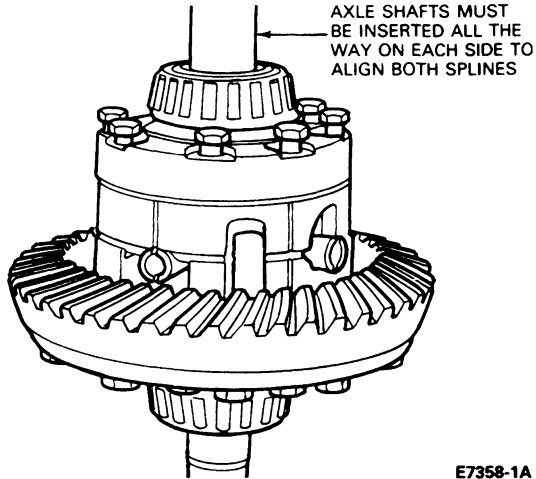
NOTE: There may be circumstances of continuing chatter / bumping in turns despite replacement of parts and lubricant, particularly in vehicles operating at close to GVW rating. Typical situations are emergency vehicles and fifth wheel trailers. In these cases, it is permissible to re-assemble the clutch pack with the disc adjacent to the side gear ring, resulting in two plates together. This results in three friction surfaces instead of the normal five, and will result in lowering the torque to rotate the wheel by 40%.

10. Place the cover half of the case over the assembly. Align case marks.
11. Install all case bolts and turn each one on a few threads. Case bolts must be clean and dry.
12. Using both axle shafts, align the splines of the side gear and the clutch ring on both sides of the case.

DISASSEMBLY AND ASSEMBLY (Continued)

13. With the axle shafts in position, tighten the case bolts evenly and alternately to 89-94 N·m (65-70 ft-lb).

NOTE: If bolt heads have "180" or seven radial lines stamped on head, tighten the case bolts to 122-136 N·m (90-100 ft-lb).



14. Remove the axle shafts.

NOTE: If the assembly has been properly assembled, each pinion mate cross-shaft should be tight on its ramp; or, if there is clearance between the cross-shaft and the ramp, it should be not more than 0.254mm (0.010 inch) and equal at all four cross-shaft ends.

SPECIFICATIONS

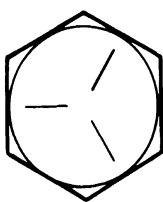
Refer to the following chart for torque limits.

DANA AXLE TORQUE LIMITS

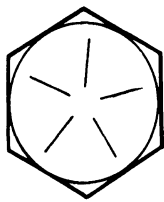
Description	Axle Model					
	60		70		80	
	Ft-Lbs	N-m	Ft-Lbs	N-m	Ft-Lbs	N-m
Pinion Shaft Nut	250-270	339-366	250-270	339-366	440-500	596-677
Differential Bearing Cap Bolts	80-90	109-147	80-90	109-147	80-90	109-147
Ring Gear Attaching Bolts	Grade 8	100-120	100-120	136-163	—	—
	Grade 9	125-135	125-135	169-183	200-240	272-330
Oil Filler Plug – 1/4 Inch Recess Drive	15-25	20-33	15-25	20-33	15-25	20-33
U-Joint Bolts	15-20	21-27	15-20	21-27	—	—
Cover to Housing Bolts	30-40	41-54	30-40	41-54	30-40	41-54

WARNING

IF FASTENERS OF A LOWER GRADE OR CLASS ARE TORQUED TO THE REQUIREMENTS OF A HIGHER GRADE OR CLASS FASTENER, IT MAY RESULT IN COMPONENT FAILURE. (E.G. GRADE 5 FASTENER TORQUED TO THE REQUIREMENTS OF A GRADE 8 FASTENER.)



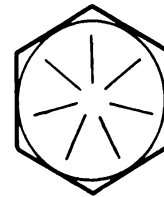
GRADE 5



GRADE 7

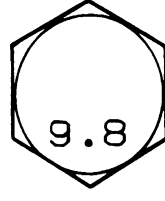
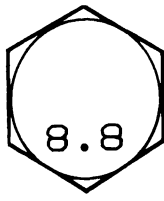
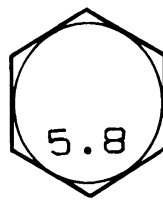


GRADE 8



GRADE 9
(High Strength Applications)

Customary (Inch) Bolts-identification marks correspond to bolt strength-increasing numbers represent increasing strength.




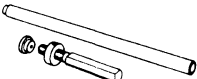

Metric Bolts-identification class numbers correspond to bolt strength-increasing numbers represent increasing strength.

Inch grade fasteners can be identified by the radial lines embossed upon the head of the fastener and will correspond to the fastener strength by two-lines less than actual grade (i.e., grade 8 fastener will display 6 radial lines on the head).

Metric fastener strength can be identified with the class identification embossed on the head of each fastener. Increasing numbers represent increasing strength.

CE7751-D

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
TOOL-4000-E Differential Housing Spreader (Dana 44,60 Axles)	 TOOL-4000-E
T83T-4205-A Limited-Slip Differential Tool — (Dana 60 Axles)	 T83T-4205-A
T53T-4221-C Differential Side Bearing RPI (Dana 60 Axles)	 T53T-4221-C

Tool Number	Description
D83T4205-A	Limited-Slip Differential Tool (Dana 60 Axles)

SECTION 05-02G Axle, 8.8-Inch Ring Gear

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		DISASSEMBLY AND ASSEMBLY (Cont'd.)	
Inspection After Disassembly	05-02G-26	Axle Disassembly	05-02G-7
Inspection Before Disassembly	05-02G-25	Rear Anti-lock Brake System Sensor	05-02G-24
DESCRIPTION AND OPERATION		REMOVAL AND INSTALLATION	
Description	05-02G-1	Pinion Seal/ Nut or Companion Flange	
Operation	05-02G-2	Replacement	05-02G-4
Rear Anti-lock Brakes	05-02G-1	SPECIAL SERVICE TOOLS	05-02G-27
DISASSEMBLY AND ASSEMBLY		SPECIFICATIONS	05-02G-26
Axle Assembly	05-02G-13	VEHICLE APPLICATION	05-02G-1

VEHICLE APPLICATION

E-150, F-150 and Bronco Vehicles

DESCRIPTION AND OPERATION

Description

The Ford Truck Integral Carrier rear axle assembly is an integral type housing, hypoid gear design with the centerline of the pinion set below the centerline of the ring gear.

The hypoid gear set consists of an 8.8-inch diameter ring gear and an overhung drive pinion which is supported by two opposed tapered roller bearings. Pinion bearing preload is adjusted by the pinion nut and a collapsible spacer maintains the seating of the inner race.

The housing assembly consists of a cast center section with two steel tube assemblies and a stamped rear cover. The cover uses silicone sealant as a gasket.

The differential case is a one-piece design with two openings to allow for assembly of the internal components and lubricant flow. The differential pinion shaft is retained with a threaded bolt assembled to the case. The differential case assembly is mounted in the carrier between two opposed tapered roller bearings. The bearings are retained in the carrier by removable bearing caps.

The axle is available in two models to accommodate tread width differences between the vehicle lines. They are similar except for minor suspension bracket connections and variations in axle shaft and housing tube lengths.

- Differential bearing preload and ring gear backlash are adjusted by the use of shims located between the differential bearing cup / races and the carrier housing.
- The use of a pinion depth gauge tool for drive pinion shim selection in conjunction with a dial indicator for differential case shim selection is required for proper gear set adjustment.
- The semi-floating axle shafts are held in the housing by C-washer locks positioned in a slot on the axle shaft splined end. These C-washers also fit into a machined recess in the differential side gears within the differential case.

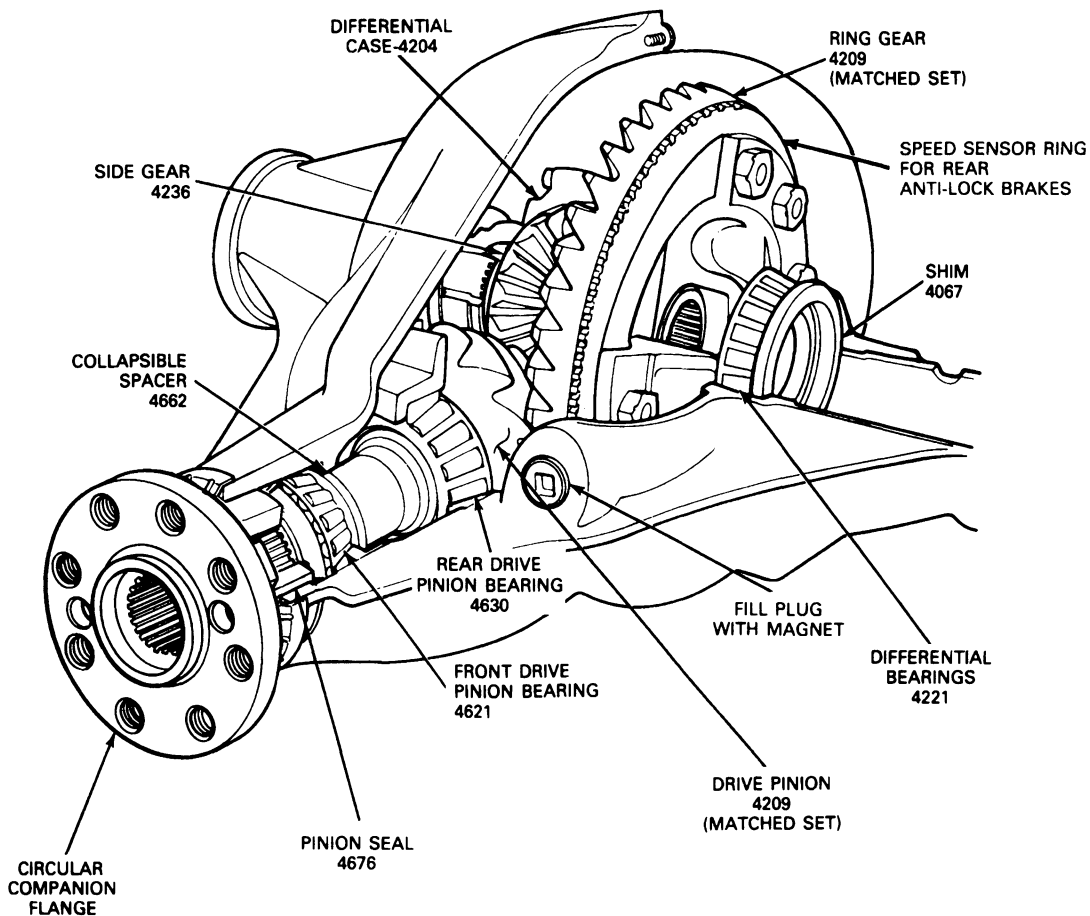
Rear Anti-lock Brakes

E-150, F-150 and Bronco vehicles use the Rear Anti-lock Brake System (RABS). The system features a 108-tooth speed sensor ring that is pressed on the differential case behind the ring gear. If the speed sensor ring is removed, it must be discarded and replaced with a new one. The speed sensor ring works in conjunction with an electronic speed sensor. This sensor is retained in a bore at the top of the carrier housing and fastened by one bolt. There is a space provided between the ring gear and sensor ring for measuring the ring gear backface runout.

DESCRIPTION AND OPERATION (Continued)**Operation**

The rear axle drive pinion receives its power from the engine through the transmission and driveshaft. The pinion gear rotates the differential case through engagement with the ring gear, which is bolted to the case outer flange.

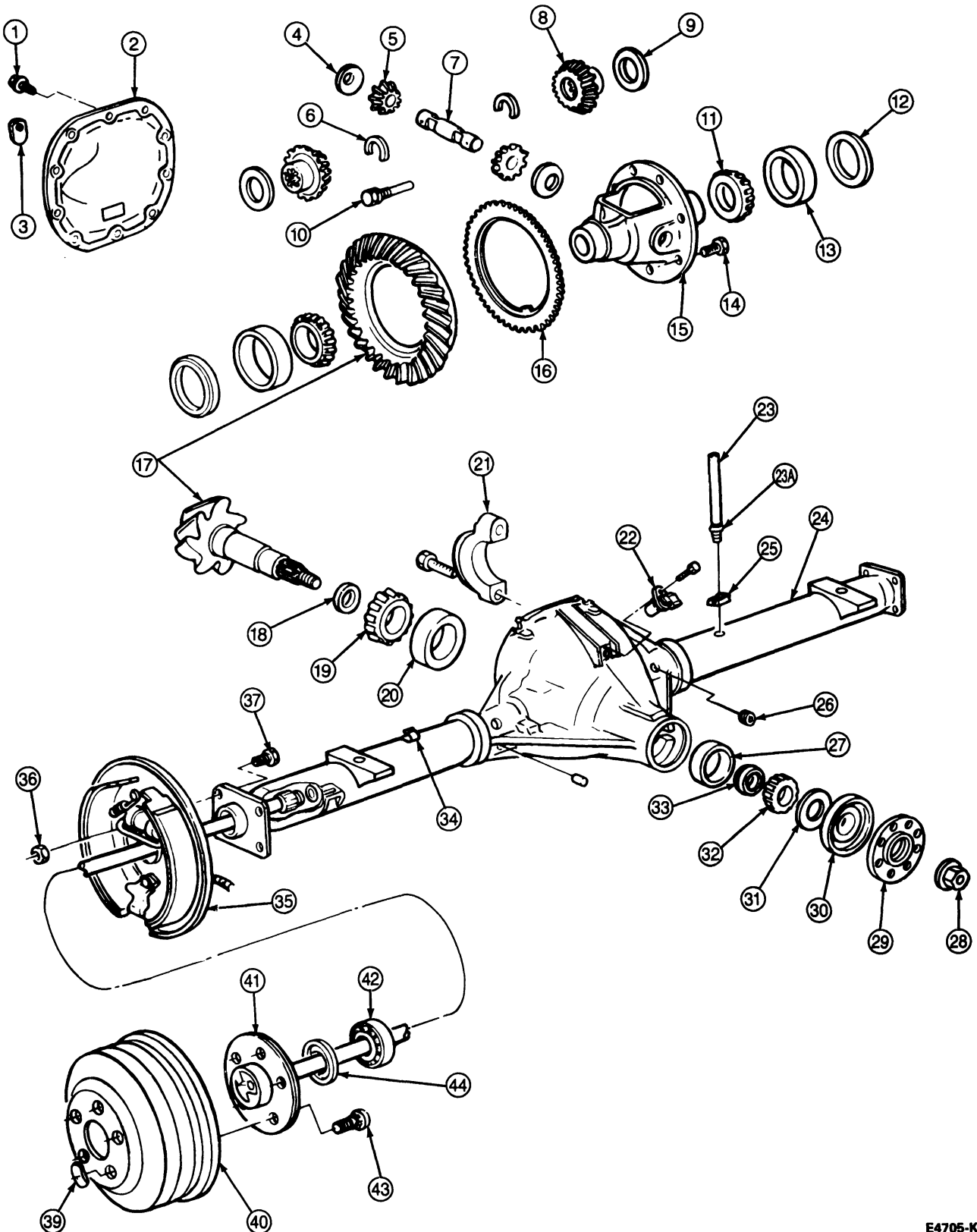
Inside the case, two differential pinion gears are mounted on the differential pinion shaft which is pinned (with lock bolt) to the case. These pinion gears are engaged with the side gears, to which the axle shafts are splined. Therefore, as the differential case turns, it rotates the axle shafts and rear wheels. When it is necessary for one wheel and axle shaft to rotate faster than the other, the faster turning side gear causes the pinions to roll on the slower turning side gear to allow differential action between the two axle shafts.

Ford Truck Integral Carrier, Rear Axle Assembly

E4704-M

DESCRIPTION AND OPERATION (Continued)

Ford Truck Integral Carrier, Rear Axle Assembly



E4705-K

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	—	Cover Screw
2	4033	Cover
3	—	Rear Axle Identification Tag
4	4230	Thrust Washer
5	4215	Pinion Gear
6	—	U-Washer
7	4211	Differential Pinion Shaft
8	4236	Side Gear
9	4228	Thrust Washer
10	—	Differential Pinion Shaft Lock Bolt
11	4221	Differential Bearing
12	4067	Differential Shims
13	4222	Differential Bearing Cup
14	—	Ring Gear Bolt
15	4204	Differential Case
16	—	Speed Sensor Ring, RABS
17	4209	Ring and Pinion Gear Set
18	—	Pinion Shim
19	4630	Rear Pinion Bearing
20	4628	Rear Pinion Bearing Cup (Part of 4010 Housing)
21	—	Bearing Cap and Bolt
22	—	RABS Sensor

(Continued)

Item	Part Number	Description
23	—	Vent Hose, F-150 and Bronco
23A	—	Axle Vent Fitting, F-150 and Bronco. Econoline Vent Hose is Integral to Brake Hose
24	4010	Axle Housing Assembly
25	—	Brake Junction Block
26	—	Filler Plug
27	4616	Front Pinion Bearing Cup
28	—	Pinion Nut
29	4851	Circular Flange Assembly
30	4676	Pinion Seal
31	4670	Slinger
32	4621	Front Pinion Bearing
33	4662	Collapsible Spacer
34	—	Brake Line Clip
35	2209 / 2210	Brake Assembly
36	—	Brake Backing Plate Nut
37	—	Bolt
39	—	Spring Push-On Nut
40	1126	Brake Drum
41	4234	Axle Shaft Assembly
42	1225	Bearing Assembly
43	—	Wheel Bolt
44	1177	Seal Assembly

TE4705A

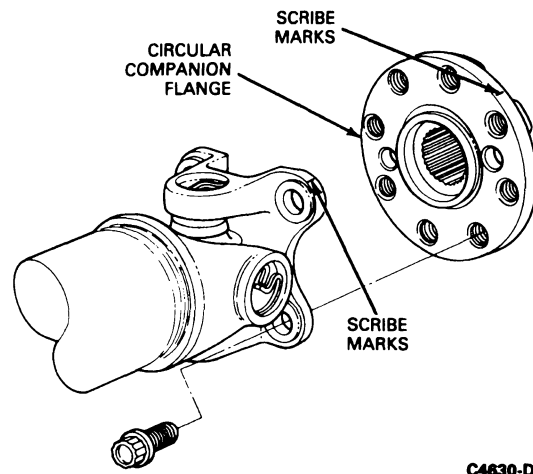
REMOVAL AND INSTALLATION

Pinion Seal/Nut or Companion Flange Replacement**Removal**

NOTE: If pinion seal is leaking, check the vent and vent tube. If the vent or vent tube is plugged with dirt or debris it will cause pressure build-up in the axle which can lead to pinion seal problems.

CAUTION: This operation disturbs the pinion bearing preload, and this preload must be carefully reset when assembling.

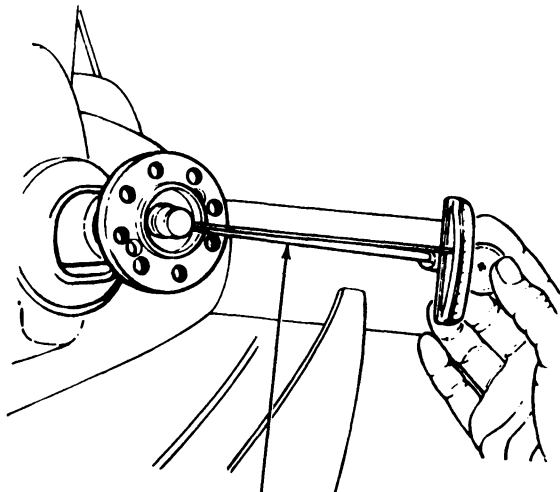
1. Raise the vehicle and install safety stands. Remove the rear wheels and brake drums to prevent brake drag during drive pinion bearing preload adjustment.
2. Mark the driveshaft axle end flange and the axle companion flange to make sure the driveshaft will be properly positioned during assembly. Disconnect the driveshaft from the rear axle companion flange. Remove the driveshaft from the transmission extension housing. Install an oil seal replacer tool in the transmission extension housing to prevent oil leakage.



C4630-D

REMOVAL AND INSTALLATION (Continued)

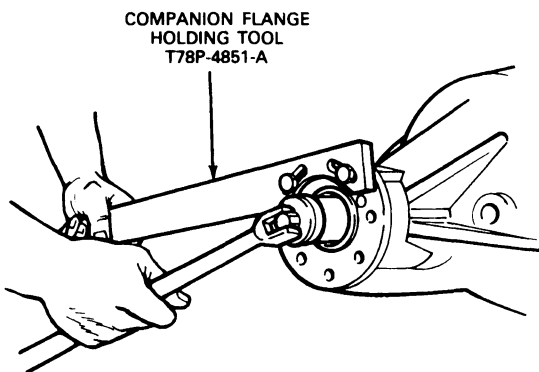
3. Install an inch-pound torque wrench on the pinion nut. Record the torque required to maintain rotation of the pinion through several revolutions.



INCH-POUND
TORQUE WRENCH

F2669-E

4. While holding the companion flange with Companion Flange Holding Tool T78P-4851-A or equivalent, remove the pinion nut.



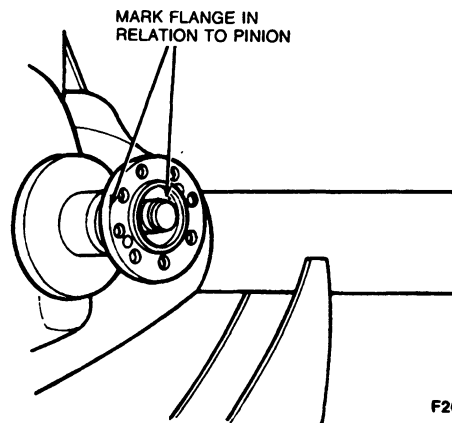
COMPANION FLANGE
HOLDING TOOL
T78P-4851-A

F5646-C

5. Clean the area around the oil seal. Place a drain pan under the seal, or raise the front of the vehicle higher than the rear.

6. Mark the companion flange in relation to pinion so flange can be reinstalled in the same position.

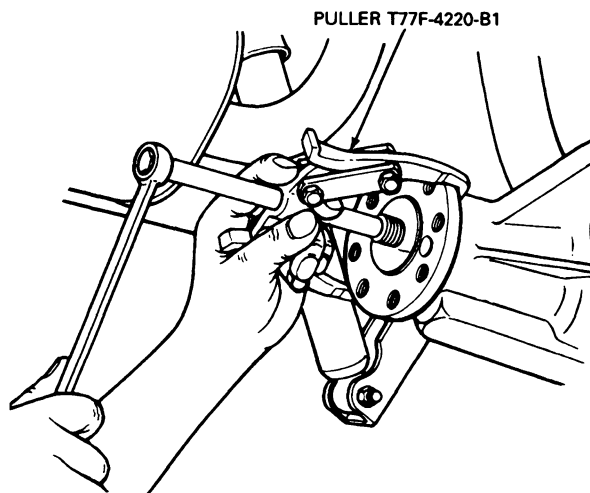
NOTE: If a new companion flange is being installed, disregard the scribe mark on the pinion shaft.



MARK FLANGE IN
RELATION TO PINION

F2671-B

7. Using Remover Tool T77F-4220-B1 or equivalent, remove the rear axle companion flange. Place drain pan under axle pinion nose.

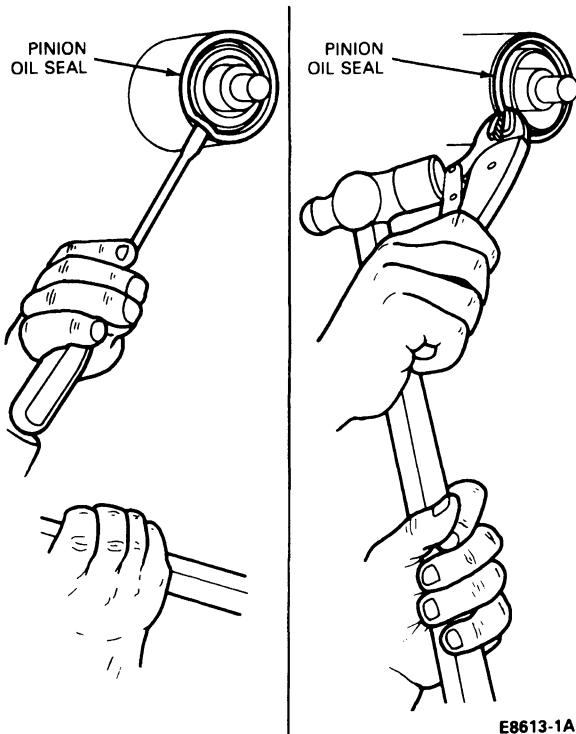


PULLER T77F-4220-B1

E4892-1B

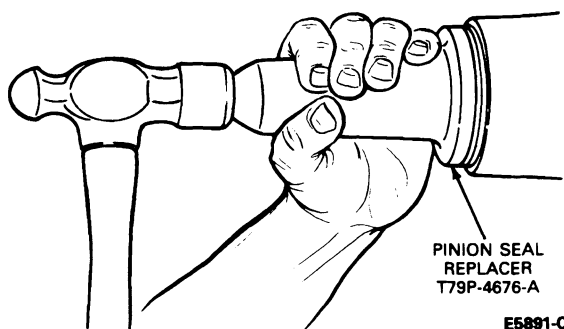
REMOVAL AND INSTALLATION (Continued)

8. Pry up on metal flange of pinion seal. Install gripping pliers and strike with hammer until pinion seal is removed.



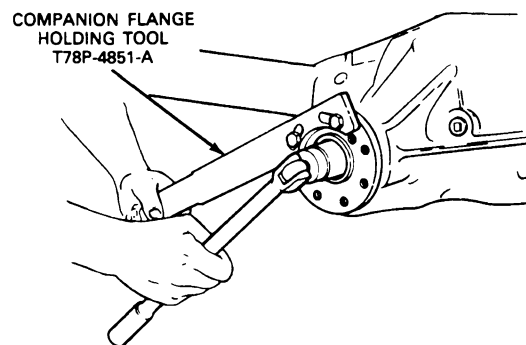
9. Clean the oil seal seat surface. Install the seal in the housing bore using Pinion Seal Replacer T83T-4676-A. Coat the lips of the seal with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.

CAUTION: Installation without the proper tool may result in seal failure. If seal becomes cocked during installation, remove it and install new one.



Companion Flange Installation

10. Apply a small amount of lubricant to the companion flange splines.
11. Align the mark on the companion flange with the mark on the pinion shaft.
12. Install the flange using Companion Flange Replacer TOOL-4858-E or equivalent.
- Install a new pinion nut on the pinion stem.
- NOTE:** If a new companion flange is being installed, disregard the scribe mark on the pinion shaft.
- CAUTION:** The companion flange must never be hammered on or installed with power tools.
13. Hold the circular companion flange with Companion Flange Holding Tool T78P-4851-A or equivalent while tightening the pinion nut.

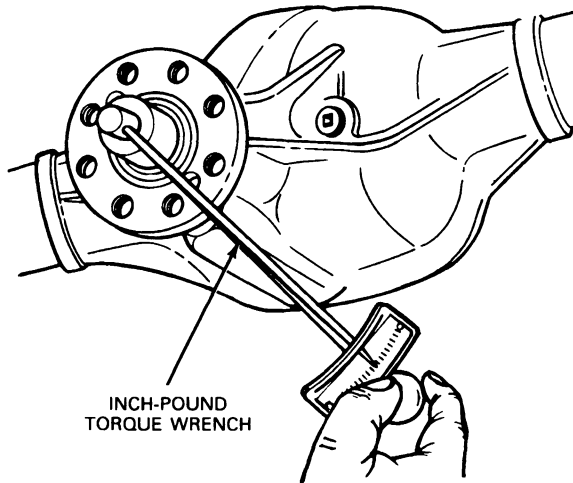


14. Tighten the pinion nut, rotating the pinion occasionally to make sure bearings seat properly. Take frequent drive pinion bearing torque preload readings until the original recorded preload reading is obtained.
15. If the original recorded preload is lower than specification (used bearings .9-1.5 N·m [8-14 in-lb] new bearings 1.8-3.3 N·m [16-29 in-lb]) tighten to specification. If the preload is higher than specification tighten to original reading as recorded in Step 3.

REMOVAL AND INSTALLATION (Continued)

16. Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.

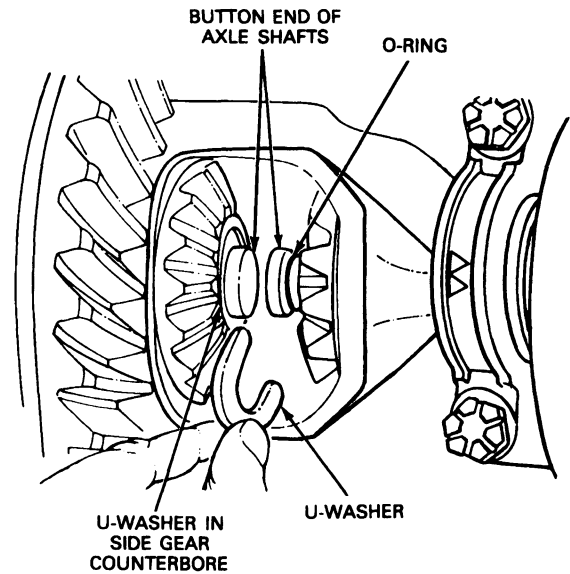
NOTE: A minimum pinion nut tightening torque of 217 N·m (160 ft-lb) must be obtained during tightening.



E4900-E

4. Push the flanged end of the axle shafts inboard and remove the U-washer from the button end of each axle shaft.

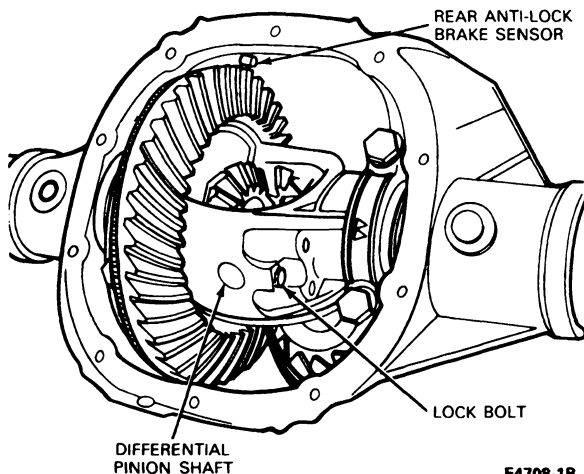
NOTE: Use care not to lose or damage the rubber O-ring which is in the axle shaft groove under the U-washer. The O-ring is used to hold the U-washer in position until the axle shafts are pulled back in place at reassembly.



E4709-C

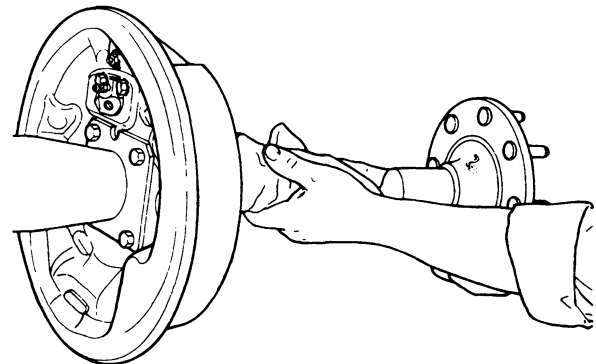
DISASSEMBLY AND ASSEMBLY**Axle Disassembly****Axle Shaft Removal**

1. Clean all dirt from the area of carrier cover with a wire brush and/or cloth.
2. Drain rear axle lubricant by removing the housing cover.
3. Remove differential pinion shaft lock bolt and differential pinion shaft.



E4708-1B

5. Remove the axle shaft from the housing, being careful not to damage the oil seal.



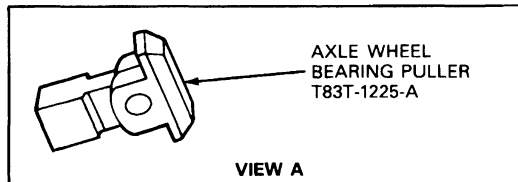
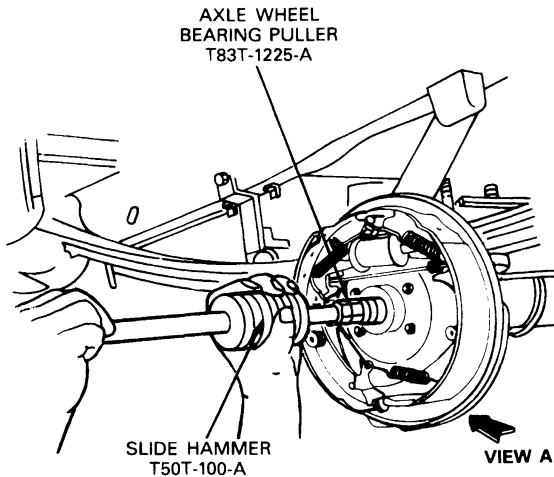
E4760-1B

Oil Seal and Wheel Bearing Removal

NOTE: If wheel oil seal is leaking, check the vent and vent tube. If the vent or vent tube is plugged with dirt or debris, it will cause pressure build-up in the axle which can lead to wheel oil seal problems.

DISASSEMBLY AND ASSEMBLY (Continued)

6. Using Slide Hammer T50T-100-A and Axle Wheel Bearing Puller T83T-1225-A or their equivalents insert into the bore as shown and position it behind the bearing so the tangs on the tool engage the bearing outer race. Remove the bearing and seal as a unit, using the slide hammer tool.



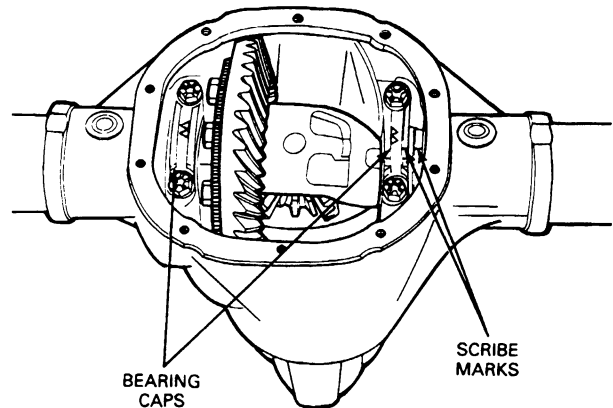
E4712-E

Differential Case Removal

NOTE: Before removing the differential case, check the ring gear runout as described in the Cleaning and Inspection portion of this section. If ring gear runout exceeds 0.10mm (0.004 inch), the differential case and ring gear must be removed to perform the differential runout check. The differential runout check will isolate the cause of excessive ring gear runout.

7. Mark one differential bearing cap to make sure the caps will be installed in their original locations and positions with triangles pointing outboard.

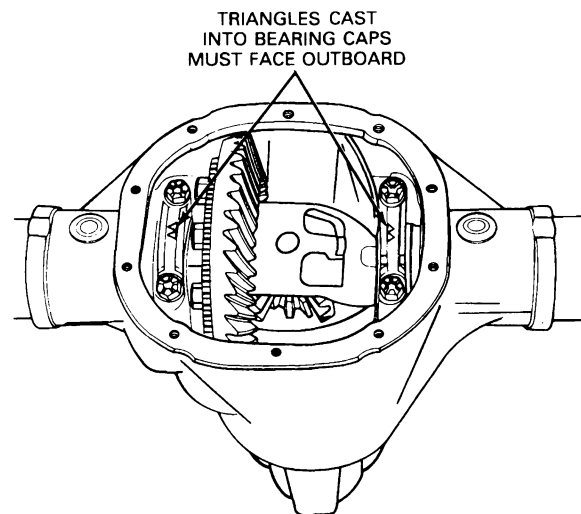
CAUTION: Right and left bearing caps **MUST NOT** be interchanged or rotated.



E4707-1C

8. Loosen the differential bearing cap bolts and bearing caps.

NOTE: The direction and location of triangles on bearing caps must be noted. When reassembled the triangles must be pointing in the same direction (outboard) as before removal.

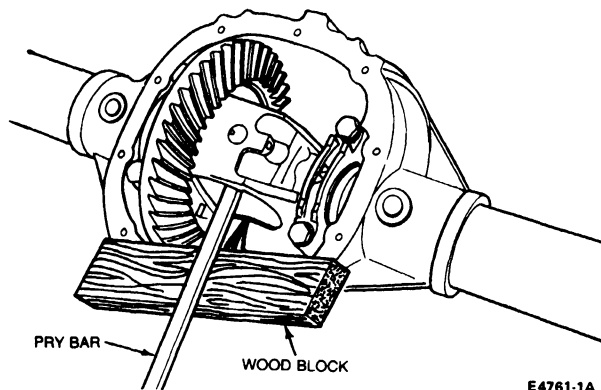


E4763-C

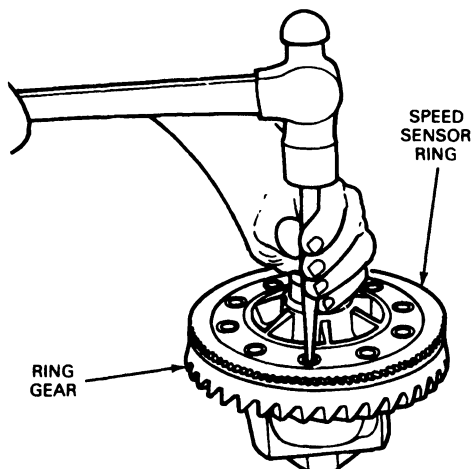
DISASSEMBLY AND ASSEMBLY (Continued)

9. Pry the differential case, bearing cups and shims out until they are loose in the bearing caps. Remove the bearing caps and remove the differential assembly from the carrier.

CAUTION: When using the pry bar, place a wood block between the pry bar and the axle housing to protect the carrier face from damage.

**Ring Gear Removal**

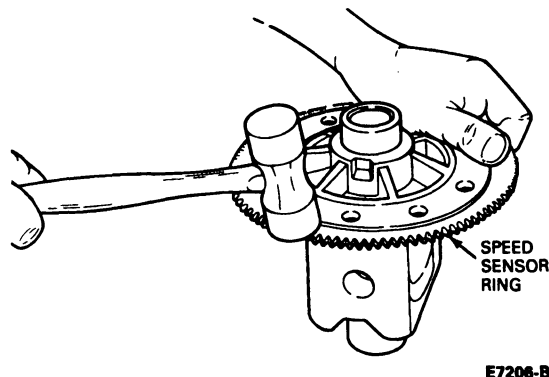
10. Remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case by striking at alternate holes around the gear. Use a punch that is small enough to hit the bottom of the tapped holes and not damage the threads. Use care to prevent damage to ring gear teeth. Support the ring gear while removing the bolts so that the ring gear doesn't fall and nick any tooth.

**Speed Sensor Ring Removal**

11. On vehicles equipped with a speed sensor ring, remove the ring gear bolts. Remove ring gear by striking at alternate holes around the gear. Support the ring gear to prevent nicked teeth.

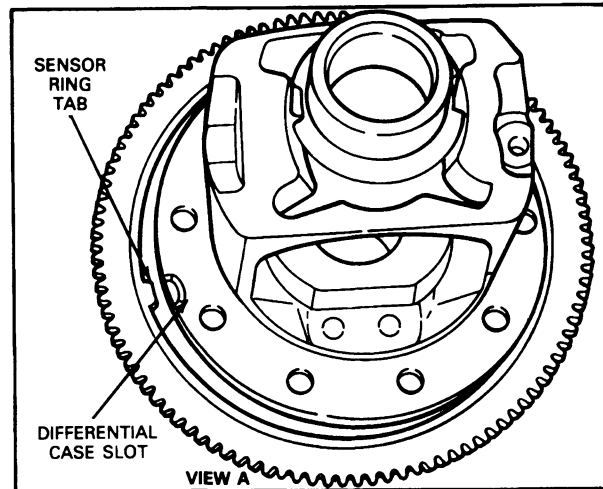
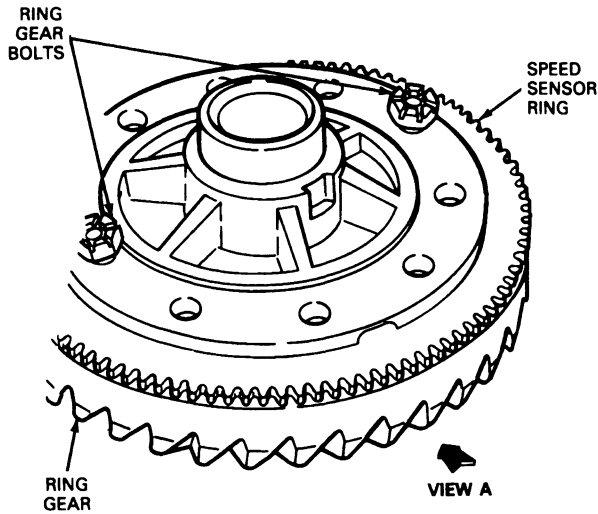
NOTE: The ring gear can be removed and installed without removing the sensor ring.

12. Remove the sensor ring with a soft-faced hammer. Discard sensor ring. **Once removed, the sensor ring cannot be reused. A new sensor must be installed.**

**Speed Sensor Ring Installation**

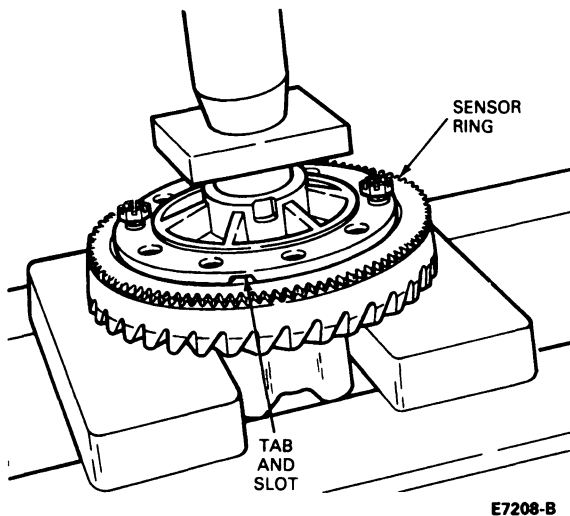
13. Align tab on sensor ring with slot in differential case. Start two ring gear bolts through the case into the ring gear to ensure case to ring gear bolt hole alignment.

CAUTION: Tab on sensor ring **MUST BE** aligned with slot in differential case.

DISASSEMBLY AND ASSEMBLY (Continued)**Speed Sensor Ring Installation**

E7207-B

14. Press the sensor ring on the differential case using the ring gear as a pilot. Apply Stud and Bearing Mount E0AZ-19554-BA (ESE-M4G167-A2) or equivalent to ring gear bolts.
15. Install ring gear bolts and tighten to 95-115 N·m (70-85 ft-lb).

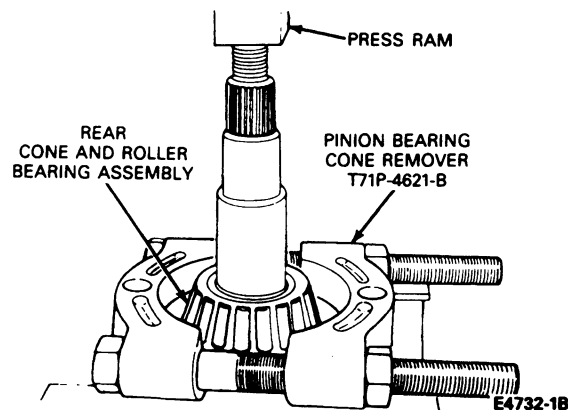
**Drive Pinion Removal**

16. Remove pinion nut, companion flange and pinion seal as described in this section.

17. With a soft-faced hammer, drive the pinion out of the front bearing cone and remove it through the rear of the carrier.

To remove the pinion rear cone and roller bearing assembly, use the Pinion Bearing Cone Remover T71P-4621-B or equivalent as shown.

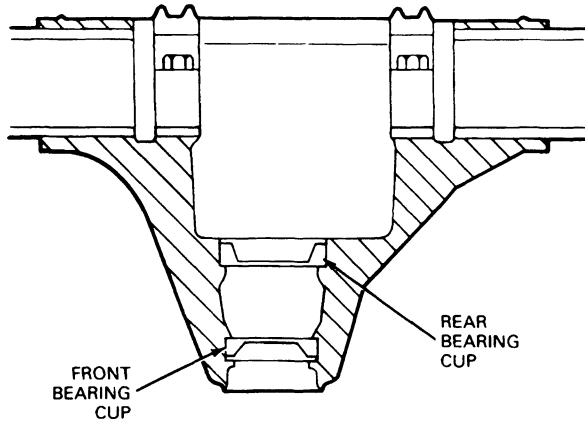
NOTE: Measure the shim, which is found under the bearing cone, with a micrometer and record the thickness (as a reference to be compared to the shim gauge reading prior to installing the bearing).

**Pinion Bearing Cup Removal**

NOTE: Do not remove the pinion bearing cups from the carrier casting unless the cups are damaged.

DISASSEMBLY AND ASSEMBLY (Continued)

18. If the pinion bearing cups are to be replaced, tap alternately (with a brass drift of suitable length) on the opposite side of the cups during removal to prevent cups from cocking in the casting.

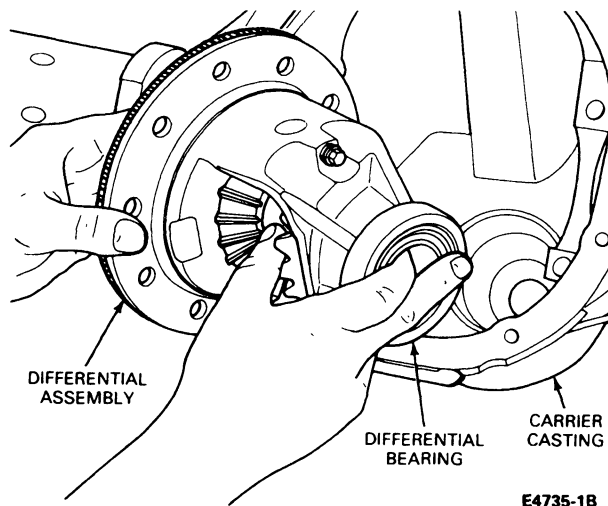


E5112-1B

Differential Runout Check

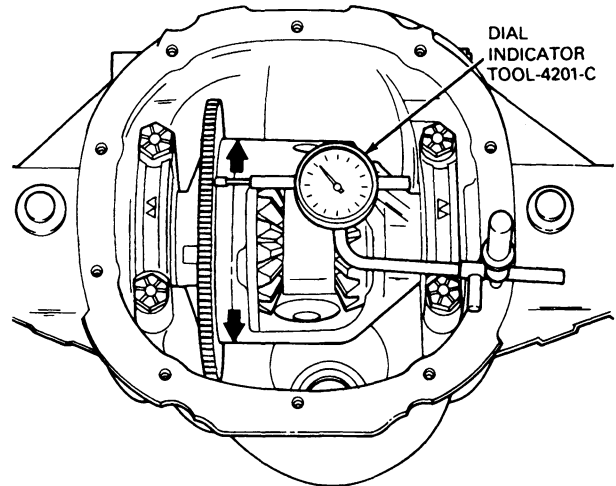
If the ring gear runout check (before disassembly) exceeds specification (0.101mm [0.004 inch]), the condition may be caused by a warped ring gear, a damaged case, excessively worn differential bearings or foreign material between mating surfaces (burrs, shavings, etc.). To determine the cause of excessive runout, proceed as follows:

19. Remove the differential case from the axle housing (refer to Differential Case and Drive Pinion Removal in this section) and remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case with a hammer and drift.
20. Install the differential assembly with the bearing cups and shims. Tighten the bearing cup bolts to 95-115 N-m (70-85 ft-lb).



E4735-1B

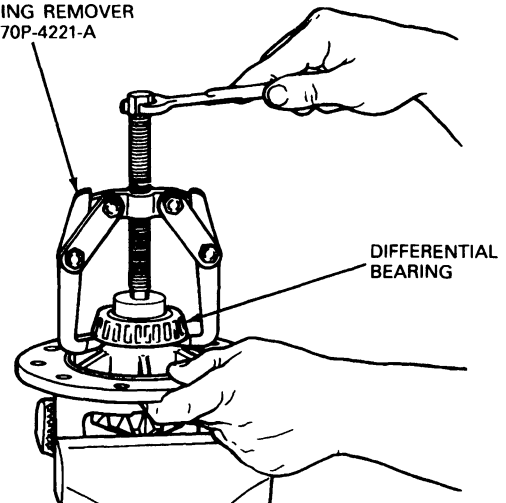
21. Check the runout of the differential case flange with a dial indicator TOOL-4201-C. If the runout is within specification (maximum 0.076mm [0.003 inch]), install a new ring and pinion gear. If the runout exceeds specification, the ring gear is true and the concern is due to either a damaged case or bearings. Visually inspect the bearings. If bearings are not damaged replace both the case and bearings. Recheck the runout with new parts (case and bearings). Visually inspect the speed sensor ring for damage and replace if required.



E4741-1C

22. Remove the differential case from the integral carrier and remove the differential bearings from the case using Differential Side Bearing Remover T70P-4221-A or equivalent.

DIFFERENTIAL SIDE BEARING REMOVER T70P-4221-A

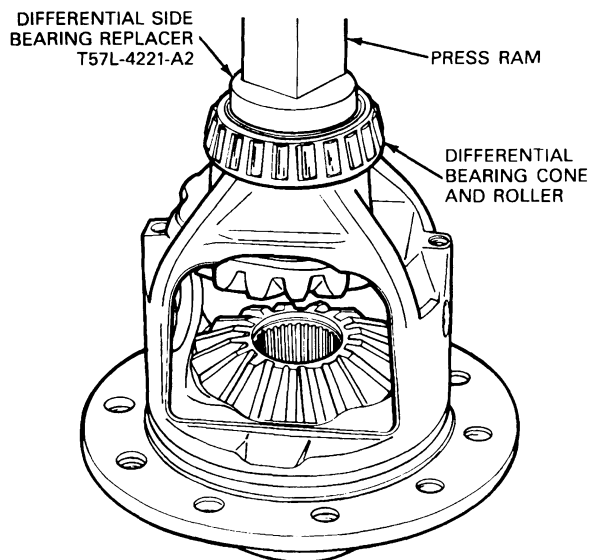


E4742-E

DISASSEMBLY AND ASSEMBLY (Continued)

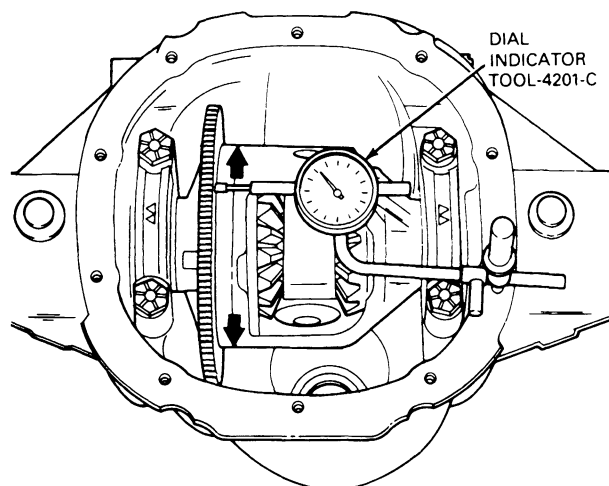
23. Install new differential bearings on the case hubs using Differential Side Bearing Replacer T57L-4221-A2 or equivalent and install the differential assembly in the carrier without the ring gear.

NOTE: Press against the bearing cone only.



E4743-D

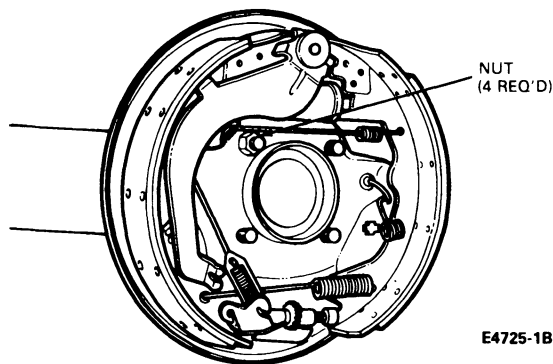
24. Check the case runout again with the new bearings. If the runout is now within 0.076mm (max. 0.003 inch), use the new bearings for assembly. If the runout is still excessive, the differential case is damaged and should be replaced.



E4741-1C

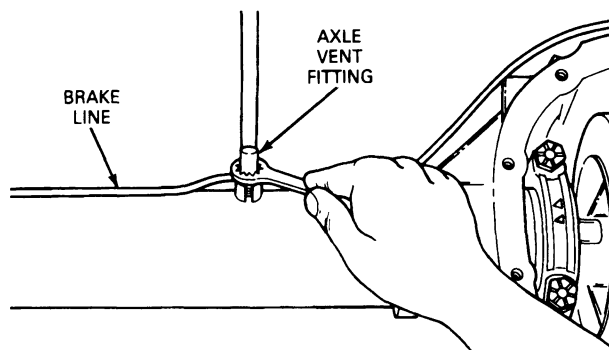
Axle Housing Removal

25. Remove the four retaining nuts from each backing plate and wire the backing plate to the underbody.



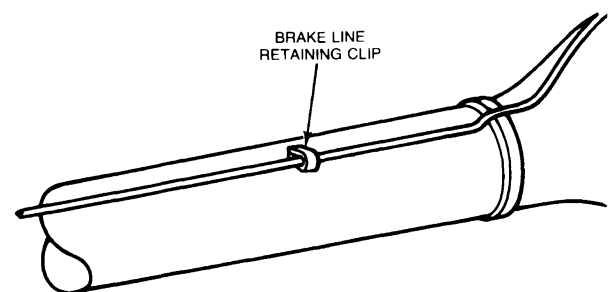
E4725-1B

26. Disconnect the vent hose from the vent fitting and the fitting from the rear axle housing.



E4726-1B

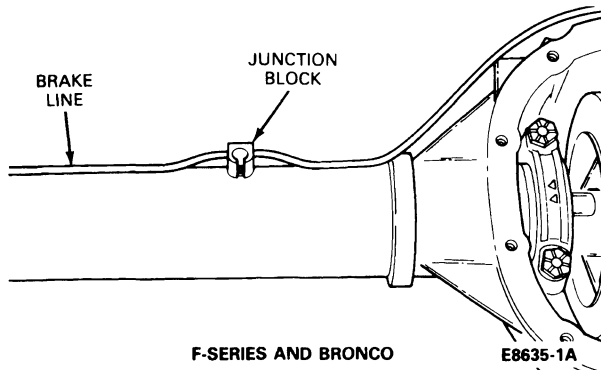
27. Disengage the brake line from the clips that retain the line to the axle housing and carrier.



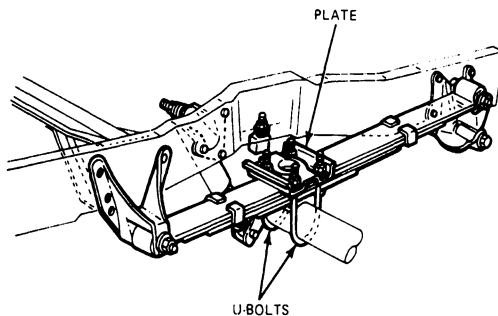
E4728-1A

DISASSEMBLY AND ASSEMBLY (Continued)

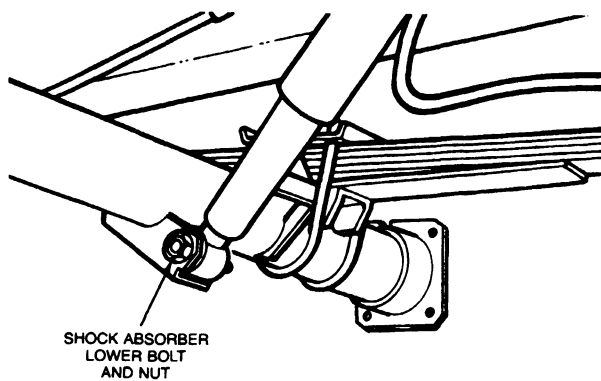
28. Remove the hydraulic brake hose junction block from the axle housing. **Do not open the hydraulic brake system lines.**



29. Support the rear axle housing on a jack, and then remove the U-bolt nuts. Remove the U-bolts and plates.

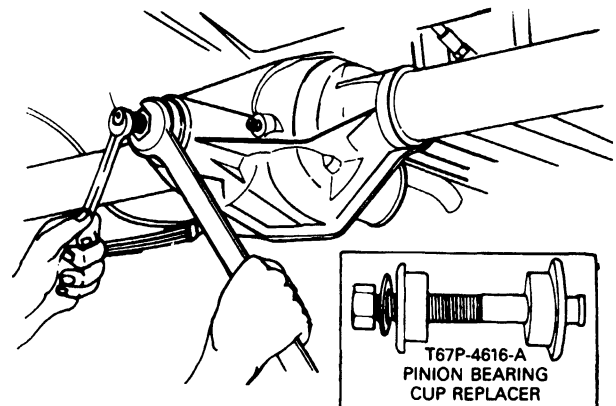


30. Disconnect the shock absorber lower bolts from the mounting brackets on the axle housing.
31. Remove the housing from the vehicle.

**Axle Assembly****Pinion Bearing Cup Installation**

NOTE: Do not remove the pinion bearing cups from the carrier casting unless the cups are damaged.

1. Install the new cups with Pinion Bearing Cup Replacer T67P-4616-A as shown. Make sure the cups are properly seated in their bores. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup is not properly seated. Whenever the cups are replaced, the cone and roller assembly should also be replaced.



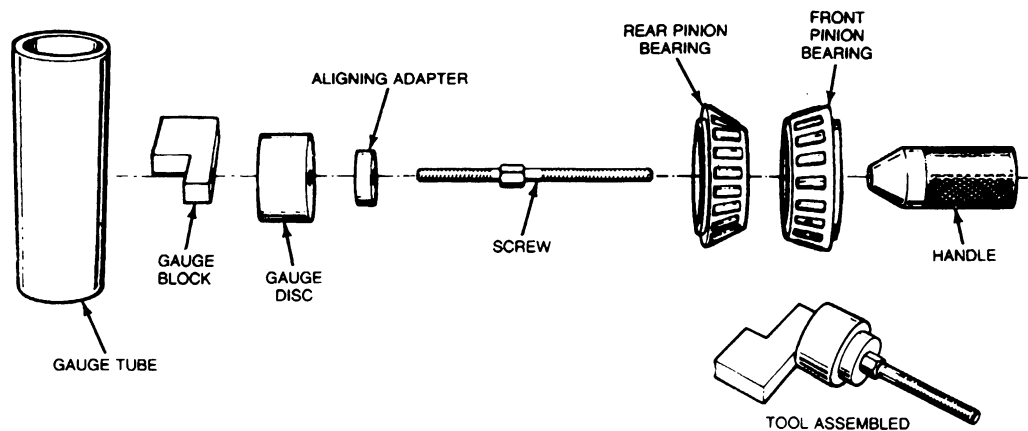
E4733-1B

Drive Pinion Shim Selection

Individual differences in machining the carrier casting and the gear set and variation in bearing widths require a shim between the pinion rear bearing and pinion head, in order to locate the pinion for correct tooth contact with the ring gear.

When replacing a ring and pinion gear, the correct shim thickness for the new gear set to be installed is determined by the following procedure using Pinion Depth Gauge T79P-4020-A.

2. Assemble the appropriate aligning adapter, gauge disc and gauge block to the screw.

DISASSEMBLY AND ASSEMBLY (Continued)**Rear Axle Pinion Depth Gauge Tool****REAR AXLE PINION DEPTH GAUGE TOOL**

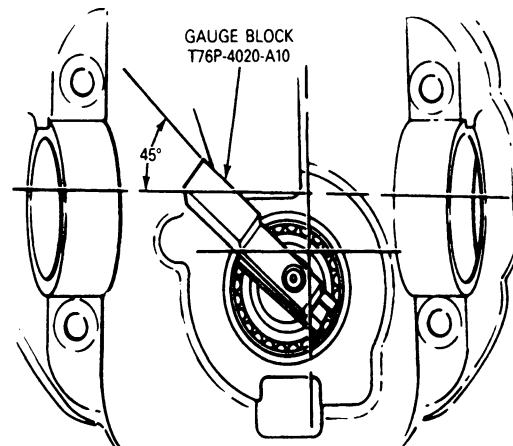
Tool Number*	Description
T76P-4020-A3	Aligning Adapter (1.612" O.D.)
T76P-4020-A9	Screw
T76P-4020-A10	Gauge Block (1.700" thick)
T76P-4020-A11	Handle
T79P-4020-A18	Gauge Disc (1.1884" thick)
T79P-4020-A19	Gauge Tube (3.0630" O.D.)

* The Tool numbers shown in column are part of Tool kit T79P-4020-A.

E4744-2A

- Place the rear pinion bearing (new, or used if in good condition) over the aligning tool and insert it into the rear pinion bearing cup of the carrier. Place the front bearing into the front bearing cup and assemble the tool handle into the screw (refer to illustration in Step 4). Roll the assembly back and forth a few times to seat the bearings while tightening the tool handle by hand. Tighten the tool handle to 27 N·m (20 ft-lb).

NOTE: The gauge block must be offset 45 degrees to obtain an accurate reading.



E4745-1B

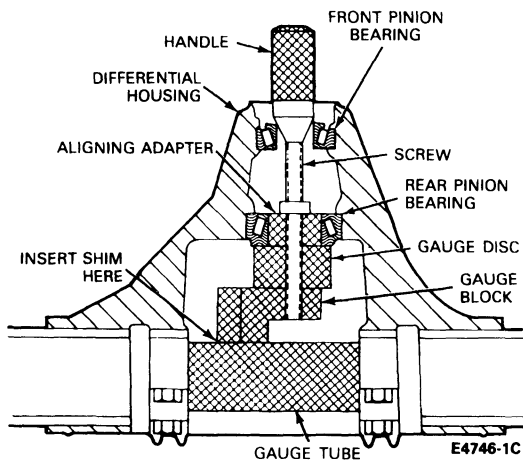
DISASSEMBLY AND ASSEMBLY (Continued)

4. Center the gauge tube into the differential bearing bore. Install the bearing caps and tighten the bolts to 95-115 N·m (70-85 ft-lb). (Caps are to be installed with the triangles pointing outboard.)

Utilize pinion shims as the gauge for shim selection. This will minimize errors in attempting to stack feeler gauge stock together or simple addition errors in calculating correct shim thickness.

NOTE: Shims must be flat. Do not use dirty, bent, nicked or mutilated shims as a gauge.

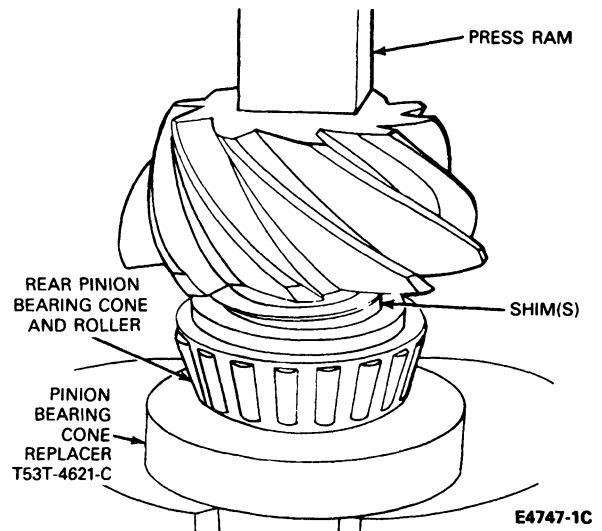
It is important to feel a slight drag on the shim for correct selection. Do not attempt to force the shim between the gauge block and the gauge tube. This will minimize selection of a shim thicker than required, which results in a deep tooth contact in final assembly of integral axles.



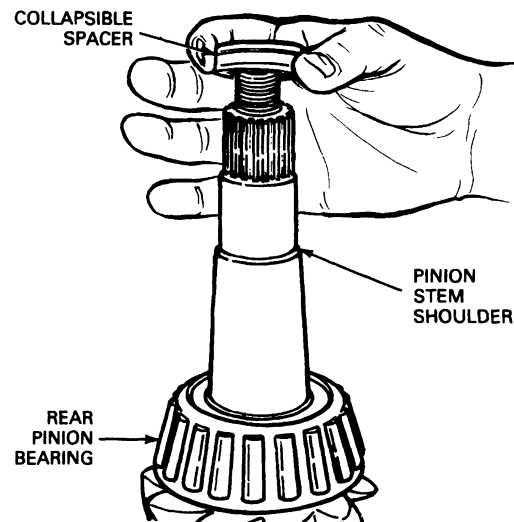
5. Place the selected shim(s) on the pinion and press the pinion bearing cone and roller assembly until it is firmly seated on the shaft.

NOTE: The same rear pinion bearing used in this procedure must be used in final assembly of the axle.

NOTE: Be sure that press load is not applied to the bearing cage.

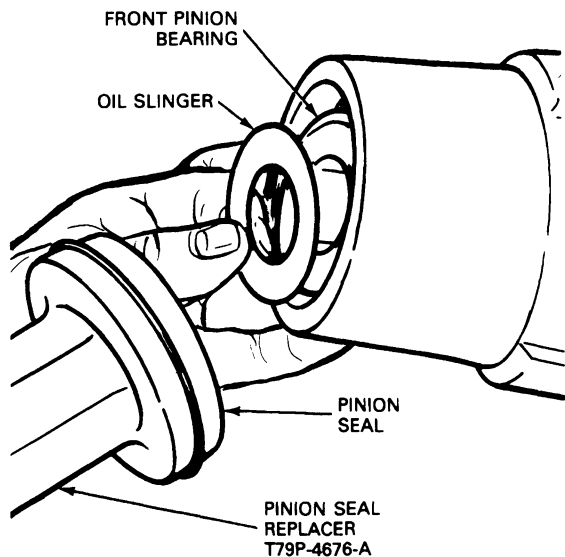


6. Check splines on the pinion shaft to be sure they are free of burrs. If burrs are evident, remove them by using a fine crocus cloth. Wipe the pinion clean.
7. Place new collapsible spacer on the pinion shaft against the pinion stem shoulder.



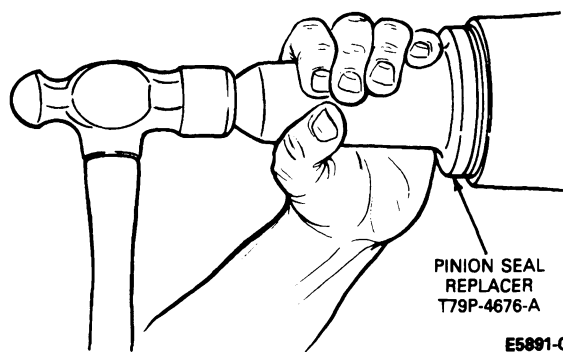
DISASSEMBLY AND ASSEMBLY (Continued)

8. Install the front pinion bearing and oil slinger in the housing bore and install the pinion seal on the Pinion Seal Replacer T83T-4676-A.



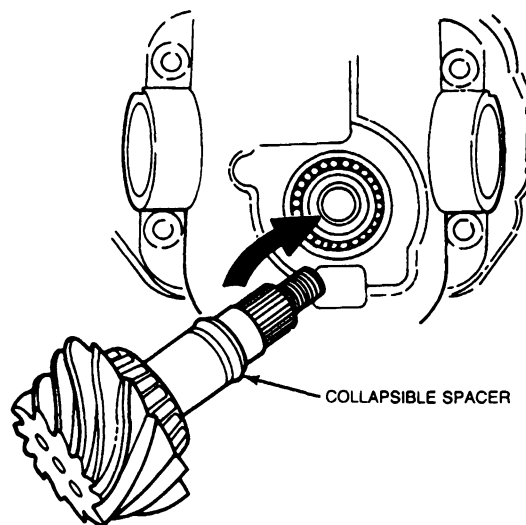
E5876-C

9. Clean the oil seal seat surface. Install the seal in the housing bore using Pinion Seal Replacer T83T-4676-A. Coat the lips of the seal with Premium Long-Life Grease XG-1-C or (ESA-M1C75-B) or equivalent.
- CAUTION:** Installation without the proper tool may result in early seal failure. If seal becomes cocked during installation, remove it and install new one.



E5891-C

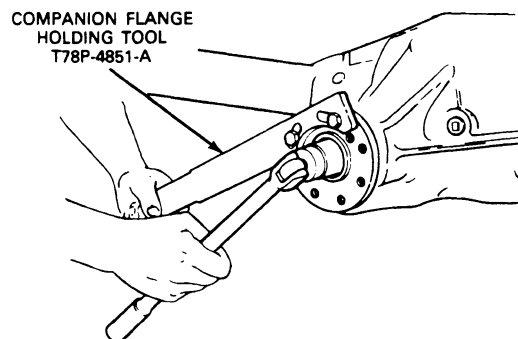
10. From the rear of the axle housing, install the drive pinion assembly (drive pinion, shim(s), rear bearing cone and roller, and collapsible spacer) into the housing pinion bore.



E4748-1A

Companion Flange Installation

11. Apply a small amount of lubricant to the companion shaft splines.
12. Align the mark on the companion flange with the mark on the pinion shaft. Install the flange using Companion Flange Replacer TOOL-4858-E or equivalent.
13. Install a new pinion nut on the pinion stem.
- NOTE:** If a new companion flange is being installed, disregard the scribe mark on the pinion shaft.
- NOTE:** The companion flange must never be hammered on or installed with power tools.
14. Hold the circular companion flange with Companion Flange Holding Tool T78P-4851-A or equivalent while tightening the pinion nut (see Step 15).



E4890-D

DISASSEMBLY AND ASSEMBLY (Continued)

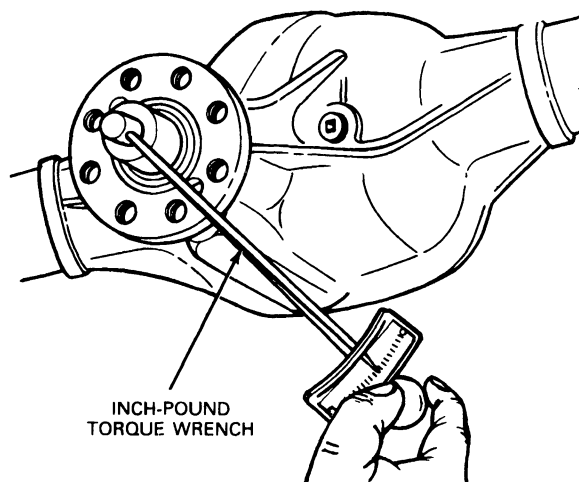
15. Tighten the pinion nut, rotating the pinion occasionally to make sure bearings seat properly. Take frequent drive pinion bearing torque preload readings until the specified preload reading is obtained.

New Bearings: 1.8-3.3 N·m (16-29 in-lb)

Used Bearings: .9-1.5 N·m (8-14 in-lb)

Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.

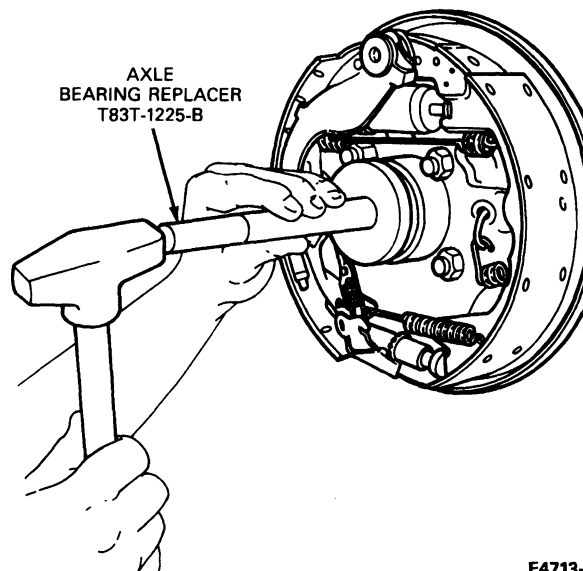
NOTE: A minimum pinion nut tightening torque of 217 N·m (160 ft-lb) must be obtained during tightening.



E4900-E

Wheel Bearing and Oil Seal Installation

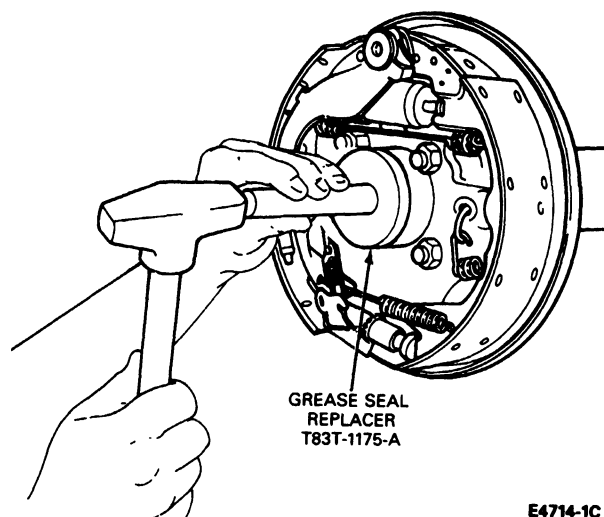
16. Lubricate the new bearing with rear axle lubricant and install the bearing into the housing bore using Axle Bearing Replacer T83T-1225-B or equivalent.



E4713-D

17. Coat the lips of the seal with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent and install the axle shaft seal using Hub Seal Installer T83T-1175-B.

CAUTION: Installation of the bearing or seal assembly without the proper tool may result in a bearing or seal failure. If seal becomes cocked in the bore during installation, remove it and install a new one.

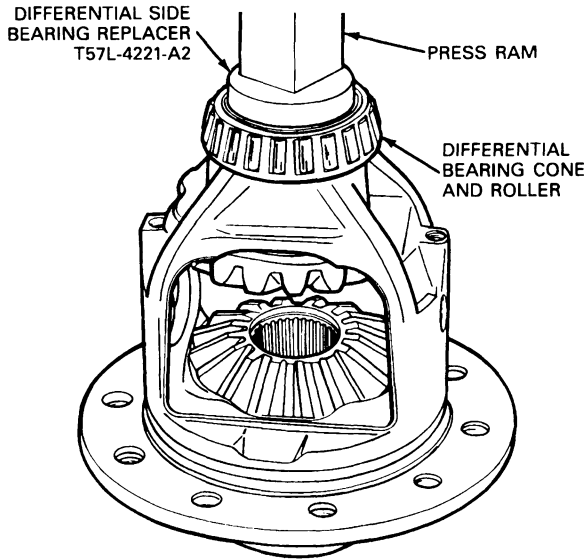


E4714-1C

DISASSEMBLY AND ASSEMBLY (Continued)**Differential Case Installation**

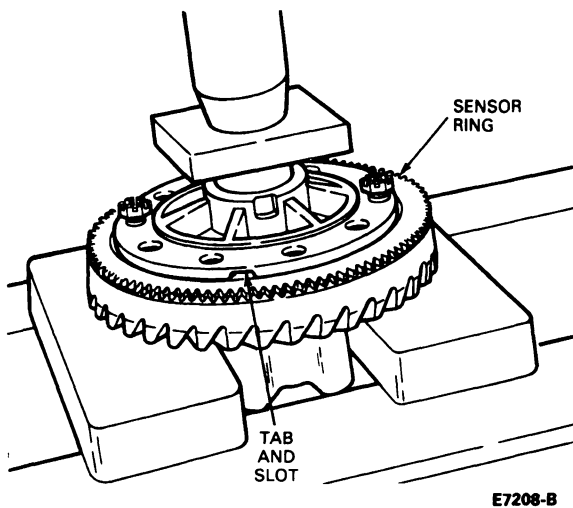
18. Install differential bearings on the case hubs using Differential Side Bearing Replacer T57L-4221-A2 or equivalent.

NOTE: Press against the bearing cone only.



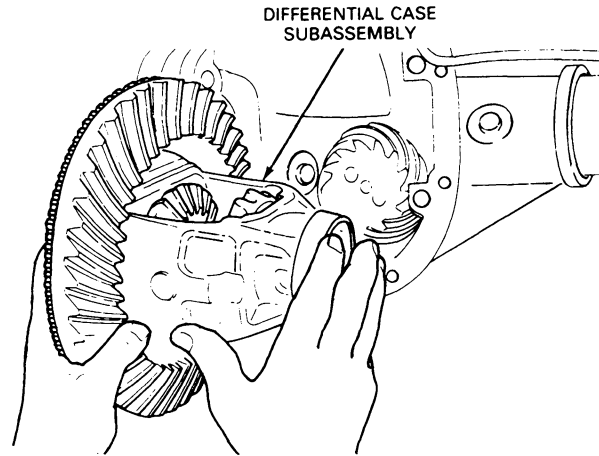
E4743-D

19. Press on the NEW speed sensor ring and ring gear, if removed, onto the differential case. Refer to procedure in this section. Apply Stud and Bearing Mount E0AZ-19554-BA (ESE-M4G167-A2) or equivalent to ring gear bolts and install. Tighten the bolts to 95-115 N·m (70-85 ft·lb).



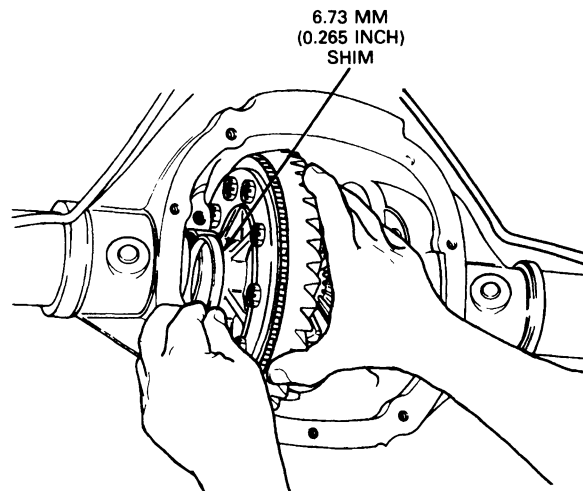
E7208-B

20. With pinion depth set and pinion installed, place differential case subassembly (with ring gear, speed sensor ring, thrust washers, side gears, bearings and cups) in carrier.



E4749-1B

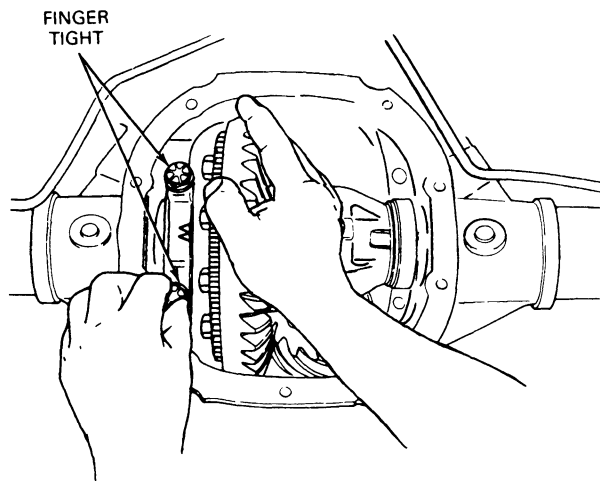
21. Install a 6.73mm (0.265 inch) shim on left side.



E4750-D

DISASSEMBLY AND ASSEMBLY (Continued)

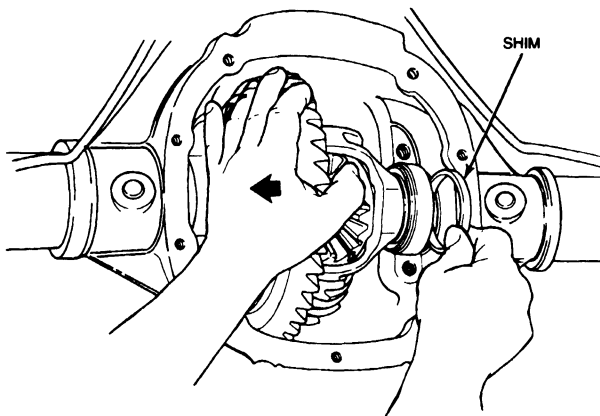
22. Install left bearing cap and tighten bolts finger-tight.



E4751-1B

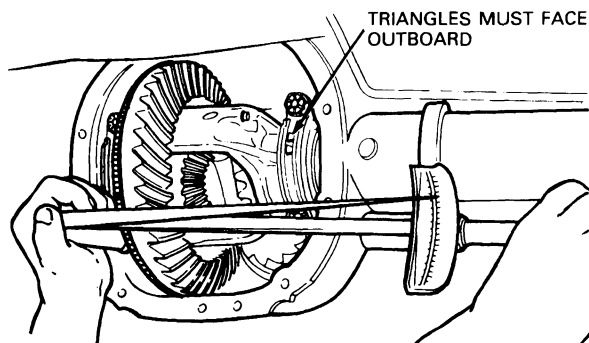
23. Install progressively larger shims on the right side until the largest shim selected can be assembled with a slight drag feel.

NOTE: Apply pressure towards left side to make sure that the left bearing cup is seated.



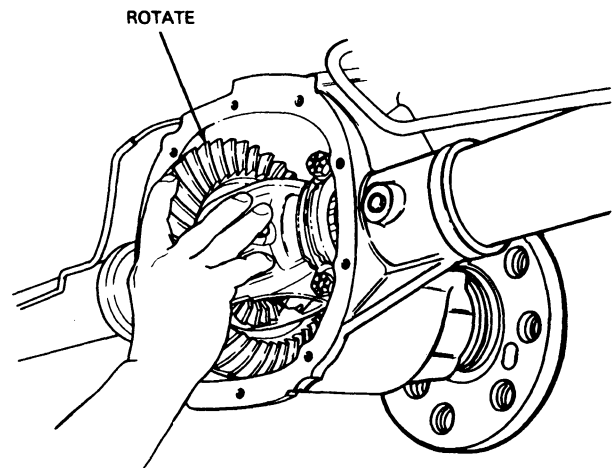
E4752-1A

24. Install right side bearing cap and tighten bearing cap bolts to 95-115 N·m (70-85 ft·lb).



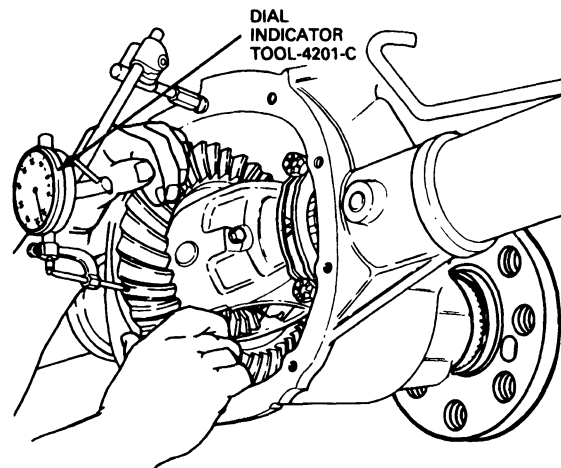
E4753-C

25. Rotate assembly to make sure it rotates freely.



E4754-B

26. Check ring gear and pinion backlash. If backlash is 0.20-0.38mm (0.008-0.015 inch) (0.30-0.38mm [0.012-0.015 inch] preferred) proceed to Step 31. If backlash is zero, go to Step 25. If backlash is not zero, but less than 0.20mm (0.008 inch), or more than 0.38mm (0.015 inch), then go to Step 29.

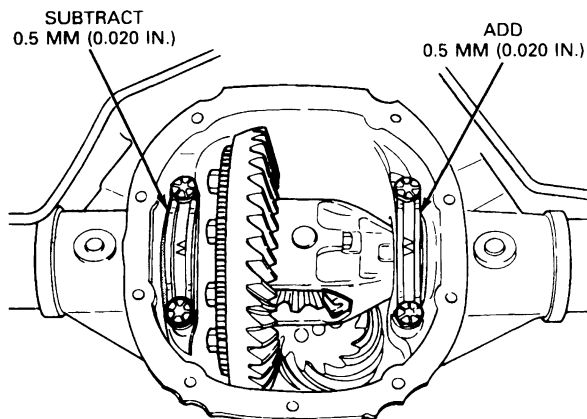


RING GEAR BACKLASH

E4755-E

DISASSEMBLY AND ASSEMBLY (Continued)

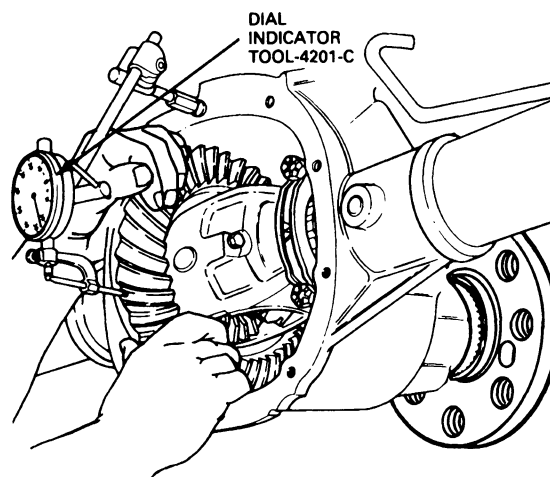
27. If a zero backlash condition occurs, add 0.5mm (0.020 inch) to the right side and subtract 0.5mm (0.020 inch) from the left side to allow for a backlash reading.



E4756-B

28. Recheck backlash. See Step 29 if backlash is not within specification. Backlash specification: 0.20-0.38mm (0.008-0.015 inch) (0.30-0.38mm [0.012-0.015 inch] preferred).

If backlash is within specification, go to Step 30.



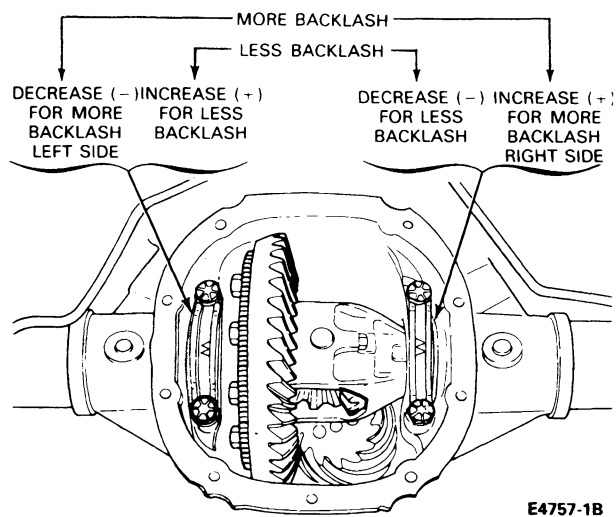
RING GEAR BACKLASH

E4755-E

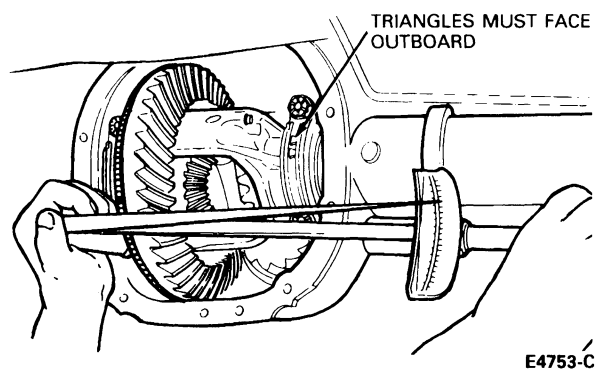
29. If backlash is not to specification, correct backlash by increasing thickness of one shim and decreasing thickness of the other shim by the same amount. Refer to chart for approximate shim change.

Backlash Change Required		Thickness Change Required		Backlash Change Required		Thickness Change Required	
mm	Inches	mm	Inches	mm	Inches	mm	Inches
.025	.001	.050	.002	.228	.009	.304	.012
.050	.002	.050	.002	.254	.010	.355	.014
.076	.003	.101	.004	.279	.011	.355	.014
.101	.004	.152	.006	.304	.012	.406	.016
.127	.005	.152	.006	.330	.013	.457	.018
.152	.006	.203	.008	.355	.014	.457	.018
.178	.007	.254	.010	.381	.015	.508	.020
.203	.008	.254	.010	—	—	—	—

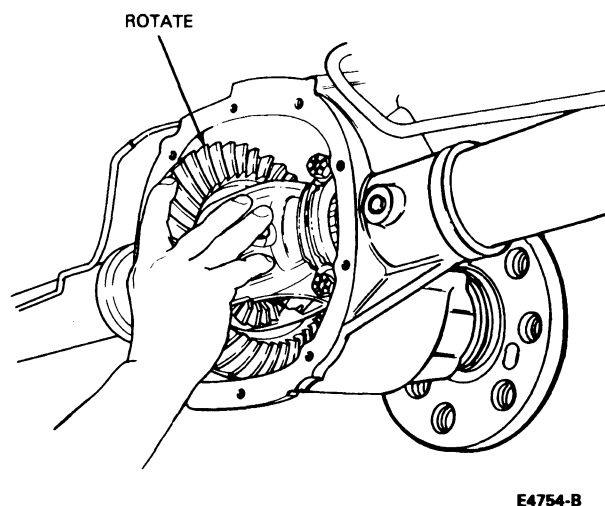
TE5113A

DISASSEMBLY AND ASSEMBLY (Continued)

30. Install shim and bearing caps. Tighten cap bolts to 95-115 N·m (70-85 ft-lb).

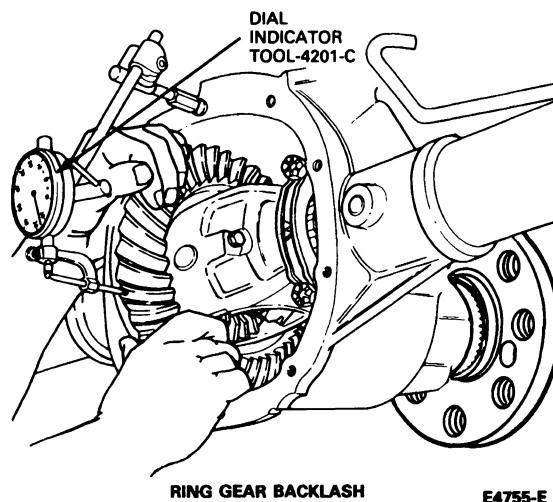


31. Rotate assembly several times to make sure differential bearings seat properly.

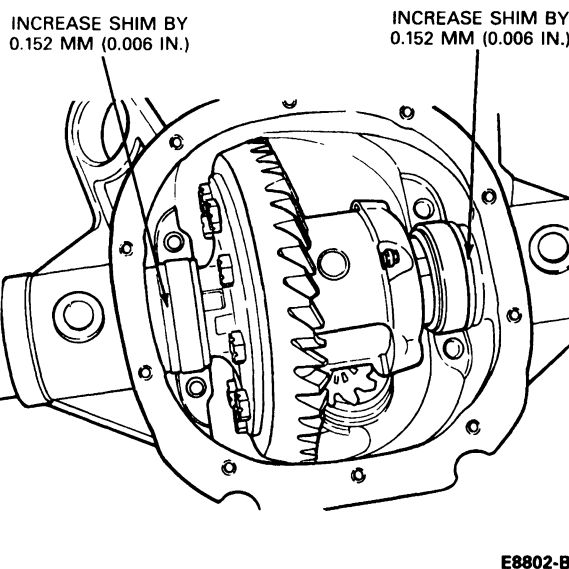


32. Recheck backlash. If backlash is within specification, go to Step 33. If backlash is not within specification, repeat Step 29.

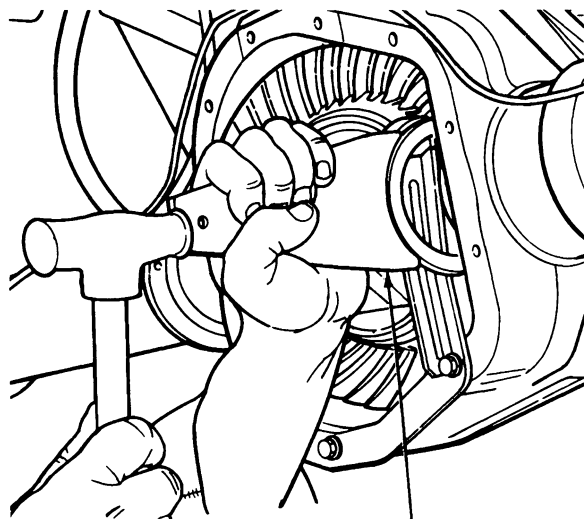
Backlash Specification: 0.20-0.38mm (0.008-0.015 inch) (0.30-0.38mm [0.012-0.015 inch] preferred).



33. Remove bearing caps and bolts. To establish differential bearing preload, increase both left and right shim sizes by 0.152mm (0.006 inch) using Shim Driver T85L-4067-AH or equivalent. Make sure shims are fully seated and assembly turns freely.



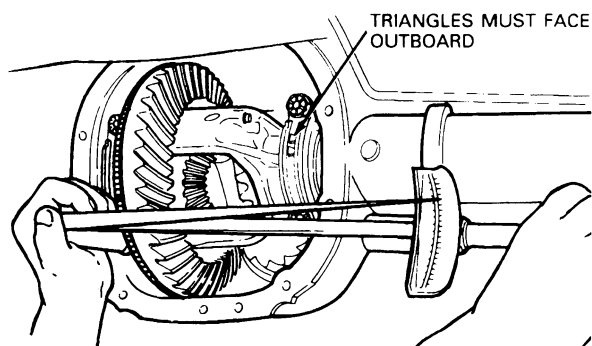
DISASSEMBLY AND ASSEMBLY (Continued)

SHIM DRIVER
T85L-4067-AH

E5900-D

34. Install bearing caps and tighten cap bolts to 95-115 N·m (70-85 ft·lb). Recheck backlash. If not to specification, repeat Step 29.
35. Utilize white marking compound to obtain a tooth mesh contact pattern in your assembly. Pattern legibility can be improved by connecting the driveshaft and rotating both tires in drive and coast direction.

Reincorporation of pattern inspection is intended to allow technician the ability to detect gross errors in set-up prior to complete reassembly. Pattern contact should be within the primary area of the ring gear tooth surface avoiding any "narrow" or "hard" contact with outer perimeter of tooth (top to root, toe to heel). Pattern inspection should be on the drive (pull) side. Assembly with correct drive pattern will result in satisfactory coast performance. If gross pattern error is detected, with preferred backlash (0.30-0.38mm [0.012-0.015 inch]) recheck pinion shim selection. Refer also to Section 15-02K for typical good and unsatisfactory tooth contact patterns.

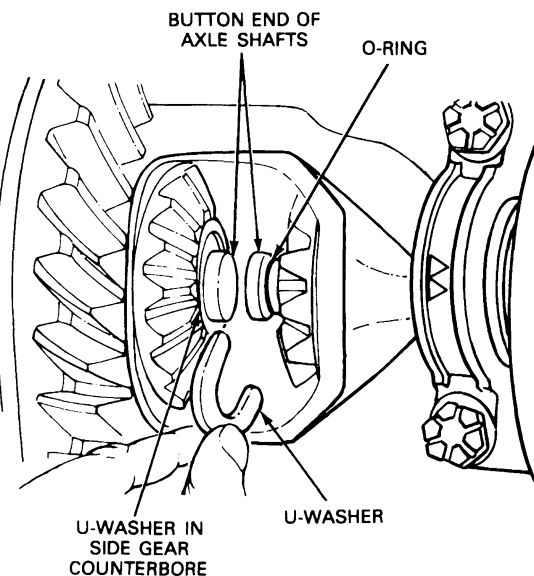


E4753-C

Axle Shaft Installation

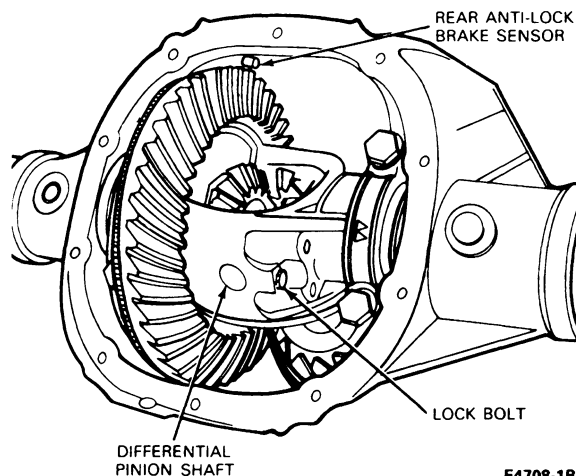
1. Slide the axle shafts into place in the axle housing. Exercise care so that the splines or any portion of the axle shafts do not damage the oil seals. Push the shafts inboard enough to allow installation of the U-washer.
2. Install the axle shaft U-washers on the button end of the axle shafts and pull the shafts outboard so that the shaft lock seats in the counterbore of the differential side gear.

NOTE: A rubber O-ring is used to hold the U-washer in position on the axle shaft. Be sure that the O-ring is in the groove at the button end of the axle shaft before installing the U-washer.



E4709-C

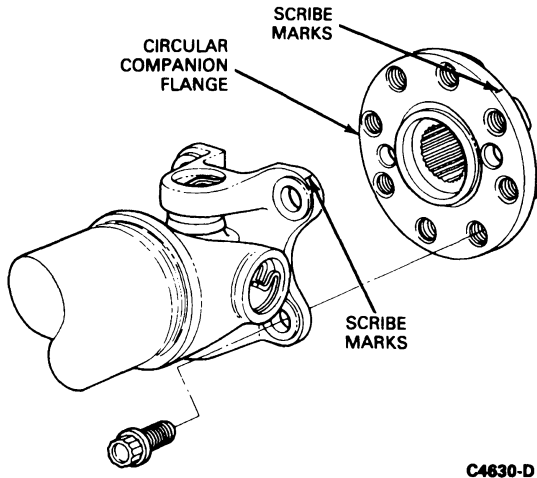
3. Position the differential pinion shaft through the case and pinions, aligning the hole in the shaft with the lock bolt hole. Apply Stud and Bearing Mount E0AZ-19554-BA (ESE-M4G 167-A2) or equivalent to the lock bolt threads. Install lock bolt and tighten to 20-40 N·m (15-30 ft·lb).



E4708-1B

DISASSEMBLY AND ASSEMBLY (Continued)

4. Remove the oil seal replacer from the transmission extension housing. Install the driveshaft in the extension housing. Align the scribe marks on the flange and driveshaft and connect the driveshaft at the axle companion flange. Tighten attaching bolts and nuts to 95-128 N·m (70-95 ft-lb) for circular companion flange.



5. Install the brake drums.

Install the wheels and tires. Tighten the wheel lugnuts to 135 N·m (100 ft-lb). Install the wheel covers.

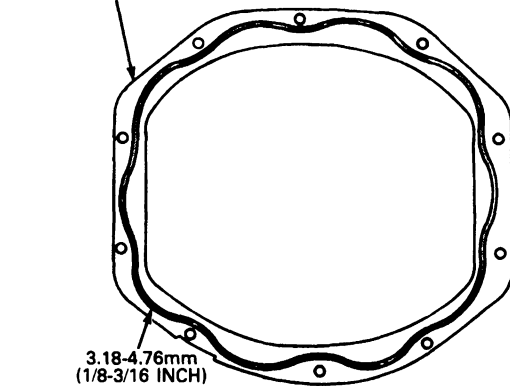
Rear Cover Installation

6. Clean the gasket mating surface of the rear axle carrier casting and cover.

Apply a new continuous bead of Silicone Rubber D6AZ-19562-AA or -BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to the new cover.

CAUTION: Make sure machined surfaces on both cover and carrier are clean and free of oil before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent contamination.

AXLE HOUSING COVER



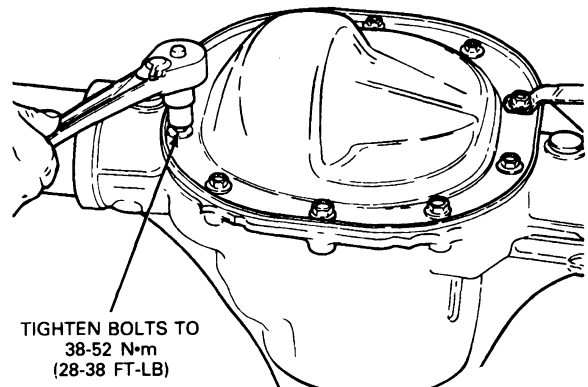
WIDE CONTINUOUS BEAD OF SILICONE RUBBER SEALANT (D6AZ-19562-AA OR BA OR EQUIVALENT).

PARTS MUST BE ASSEMBLED WITHIN 15 MINUTES AFTER APPLICATION OF SEALANT. GASKET SURFACE OF HOUSING AND COVER MUST BE FREE OF OIL.

E8803-A

7. Install cover and tighten cover bolts to 38-52 N·m (28-38 ft-lb) as shown. Tighten the cover bolts in a cross-wise pattern to prevent cover from getting cocked.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied. If time permits, allow one hour before filling with lubricant to make sure silicone sealant has properly cured.

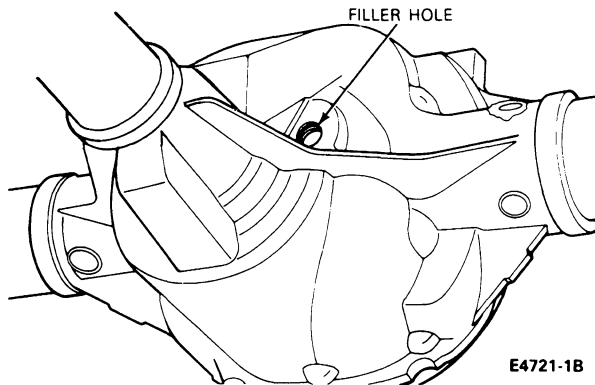


E4711-C

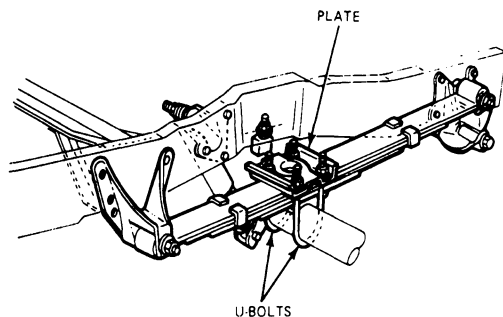
8. Add lubricant through the filler hole until the lubricant level is 1/4 to 9/16 inch below the bottom of the filler hole with the axle in the running position. For axles with conventional differentials, use Rear Axle Lubricant (SAE 90) XY-90-QL or -KL (ESP-M2C154-A) lubricant or equivalent. Install the filler plug and tighten to 20-40 N·m (15-30 ft-lb).

DISASSEMBLY AND ASSEMBLY (Continued)

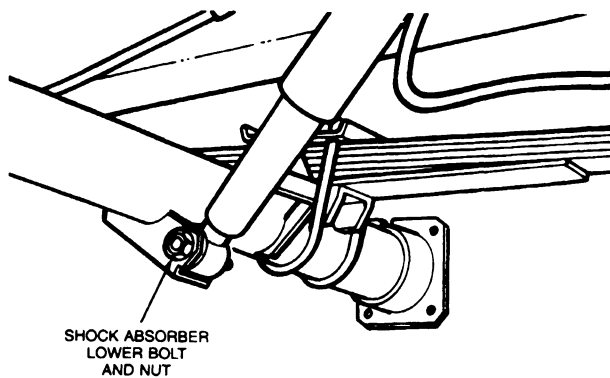
9. Lower vehicle and road test.

**Axle Housing Installation**

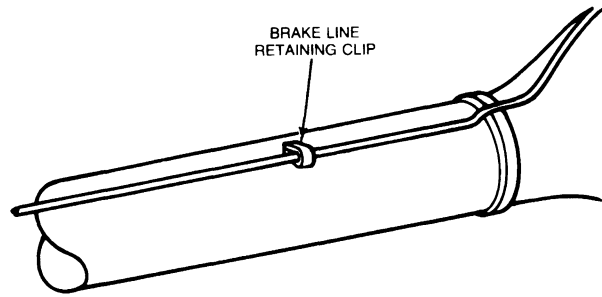
10. Raise the axle housing into position so that the U-bolt plates can be installed. Tighten the U-bolts to the specification listed in Section 04-02. (There are different specifications, depending on the vehicle.)



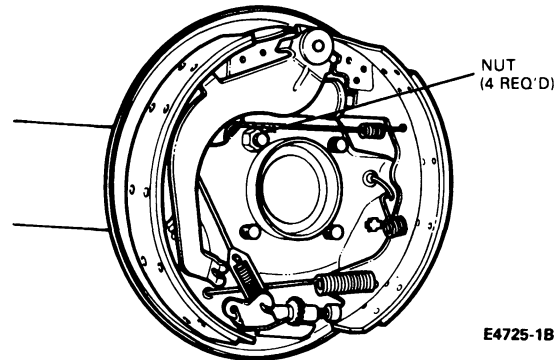
11. Connect the shock absorber lower bolts to the mounting bracket on the axle housing. Install the attaching nuts and tighten to the specification listed in Section 04-02.



12. Insert the vent fitting into the hydraulic junction block and position the assembly over the housing vent hole. Hand start the vent fitting and tighten.



13. Position the brake lines to the axle housing and secure with the retaining clips at the right hand axle tube and vent fitting through the junction block.
14. Install the brake backing plates on the axle housing flanges (no gaskets required). Tighten the attaching nuts to 28-54 N·m (20-40 ft·lb).

**Rear Anti-lock Brake System Sensor****Removal**

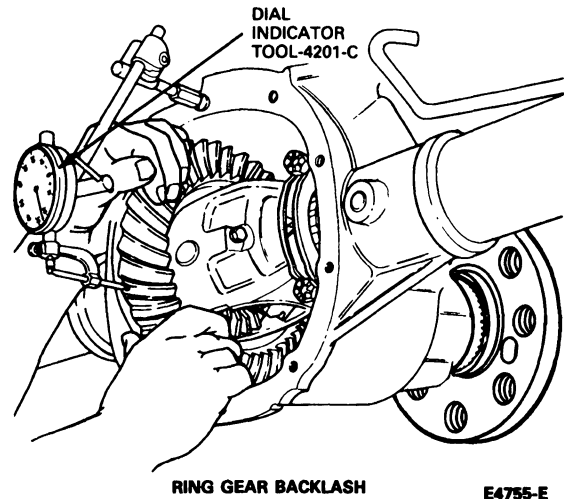
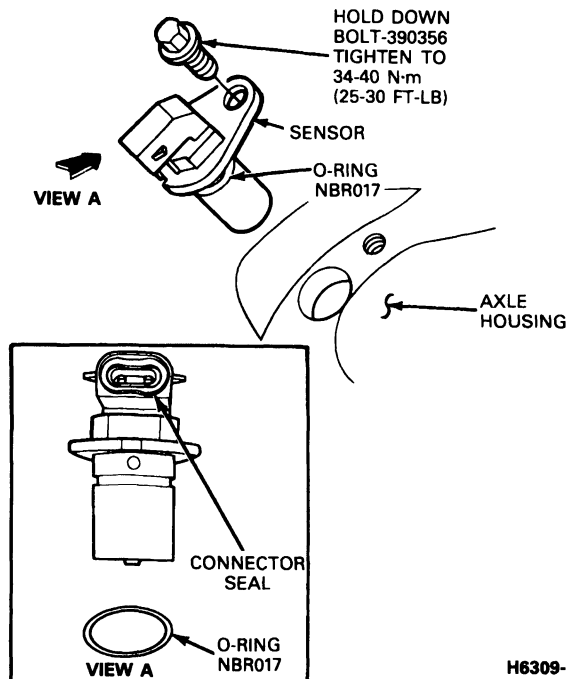
1. Remove sensor hold down bolt. Remove sensor.
2. Clean axle mounting surface, using caution to prevent dirt from entering axle housing.
3. Observe if axle lubricant has leaked up through core or around perimeter of sensor O-ring. Discard if leakage is present.

Installation

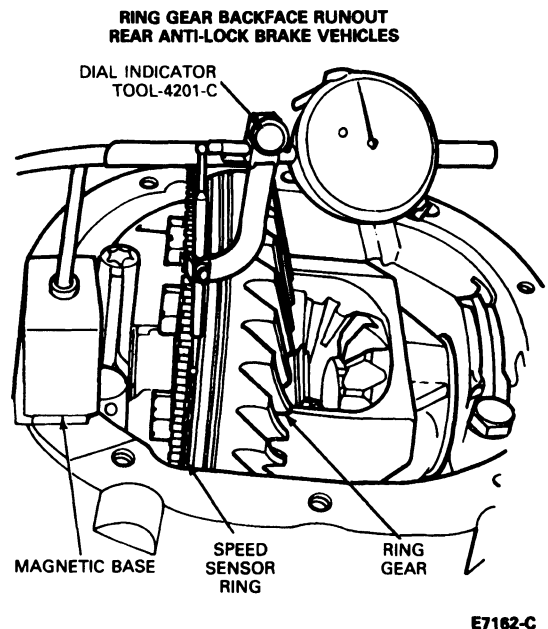
1. If new sensor is to be installed, lightly lubricate O-ring with motor oil.
 - a. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
 - b. Install hold down bolt and tighten to 34-41 N·m (25-30 ft·lb).

DISASSEMBLY AND ASSEMBLY (Continued)

2. If old sensor is to be reinstalled, clean and blow off metal particles using shop air.
 - a. Remove and replace O-ring with a new O-ring.
 - b. Apply a light film of motor oil to O-ring.
 - c. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
 - d. Install hold down bolt and tighten to 34-41 N·m (25-30 ft-lb).



4. Set up a dial indicator and check ring gear backlash and ring gear backface runout. Backlash should be 0.20-0.38mm (0.008-0.015 inch) (0.30-0.38mm [0.012-0.015 inch] preferred).

**CLEANING AND INSPECTION****Inspection Before Disassembly**

The differential case assembly and drive pinion should be inspected before they are removed from the carrier. These inspections can determine the cause of the concern and the resolution.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to see if there is any roughness which would indicate damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.

5. Check ring gear backface runout. To check ring gear backface runout, mount Dial Indicator with Bracketry TOOL-4201-C or equivalent on the carrier so the tip of the dial indicator contacts the backface of the ring gear. Backface runout should be no more than 0.101mm (0.004 inch).

NOTE: There is a space provided between the excitor ring and the ring gear for measuring ring gear backface runout.

CLEANING AND INSPECTION (Continued)

6. A contact pattern may not always be an acceptable guide to check for noise. However, if the pattern is incorrect, the axle will probably be noisy. Refer to Section 00-04, Noise, Vibration and Harshness Diagnosis, for contact pattern example. Proper gear set assembly must be checked using the Rear Axle Pinion Depth Gauge Tool set which shows the correct pinion shim required to make sure an acceptable running condition is achieved. Refer to Axle Assembly in this section.

Inspection After Disassembly

1. Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air.
2. Oil the bearings immediately to prevent rusting.
3. Inspect the parts for any major damage.
4. Clean the inside of the housing before rebuilding. When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly. Inspection procedures for individual parts are outlined as follows.

Sensor

Inspect the Rear Anti-lock Brake System (RABS) Sensor pole piece (magnetic) for loose metal particles and clean if required.

Speed Sensor Ring

Examine the Rear Anti-lock Brake System (RABS) speed sensor ring to see that it is firmly pressed onto the differential case and check it for dented, chipped or missing teeth that could result in erratic RABS performance. If damage is found, remove and replace speed sensor ring.

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Bearing Cups

Check bearing cups for deep scores, galling, or spalling. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup must be reseated.

Cone and Roller Assemblies

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

Companion Flange

The end of the circular flange that contacts the bearing cone as well as the nut counterbore and seal surface must be smooth and free of nicks.

Carrier Housing

Make sure that the differential and pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

SPECIFICATIONS**TORQUE SPECIFICATIONS (INTEGRAL CARRIER),
CONVENTIONAL**

Description	N-m	Lb-Ft
Differential Bearing Cap Bolt	95-115	70-85
Differential Pinion Shaft Lock Bolt, Using Loctite E0AZ-19554-B (or equivalent)	20-40	15-30
Ring Gear Attaching Bolts, Using Loctite E0AZ-19554-B (or equivalent)	95-115	70-85
Rear Cover Screw	38-52	28-38
Oil Filler Plug	20-40	15-30
Axle Vent	20-34	15-25
Brake Backing Plate Nuts	28-54	20-40
Driveshaft to Axle Circular Companion Flange Attaching Bolts — E-150 and Bronco	95-128	70-95
RABS Sensor Hold-Down Bolt	34-41	25-30

**ADJUSTMENT TORQUE SPECIFICATIONS (INTEGRAL
CARRIER) — CONVENTIONAL**

Description	N-m	Lb-Ft
Approximate torque required to tighten pinion flange nut to obtain correct pinion bearing preload	217	160 ^a
Pinion Bearing Preload		
— Used Bearings	.9-1.5	8-14 In-Lb
— New Bearings	1.8-3.3	16-29 In-Lb

a If pinion bearing preload exceeds specification before this torque is obtained, install a new collapsible spacer.

TE8636A

SPECIFICATIONS (Continued)

CLEARANCE, TOLERANCE AND ADJUSTMENTS
(INTEGRAL CARRIER)

Description	Inches
Maximum Runout of Back Face of Ring Gear	0.004
Maximum Runout of Back Face of Differential Case Flange	0.003
Differential Side Gear Thrust Washer Thickness	0.030-0.032
Differential Pinion Gear Thrust Washer Thickness	0.030-0.032
Nominal Pinion Locating Shim	0.030

(Continued)

CLEARANCE, TOLERANCE AND ADJUSTMENTS
(INTEGRAL CARRIER) (Cont'd)

Description	Inches
Available Pinion Gear Shims in Steps of 0.001 Inch	0.021-0.037
Backlash Between Ring Gear & Pinion Teeth	0.008-0.015 (0.012-0.015 Preferred)
Maximum Backlash Variation Between Teeth	0.004
Maximum Runout of Companion Flange in Assembly	0.012 T.I.R.
Sensor Pole to Top of Sensor Ring Gap	0.005-0.045

TE5118A

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER) — CONVENTIONAL

Vehicle	Engine	Axle	Approximate Lubricant Capacity ^a		
			U.S. Pints	Imperial Pints	Liters
F-150	All	8.8 Inch Ring Gear	5.50 ^b	4.58	2.60
Bronco	All	8.8 Inch Ring Gear	5.50 ^b	4.58	2.60
E-150	All	8.8 Inch Ring Gear	5.50 ^b	4.58	2.60

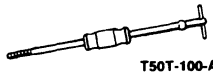
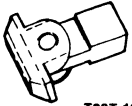


a All conventional and Traction-Lok Axles use Rear Axle Lubricant, XY-90-QL or -KL (ESP-M2C154-A) or equivalent plus 4 ounces of friction modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent for complete refill of Traction-Lok Rear Axles.

b Lubricant levels are determined by filling the axle 1/4 to 9/16 inch below the bottom of the filler hole with vehicle in a level position.



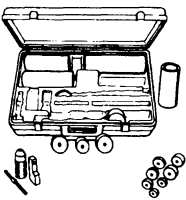
NOTE: Rear axle lube quantities must be replaced every 160,000 km (100,000 miles) or if the axle has been submerged in water. Otherwise, the lube should not be checked or changed unless a leak is suspected or repair required.

TE5120A

SPECIAL SERVICE TOOLS

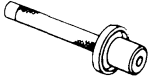
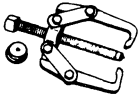


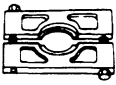
Tool Number/ Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T83T-1225-A Axle Wheel Bearing Puller (Use With Slide Hammer)	 T83T-1225-A
T83T-1175-B Hub Seal Installer	 T83T-1175-B
T83T-1225-B Axle Bearing Replacer	 T83T-1225-B

(Continued)


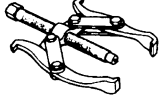
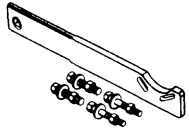

Tool Number/ Description	Illustration
T85L-4067-AH Differential Shim Driver	 T85L-4067-AH
TOOL-4201-C Dial Indicator With Bracketry	 TOOL-4201-C
T79P-4020-A Pinion Depth Gauge	 T79P-4020-A

(Continued)

SPECIAL SERVICE TOOLS (Continued)

Tool Number/ Description	Illustration
T57L-4221-A2 Differential Side Bearing Replacer	 T57L-4221-A2
T70P-4221-A Differential Side Bearing Remover	 T70P-4221-A
T67P-4616-A Pinion Bearing Cup Replacer	 T67P-4616-A
T53T-4621-C Pinion Bearing Cone Replacer	 T53T-4621-C
T71P-4621-B Pinion Bearing Cone Remover	 T71P-4621-B

(Continued)

Tool Number/ Description	Illustration
T83T-4676-A Pinion Seal Replacer	 T83T-4676-A
T77F-4220-B1 Companion Flange Remover	 T77F-4220-B1
T78P-4851-A Companion Flange Holding Tool — Circular Flange	 T78P-4851-A
TOOL-4858-E Companion Flange Replacer	 TOOL-4858-E

SECTION 05-02H Differential, Traction-Lok, Ford 8.8-Inch Ring Gear

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		DIAGNOSIS AND TESTING (Cont'd.)	
Bench Torque Test	05-02H-8	Noise Acceptability	05-02H-3
Clutch Pack Preload Adjustment	05-02H-4	DISASSEMBLY AND ASSEMBLY	
DESCRIPTION AND OPERATION		Differential Case	05-02H-3
Description	05-02H-1	REMOVAL AND INSTALLATION	05-02H-3
Operation	05-02H-2	SPECIAL SERVICE TOOLS	05-02H-9
DIAGNOSIS AND TESTING		SPECIFICATIONS	05-02H-9
Limited-Slip Differential Operation		VEHICLE APPLICATION	05-02H-1
Check	05-02H-3		

VEHICLE APPLICATION

E-150, F-150, and Bronco Vehicles Equipped with 8.8-Inch Ring Gear Axle

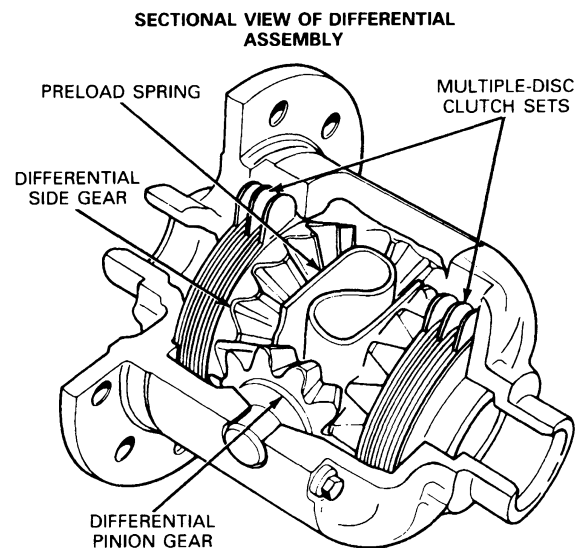
DESCRIPTION AND OPERATION

Description

The Limited-Slip axle assembly is identical to the conventional axle except for the differential case and its internal components.

The Limited-Slip differential employs two sets of multiple-disc clutches to control differential action. The side gear mounting distance is controlled by seven plates on each side: four steel, three friction, and one steel shim. This steel shim is of the selective type to control side gear position.

The plates are stacked on the side gear hub and are housed in the differential case. Also located in the differential case, between the side gears, is a one-piece preload spring, which applies an initial force to the clutch packs. Additional clutch capacity is delivered from the side gear thrust loads. Splined plates are splined to the side gear hubs which, in turn, are splined to the left and right axle shaft. The friction plate ears are keyed to the case so the clutch packs are always engaged.



E4975-D

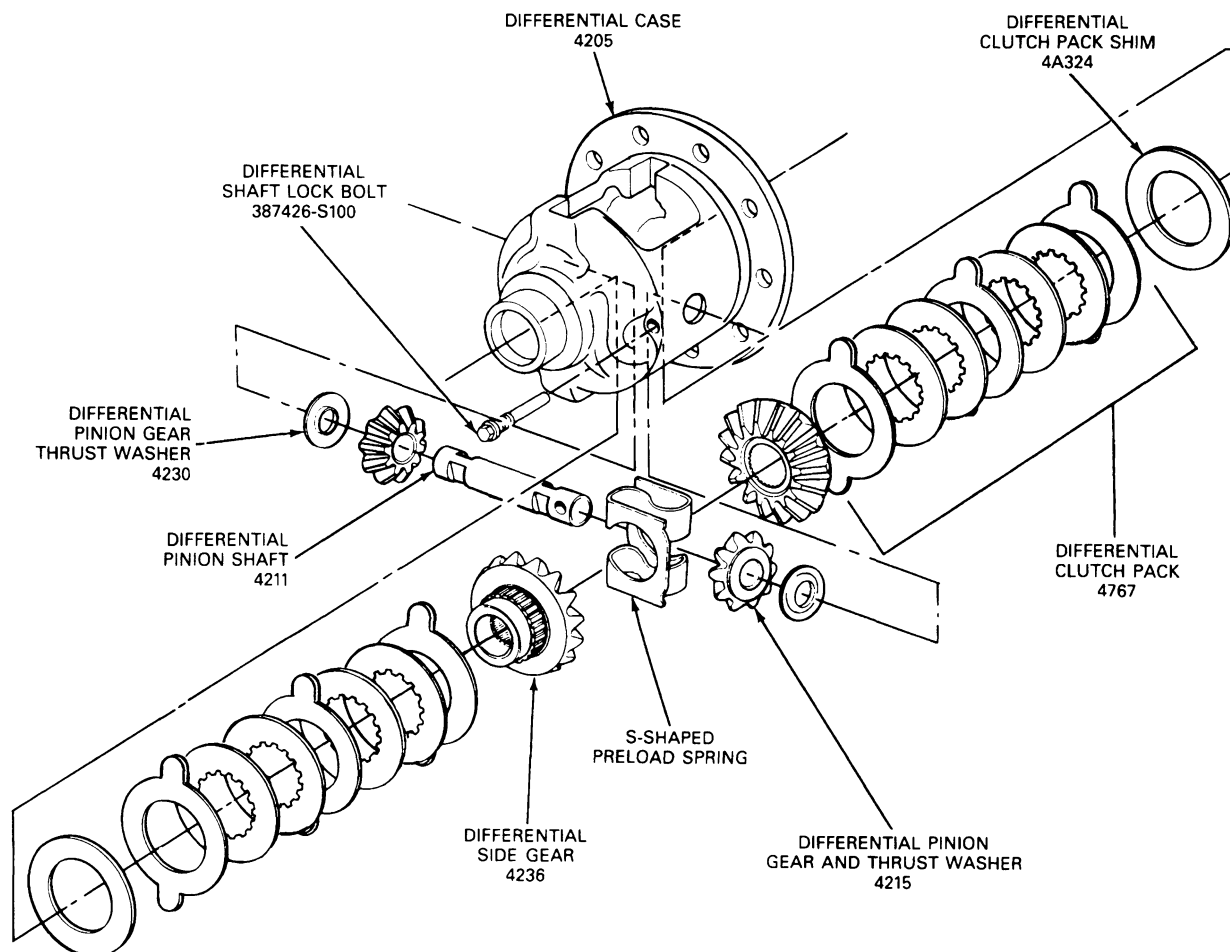
DESCRIPTION AND OPERATION (Continued)

Operation

The pressure between clutch plates opposes differential action at all times. When the vehicle turns a corner, the clutch slips, allowing normal differential action to take place. Under adverse weather conditions, where one or both wheels may be on a low-traction surface such as snow, ice or mud, the friction between the clutch plates will transfer a portion of the usable torque to the wheel with the most traction. Thus, the wheel that is on ice or snow will have a tendency to operate with the opposite wheel in a combined driving effort.

CAUTION: Extended use of other than conventional spare tires on a Traction-Lok rear axle could result in reduction in effectiveness (bias torque). This loss of effectiveness does not affect normal driving and should not be noticeable to the driver. However, extended usage will reduce the ability of the axle to provide added traction on slippery surfaces.

Differential Assembly Components



E5076-F

DIAGNOSIS AND TESTING

Noise Acceptability

A gear-driven unit (especially on a drive axle) will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions. For example, as on a newly paved blacktop road. The slight noise is in no way detrimental to operation of the rear axle and must be considered normal.

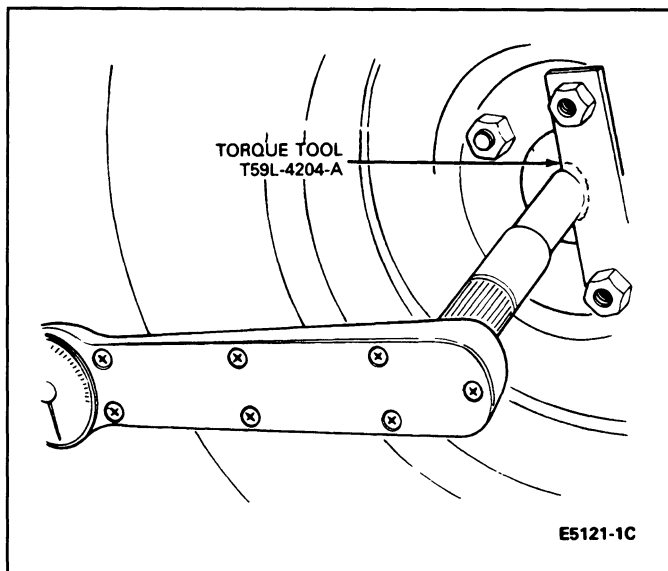
NOTE: Vehicles equipped with a Limited-Slip differential may exhibit a slight stick-slip noise on tight turns after extended highway driving. This is considered acceptable and has no detrimental effect.

Limited-Slip Differential Operation Check

A Limited-Slip differential can be checked for proper operation without removing the differential from the axle housing.

WARNING: A VEHICLE EQUIPPED WITH A LIMITED-SLIP DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. IF, WHILE THE VEHICLE IS BEING SERVICED, ONLY ONE WHEEL IS RAISED OFF THE FLOOR AND THE REAR AXLE IS DRIVEN BY THE ENGINE, THE WHEEL ON THE FLOOR COULD DRIVE THE VEHICLE OFF THE STAND OR JACK.

1. Jack up one rear wheel and remove the wheel cover. Fabricate a torque tool such as Traction-Lok Torque Tool T59L-4204-A and install on the axle shaft flange studs as shown.
2. Using a torque wrench of at least 271 N·m (200 ft-lb) capacity, rotate the axle shaft. Be sure the engine is off and the transmission is in neutral, one rear wheel is on the floor, and the other rear wheel is raised off the floor. The break-away torque required to start rotation should be at least 27 N·m (20 ft-lb). The initial break-away torque may be higher than the continuous turning torque, but this is normal. The axle shaft should turn with even pressure throughout the check without slipping or binding. If the torque reading is less than specified, check the differential for proper assembly.



REMOVAL AND INSTALLATION

Removal and installation procedures for the Limited-Slip differential axle shaft, axle shaft seal and bearing, axle housing and pinion oil seal are the same as those for the Ford truck 8.8-inch ring gear integral carrier axle with a conventional differential. Refer to Section 05-02G for these procedures.

DISASSEMBLY AND ASSEMBLY

Differential Case

Refer to Section 05-02G, Axle Housing Disassembly and Assembly, for the procedures for removing and installing the Limited-Slip differential.

The Limited-Slip differential is removed and installed in the same manner as a conventional differential.

To disassemble and assemble the case, remove and install the ring gear and differential cone and roller assemblies following the procedures used for the conventional differential.

NOTE: It is not necessary to remove the differential bearings from the case journals unless they are damaged. If the bearings remain on the case during repair, keep them clean and free from foreign material.

To remove and install the preload spring, pinion shaft and gears, and clutch packs, follow the procedure under Adjustments in this section.

ADJUSTMENTS

In-vehicle adjustments are possible on this unit without removing the differential case from the axle housing. If the operation check was not to specification, the following procedure can be used to correct the condition:

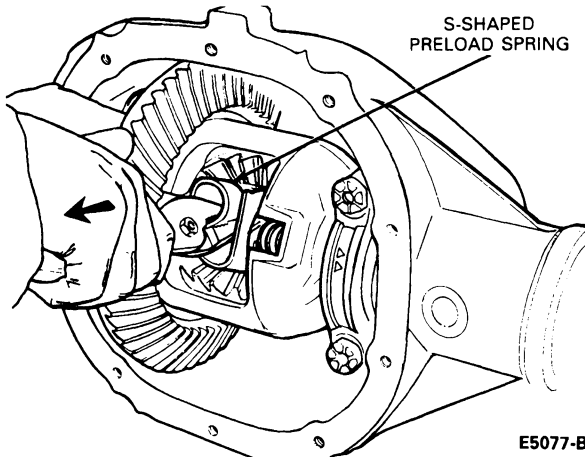
NOTE: Refer to Section 05-02G for speed sensor ring service on anti-lock brake system-equipped vehicles.

ADJUSTMENTS (Continued)**Clutch Pack Preload Adjustment**

NOTE: Before clutch pack preload can be adjusted, the axle shafts must be removed following the procedure in Section 05-02G. The shafts must be removed completely from the housing so that the oil seals will not be damaged. After adjustment, install the shafts following the procedure in Section 05-02G.

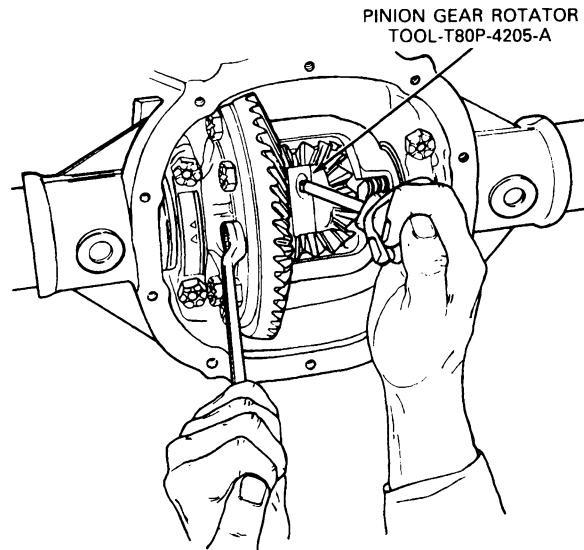
1. With a suitable drift, drive the S-shaped preload spring half-way out of the differential case. Rotate the differential case 180 degrees. Hold the S-shaped preload spring with a pair of pliers and tap the spring until it is removed from the differential.

WARNING: CARE MUST BE USED WHEN REMOVING THE PRELOAD SPRING DUE TO THE SPRING TENSION.



2. Using Gear Rotator T80P-4205-A or equivalent rotate the pinion gears until the gears can be removed from the differential.

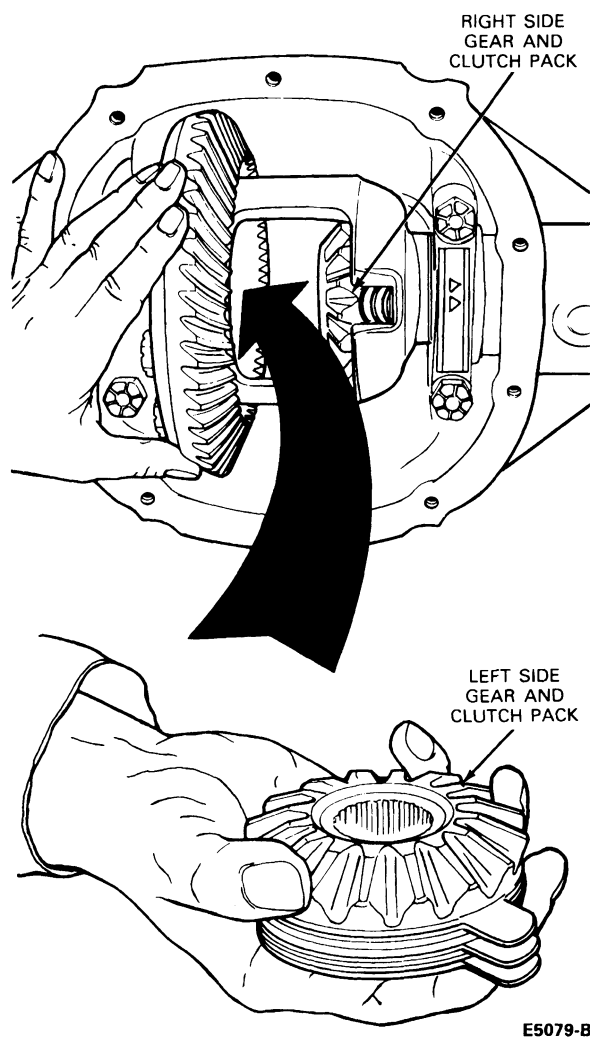
NOTE: A twelve-inch extension is required to remove the pinion gears.



ADJUSTMENTS (Continued)

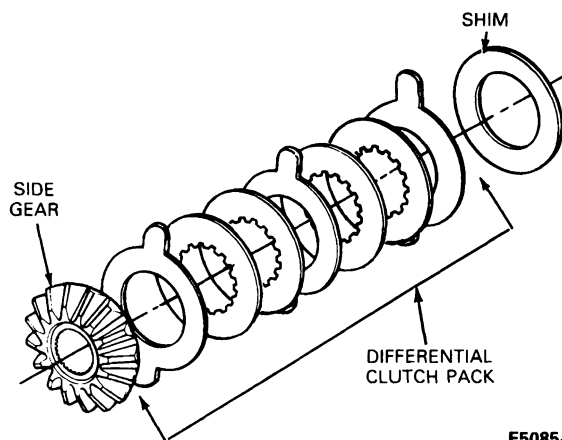
3. Remove the right and left side gear and clutch pack with the shim and tag them "right" and "left". Set them aside until Step 4. Clean and inspect the remaining parts of the differential case assembly for wear or damage. Replace parts as required.

NOTE: Do not mix clutch plates or shims from one side with the other.



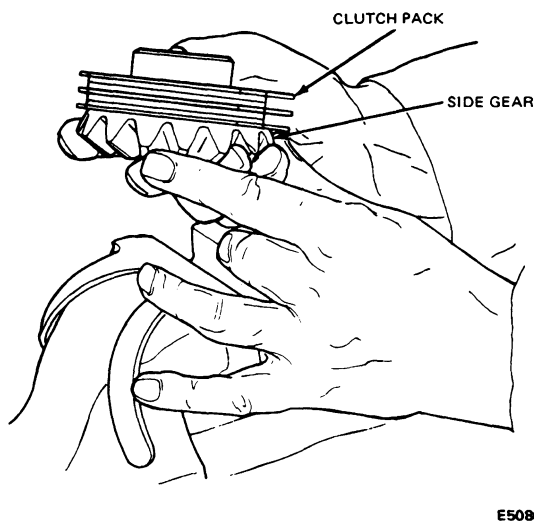
4. Clean and inspect the clutch packs for wear and replace parts as necessary.

NOTE: Do not use acids or solvents when cleaning clutch components. Wipe components with a clean lint-free cloth only.



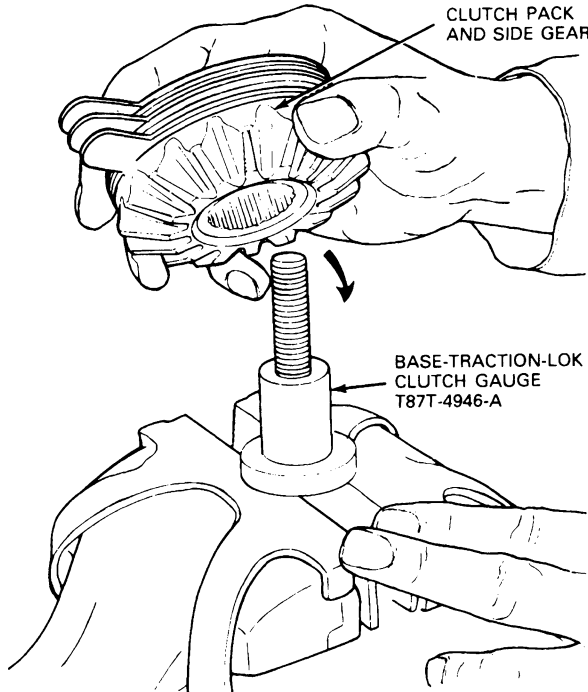
5. Assemble the clutch packs (without shims) on the respective side gears. **Pre-lubricate all coated friction plates with Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent by soaking the plates for 15 minutes.**

NOTE: Do not mix clutch plates or shims from one side with the other.



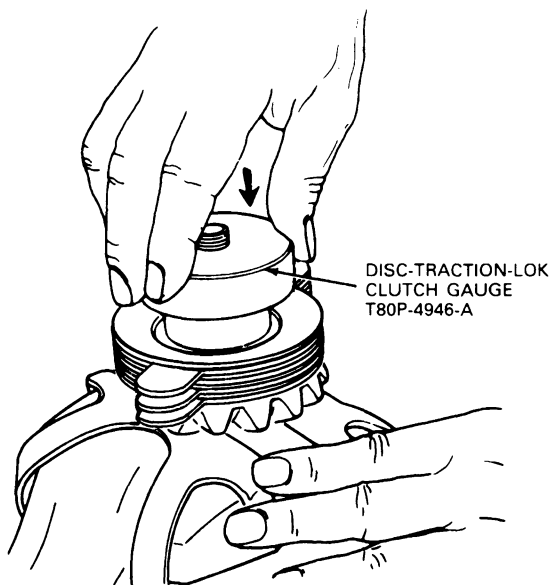
ADJUSTMENTS (Continued)

6. Place the base portion of Traction-Lok Clutch Gauge T87T-4946-A in a vise. Install the clutch pack and side gear (without the differential clutch pack shim) over the base.



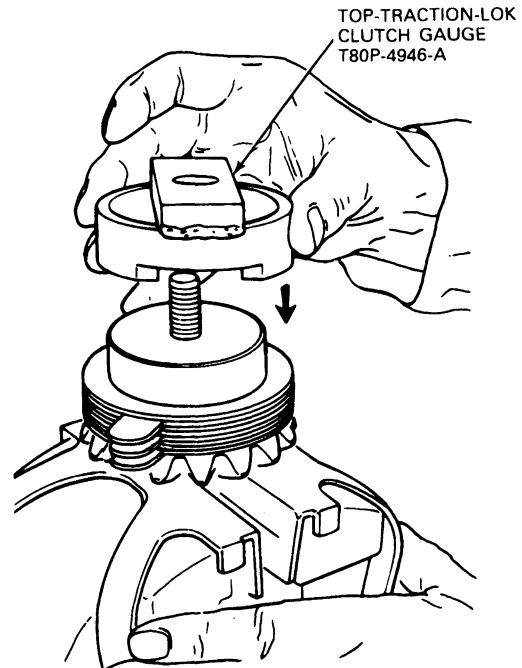
E5723-C

7. Install the disc of Traction-Lok Clutch Gauge T80P-4946-A over the base and on top of the clutch pack.



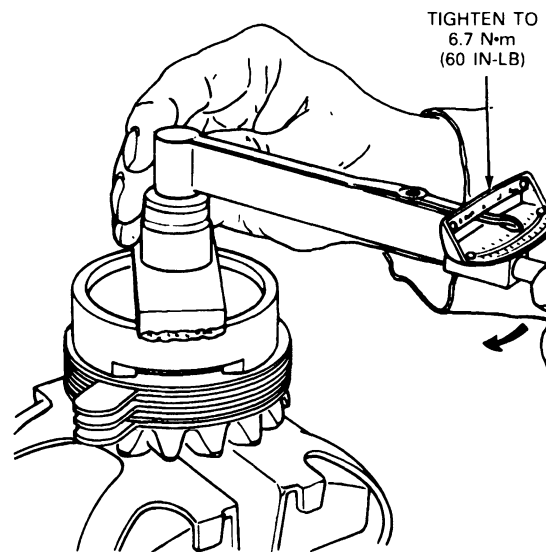
E5724-B

8. Install the top portion of Traction-Lok Clutch Gauge T80P-4946-A over the disc and base stud.



E5725-B

9. Install the nut of Traction-Lok Clutch Gauge T80P-4946-A over the top and base stud. Tighten the nut to 6.7 N·m (60 in-lb).



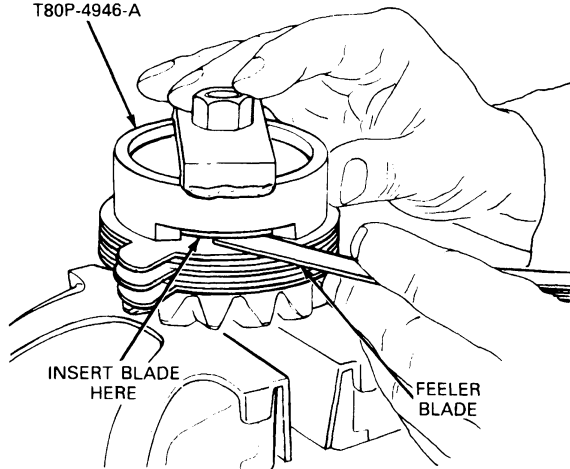
E5726-B

ADJUSTMENTS (Continued)

10. Using a feeler gauge, select the thickest blade that will enter between the tool and the clutch pack. This reading will be the thickness of the new shim.

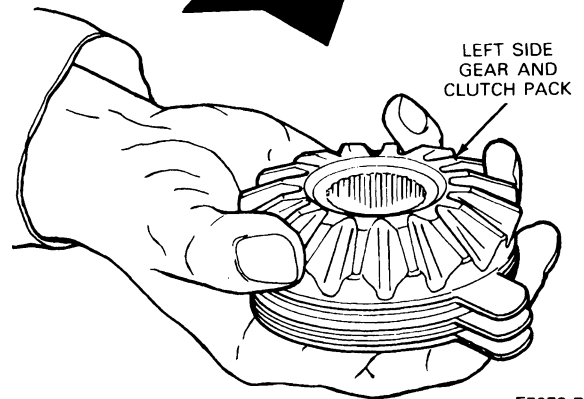
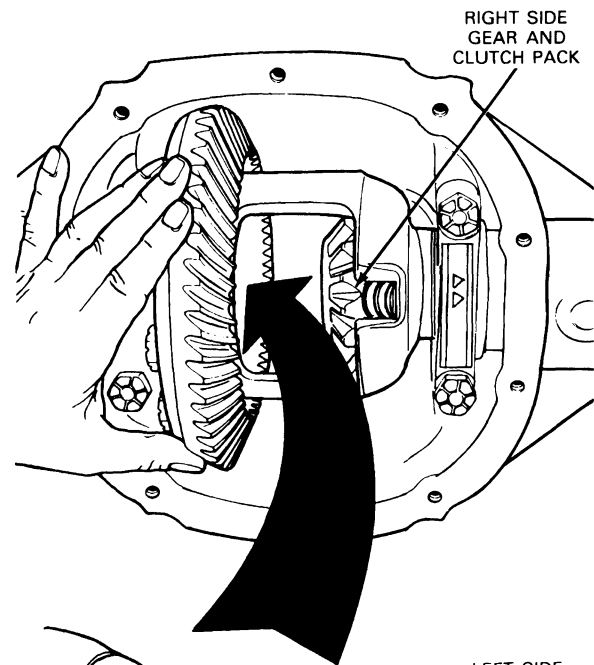
NOTE: Be sure to lubricate friction plates with the proper Additive Friction Modifier C8AZ-19B546-A (EST-M2C 118-A) or equivalent prior to reassembly. Refer to Step 5 of this procedure.

TRACTION-LOK
CLUTCH GAUGE
T80P-4946-A



E5082-C

11. Install the right side-gear, clutch pack and new shim into the cavity in the differential case. Repeat these procedures for the left side.

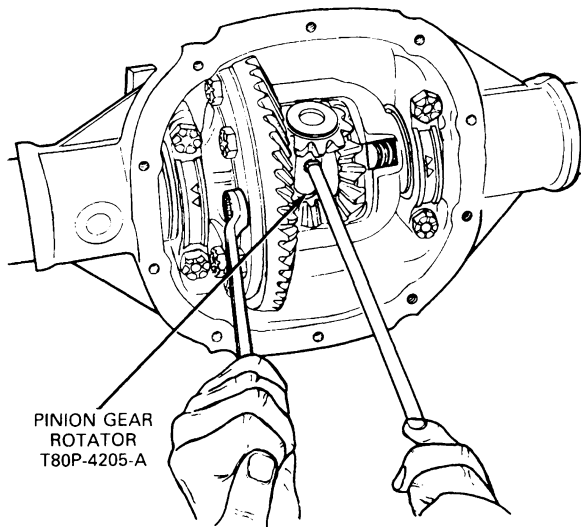


E5079-B

ADJUSTMENTS (Continued)

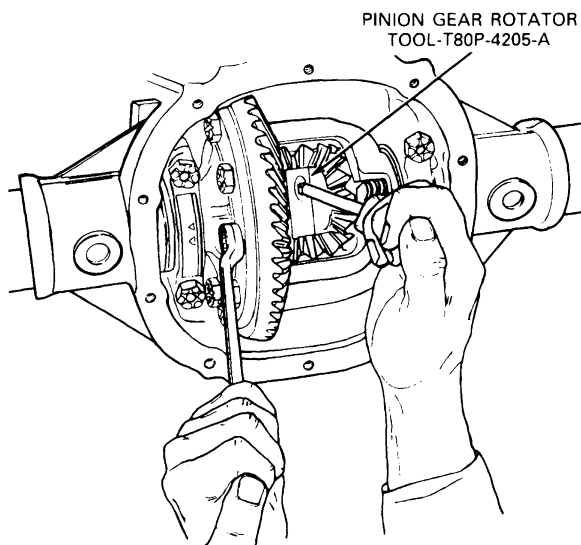
12. Place the pinion gears and thrust washers 180 degrees apart on the side gears. Install Pinion Gear Rotator T80P-4205-A or equivalent as shown.

NOTE: A twelve inch extension is required to install the pinion gears.



E5083-B

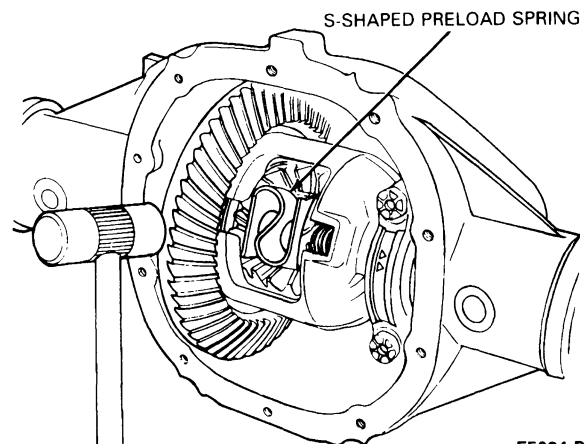
13. Rotate the tool until the pinion gears are aligned with the pinion shaft hole as shown. Remove the tool from the differential case.



E5078-C

14. Hold the S-shaped preload spring up to the differential case window and, with a soft-faced hammer, hammer the spring into position.

NOTE: Inspect the preload spring for damage.



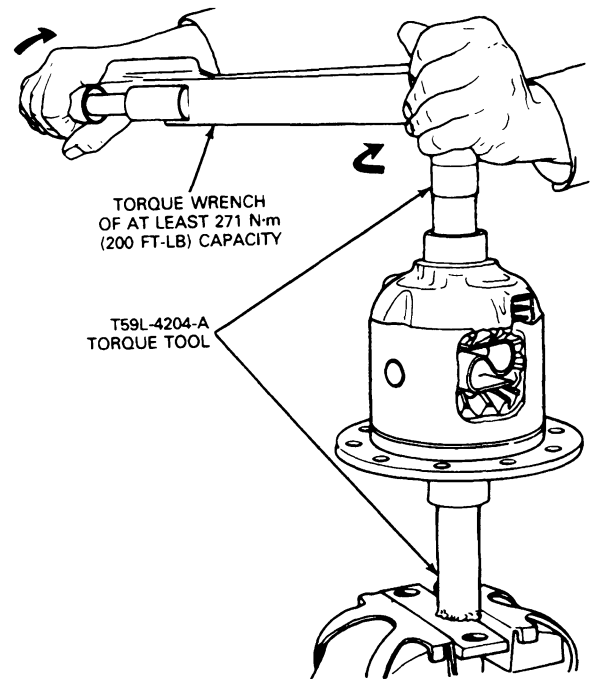
E5084-B

Bench Torque Test

A bench torque test must be made if the differential assembly has been removed from the axle and adjustments have been made.

With the locker tools in T59L-4204-A or equivalent torque tool, check the torque required to rotate one side gear while the other is held stationary.

The initial break-away torque, if original clutch plates are used, should be at least 27 N·m (20 ft·lb). The rotating torque required to keep the side gear turning with new clutch plates may fluctuate.



E5712-1C

SPECIFICATIONS

TORQUE SPECIFICATIONS
(INTEGRAL CARRIER), LIMITED-SLIP

Description	N·m	Lb·Ft
Rear Cover Screw	34-47	25-35
Oil Filler Plug	20-40	15-30

ADJUSTMENT TORQUE SPECIFICATIONS (INTEGRAL
CARRIER) — LIMITED-SLIP

Description	(Ft·Lb) N·m
Minimum rotating torques required during bench check after assembly or in vehicle with one wheel on the ground for original clutch pack.	27 (20)

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER) — LIMITED-SLIP

Vehicle	Engine	Axle	U.S. Measure Capacity (Pints) ^a	Imperial Capacity (Pints) ^a	Liters ^a
F-150, Bronco (4x4) and E-150	All	8.8-Inch Ring Gear	5.5	4.6	2.6

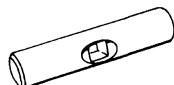


^a Use Rear Axle Lubricant XY-90-QL or -KL (ESP-M2C154-A) lubricant or equivalent, plus 4 U.S. ounces of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A), or equivalent.

Backlash Between Ring Gear and Pinion

Backlash — 0.20 - 0.38mm (.008-.015 In)

Ring Gear Backface Runout — 0.10mm (.004 In)

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T80P-4205A Gear Rotator	 T80P-4205-A
T80P-4946A Traction-Lok Clutch Gauge	 T80P-4946-A
T87T-4946A Traction-Lok Clutch Gauge	 T87T-4946-A

SECTION 05-02J Axle, Front Drive, Dana Model 60 Monobeam

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		DISASSEMBLY AND ASSEMBLY (Cont'd.)	
Front Wheel Bearing Adjustment.....	05-02J-31	Pinion, Drive Gear and Differential Case	
DESCRIPTION AND OPERATION.....	05-02J-1	Carrier.....	05-02J-13
DIAGNOSIS AND TESTING.....	05-02J-1	REMOVAL AND INSTALLATION	
DISASSEMBLY AND ASSEMBLY		Axle Shaft.....	05-02J-2
Assembly of Differential Into Housing.....	05-02J-24	Drive Pinion Oil Seal.....	05-02J-12
Axle Shaft.....	05-02J-30	Front Axle.....	05-02J-9
Depth Gauge Check.....	05-02J-22	Steering Knuckle and Upper and Lower Ball	
Differential Case.....	05-02J-18	Joins.....	05-02J-6
Gear Tooth Contact Pattern Check.....	05-02J-27	SPECIAL SERVICE TOOLS/EQUIPMENT.....	
Pinion Bearing Cup Installation.....	05-02J-21	SPECIFICATIONS.....	
Pinion Bearing Preload and Final Depth		VEHICLE APPLICATION.....	
Check.....	05-02J-23		

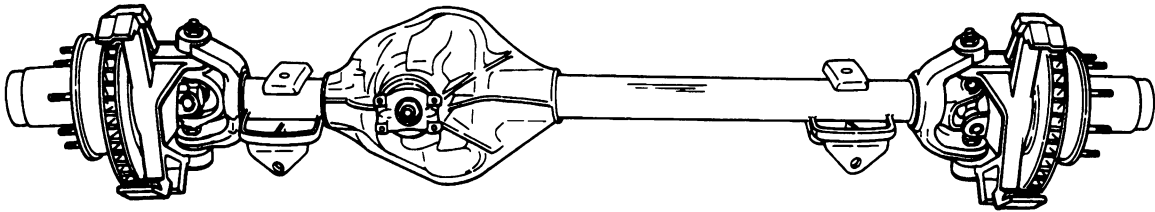
VEHICLE APPLICATION

F-350 (4x4) Vehicles

DESCRIPTION AND OPERATION

Dana Model 60 monobeam front drive axle is used on the F-350 4x4 vehicles and has open yoke design.

Other than the unique parts required for front-wheel drive, these axles are mechanically identical to Model 60 rear axles. It should be noted that the automatic locking hubs are standard with manual locking hubs optional.



DANA MODEL 60 MONOBEAM FRONT DRIVE AXLE

E6532-B

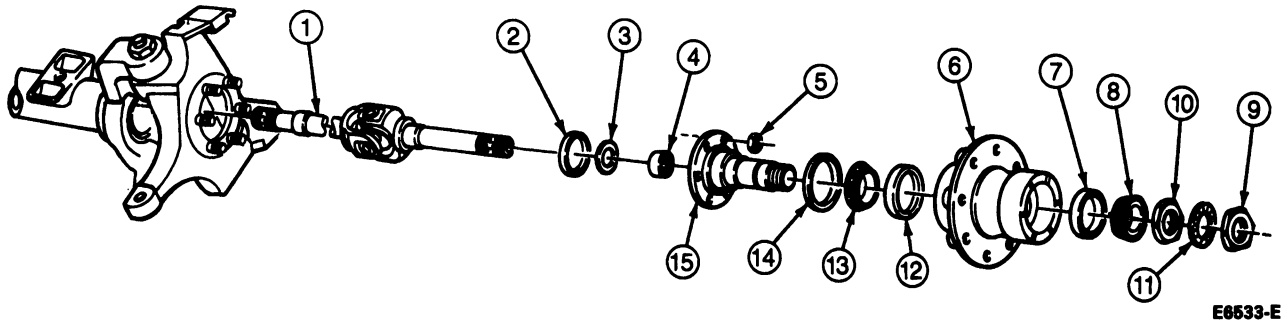
DIAGNOSIS AND TESTING

Refer to Section 05-00 for diagnosis and testing procedures.

REMOVAL AND INSTALLATION

Axle Shaft**Removal**

1. Raise the front of the vehicle and install safety stands.
2. Remove the lugnuts and remove the front wheel and tire assembly.

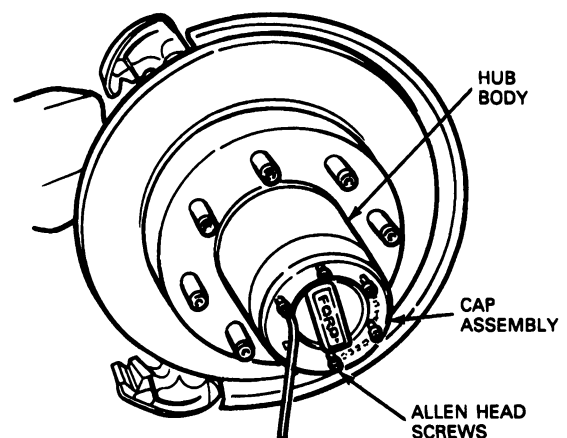
Dana Model 60 Monobeam Front Drive Axle

Item	Description
1	Axle Shaft Assembly
2	Rolling Diaphragm Seal
3	Integral Spacer / Seal
4	Caged Needle Bearing
5	Nut
6	Hub
7	Outer Bearing Cup

(Continued)

Item	Description
8	Outer Bearing
9	Outer Locknut
10	Inner Locknut
11	Lockwasher
12	Inner Bearing Cup
13	Inner Bearing
14	Grease Retainer
15	Spindle

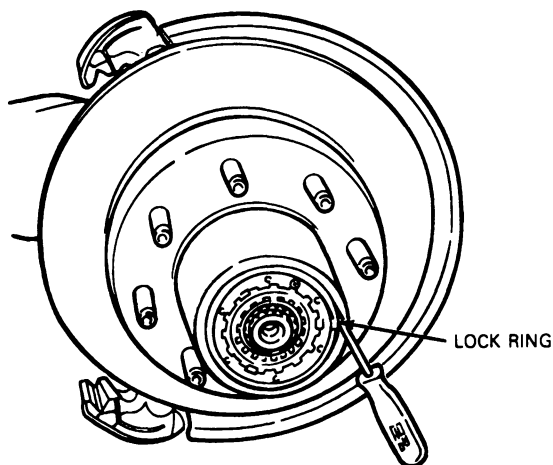
3. Remove the caliper as described in Section 06-03. Securely wire the caliper to the frame.
CAUTION: After removal, the caliper must be wired to the frame or otherwise supported to prevent suspending the caliper by the flexible hose. If securing the caliper is not practical, disconnect and plug the hose to the caliper. Upon caliper installation, bleed the system as described in Section 06-00.
4. Remove the six Torx® -head capscrews retaining the cap to the hub body. Remove the cap.



F4655-C

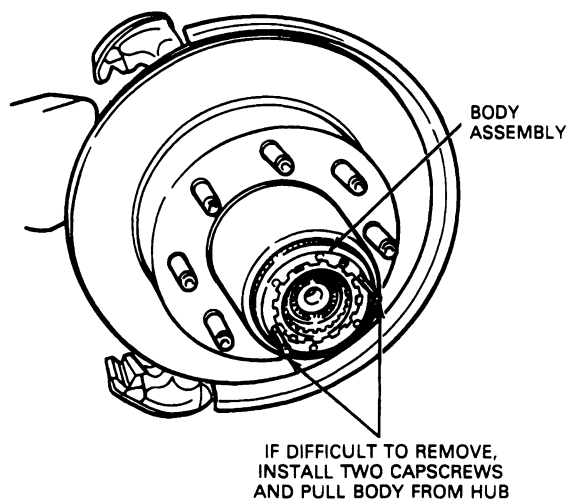
REMOVAL AND INSTALLATION (Continued)

5. Remove the lock ring seated in the groove of the wheel hub.



F4658-C

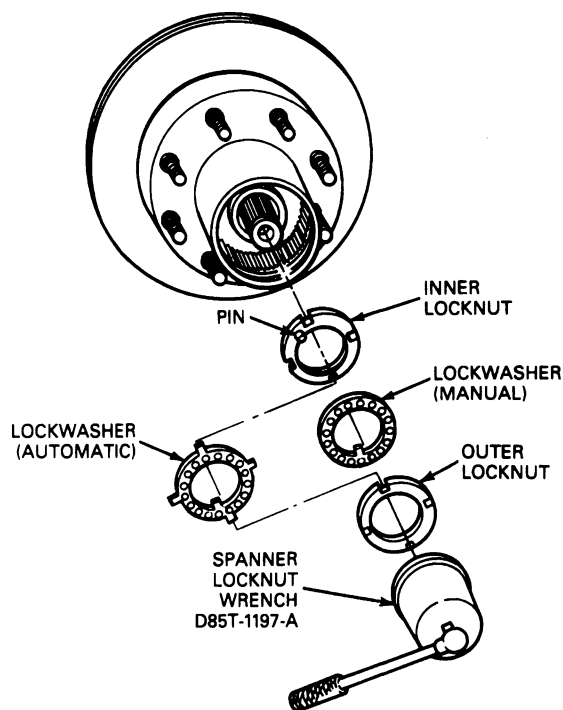
6. Remove the body assembly from the hub. If the body is difficult to remove, install two capscrews. Pull the body assembly out of the hub.



F4659-C

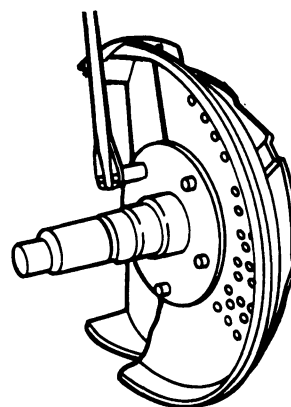
7. Remove the outer-locknut from the spindle with Spanner Locknut Wrench D85T-1197-A or equivalent.
8. Remove the lockwasher from the spindle.

9. Remove the inner locknut from the spindle using Spanner Locknut Wrench D85T-1197-A or equivalent.



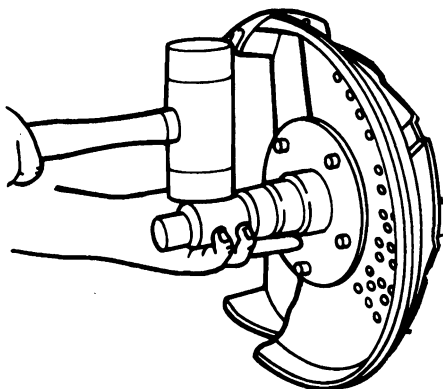
F7744-A

10. Remove the hub and rotor assembly from the spindle.
11. Remove the nuts retaining the spindle to the knuckle. Lightly tap the spindle with a rawhide hammer to remove from the knuckle.



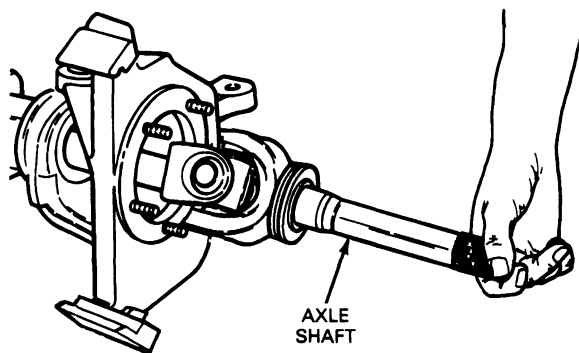
E8787-A

REMOVAL AND INSTALLATION (Continued)



E8788-A

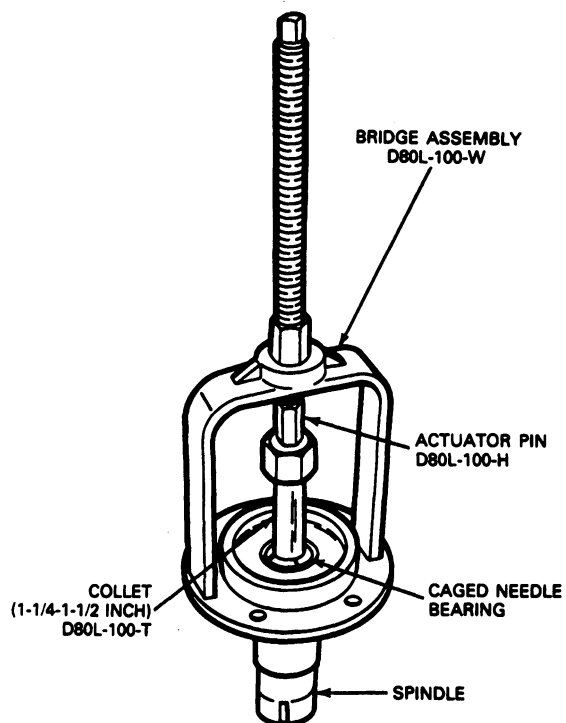
12. Remove the splash shield from the knuckle.
13. Pull the axle shaft assembly out of the steering knuckle. If required, remove the spacer from the axle shaft assembly.



E8535-D

14. If required, remove the caged needle bearing seal, and integral thrust washer from the spindle. Pull the bearing out of the spindle using Collet (1-1/2 to 1-3/4 inch) D80L-100-T, Actuator Pin D80L-100-H and Bridge Assembly D80L-100-W or equivalents.

NOTE: Actuator pin may travel far enough up and contact bridge. If this occurs, remove bridge assembly and use a slide hammer to complete removal.



E8536-1A

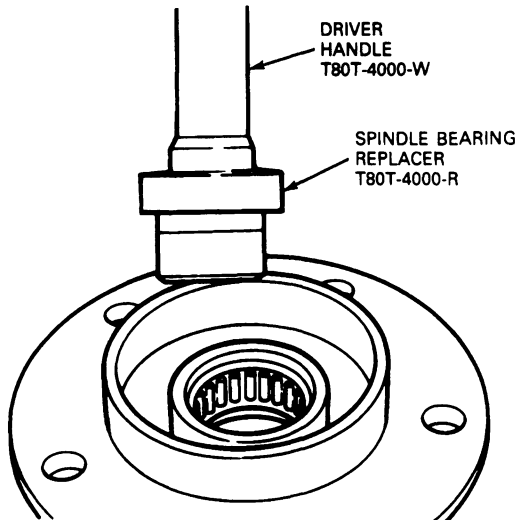
Installation

1. If removed, pack a new bearing with High Temperature (4x4) Front Axle and Wheel Bearing Grease E8TZ-19590-A (ESA-M1C198-A) or equivalent.
2. Position the bearing in the spindle bore.

NOTE: The writing on the bearing must face the inboard side of the spindle, toward the driving tool.

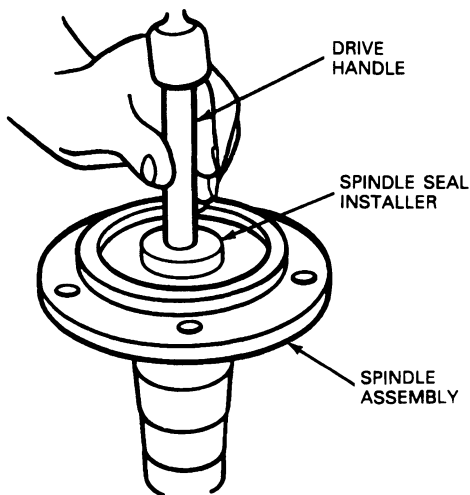
REMOVAL AND INSTALLATION (Continued)

3. Drive the bearing in the spindle with Spindle Bearing Replacer T80T-4000-R and Driver Handle T80T-4000-W until the tool bottoms out against the spindle.



E6537-B

4. Install the thrust washer / seal assembly using the seal installer tool.

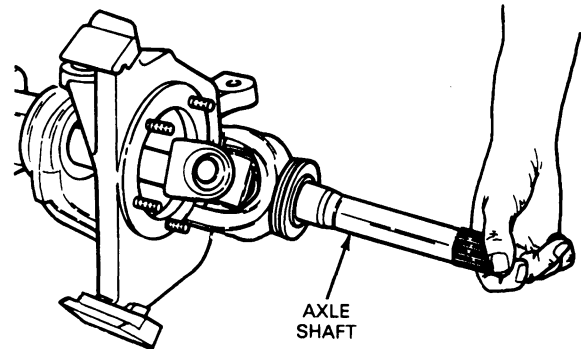


E8789-B

5. Lightly coat the thrust face of the seal in the spindle bore and the Rolling Diaphragm Seal (RDS) on the axle shaft with High Temperature (4x4) Front Axle and Wheel Bearing Grease E8TZ-19590-A (ESA-M1C198-A) or equivalent.
6. Seat the RDS spindle seal by tapping on the inner sheet metal lip of the seal with a straight punch.

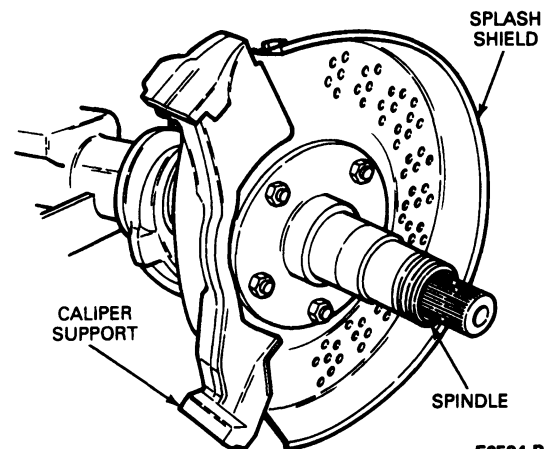
CAUTION: Do not bend the sheet metal portion of the seal.

7. Carefully guide the axle shaft through knuckle and into the axle housing. Check the axle shaft splines are engaged in the differential side gear splines.
8. Install the spacer on axle shaft assembly. The chamfered side of spacer must be inboard against the axle shaft.



E6535-D

9. Install the splash shield bracket on the steering knuckle.
10. Place spindle on steering knuckle. Install nuts and tighten to 68-81 N·m (50-60 ft·lb).

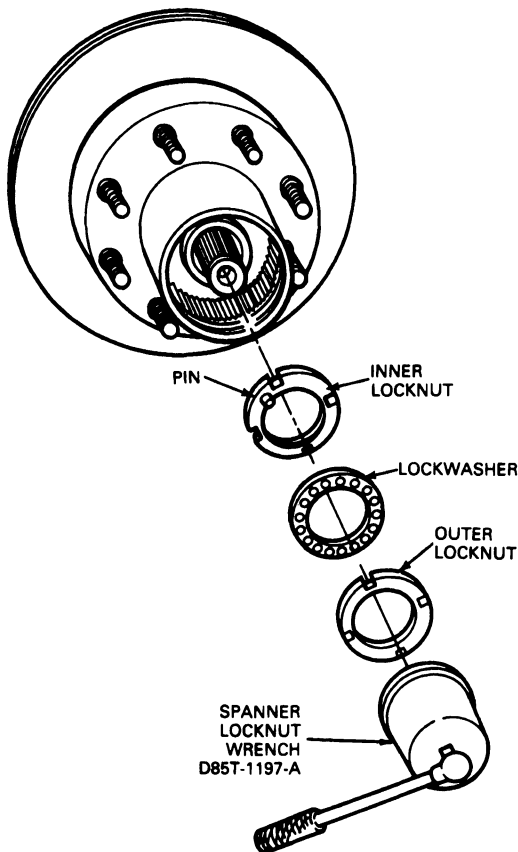


E6534-B

11. Install the hub and rotor assembly on the spindle, inspecting the wheel bearings and grease seal, and making sure there is adequate lubrication with High Temperature (4x4) Front Axle and Wheel Bearing Grease E8TZ-19590-A (ESA-M1C198-A) or equivalent.
12. Install the inner locknut on the spindle and seat the bearing by tightening the locknut to 68 N·m (50 ft·lb) with Spanner Locknut Wrench D85T-1197-A or equivalent.
13. Back off the inner locknut and retighten to 47 N·m (35 ft·lb) while rotating the hub and rotor.
14. Back off the locknut 90 degrees.

REMOVAL AND INSTALLATION (Continued)

15. Install the lockwasher so the key is positioned in the spindle groove. Tighten the inner locknut so the pin is aligned into the nearest hole in the lockwasher.



F4654-B

16. Install the outer locknut and tighten to 217-277 N·m (160-205 ft-lb) using Spanner Locknut Wrench D85T-1197-A.

NOTE: The final wheel bearing end play should be 0.00-0.15mm (0.000-0.004 inch). The maximum allowable torque to rotate the hub is 2.3 N·m (20 in-lb).

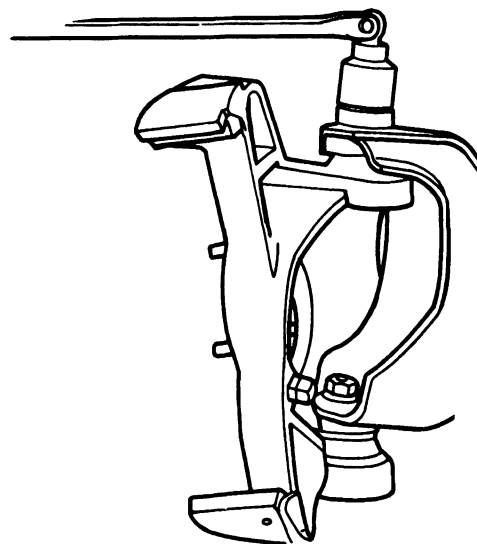
17. Install the manual locking hub body assembly in the hub and rotor.
18. Install the lock ring in the hub groove to retain the hublock body in the hub.

19. Position the cap assembly with new seal on the body. Install the six Torx® -head capscrews and tighten to 4.0-5.0 N·m (35-50 in-lb).
20. Install the caliper as described in Section 06-03.
21. Install the front wheel and tire assembly. Install the lugnuts and tighten to specification.

Steering Knuckle and Upper and Lower Ball Joints**Removal**

NOTE: If replacing both or just the upper ball joint, the lower ball joint must be removed first and installed last.

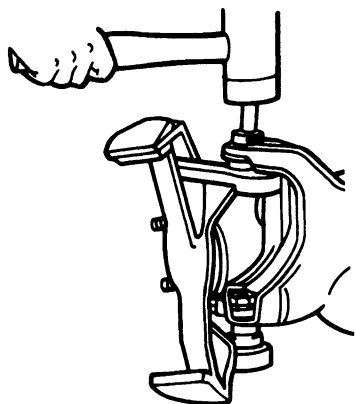
1. Raise the vehicle on a hoist and position suitable safety stands under the frame.
2. Remove the lugnuts and the wheel and tire assembly.
3. Remove the caliper as described in Section 06-03. Securely wire the caliper to the frame.
4. Remove the axle shaft and spindle as described under Axle Shaft Removal and Installation in this section.
5. Disconnect the steering arm from the knuckle.
6. Remove the cotter pin from the upper ball joint stud. Loosen both upper and lower ball joint retaining nuts. Remove the top nut.



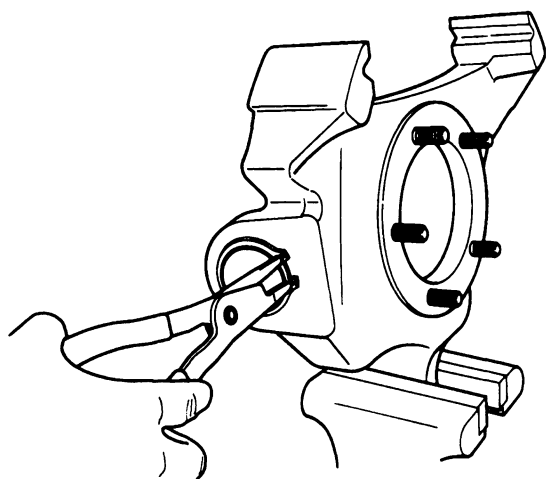
E8791-A

REMOVAL AND INSTALLATION (Continued)

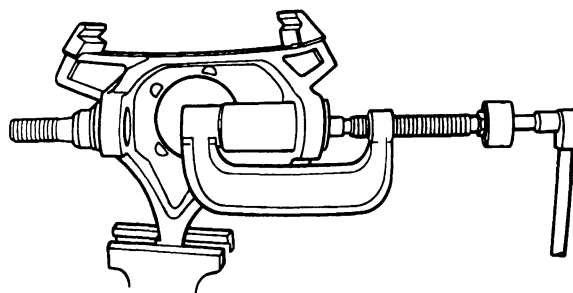
7. Using a rawhide or heavy duty plastic hammer, hit sharply on the top stud to free the knuckle from the tube yoke. After the knuckle is free from the yoke, remove the lower nut and remove the knuckle from the tube yoke.

**E8792-A**

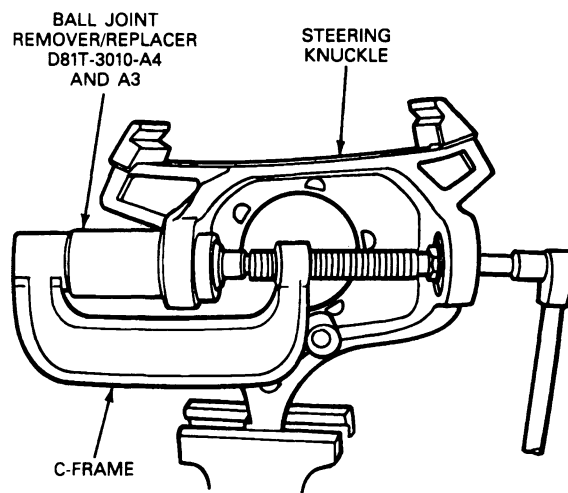
8. Secure the knuckle in a vise. Remove the snap ring from the lower ball joint.

**E8793-A**

9. Assemble U-Joint Tool T74P-4635-C and Ball Joint Remover / Replacer T92T-3010-A over the lower ball joint. Turn the forcing screw clockwise to remove the ball joint.

**E8794-A**

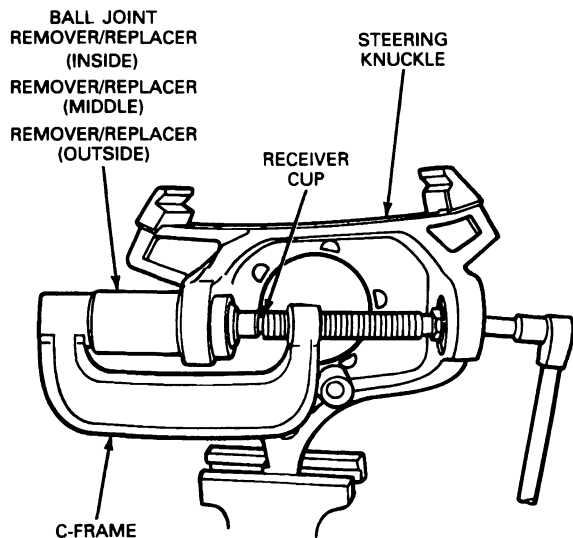
10. Assemble U-Joint Tool T74P-4635-C, Ball Joint Remover / Replacer D81T-3010-A4 and Ball Joint Remover / Replacer D81T-3010-A3 or equivalents over the upper ball joint. Turn the forcing screw clockwise to remove the upper ball joint.

**E8795-B****Installation**

NOTE: The upper ball joint must be installed first.

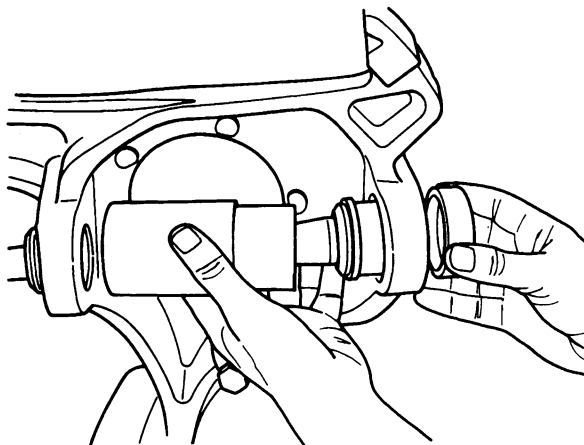
REMOVAL AND INSTALLATION (Continued)

1. Position the upper ball joint along with U-Joint Tool T74P-4635-C, Receiver Cup D81T-3010-A5, Ball Joint Remover / Replacer tools D81T-3010-A1, D81T-3010-A3 and D81T-3010-A4 or equivalents on the knuckle. Turn the forcing screw clockwise until the ball joint bottoms in the bore. Remove the tools.

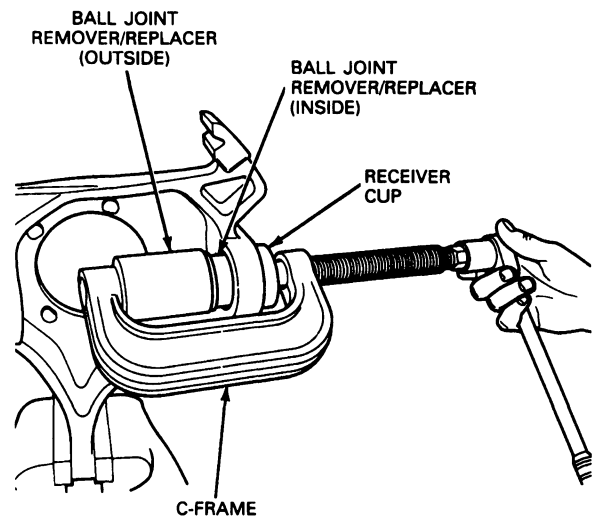


E8797-B

2. Position the lower ball joint and U-Joint Tool T74P-4635-C, Ball Joint Remover / Replacer T92T-3010-B and Ball Joint Remover / Replacer T92T-3010-A on the knuckle. Turn the forcing screw clockwise until the ball joint bottoms in the bore. Remove the tools.

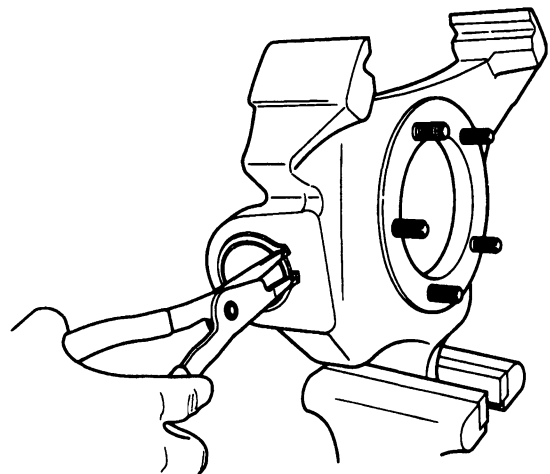


E8799-B



E8800-B

3. Install the snap ring on the lower ball joint.



E8793-A

4. Assemble the knuckle to the tube yoke. Install the camber bushing, if previously removed. Install the upper ball joint attaching nut. Do not tighten at this time.
5. Install the lower ball joint attaching nut.
6. Tighten both ball joint attaching nuts as follows:
 - a. Tighten lower ball joint nut to 47 N·m (35 ft-lb).
 - b. Tighten upper ball joint nut to 95 N·m (70 ft-lb).
 - c. Advance upper ball joint nut to next castellation, and install new cotter pin.

REMOVAL AND INSTALLATION (Continued)

- d. Re-tighten lower ball joint nut to 203 N·m (150 ft-lb).

CAUTION: If the above tightening procedures are not followed, ball joint life will be reduced.

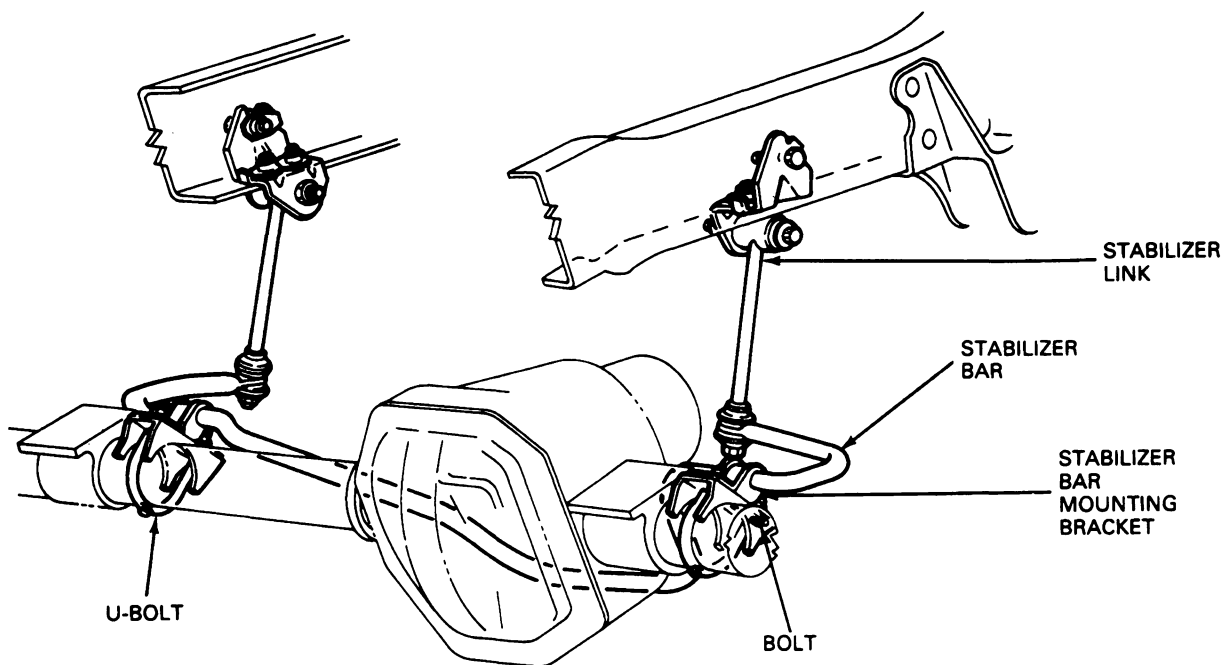
7. Assemble the spindle and axle shaft as described under Axle Shaft Removal and Installation in this section.
8. Install the caliper as described in Section 06-03.
9. Connect the steering arm to the knuckle. Tighten the attaching nut to 95-135 N·m (70-100 ft-lb).
10. Install the tire and wheel assembly. Tighten the lugnuts to specifications. Refer to Section 04-04.
11. Remove the safety stands and lower the vehicle.

Front Axle**Removal**

1. Raise the vehicle on a twin-post hoist.
2. Remove the front wheel and tire assemblies from the vehicle.
3. Remove the brake caliper from the rotor according to the procedures outlined in the Body / Chassis Manual, Section 06-03.

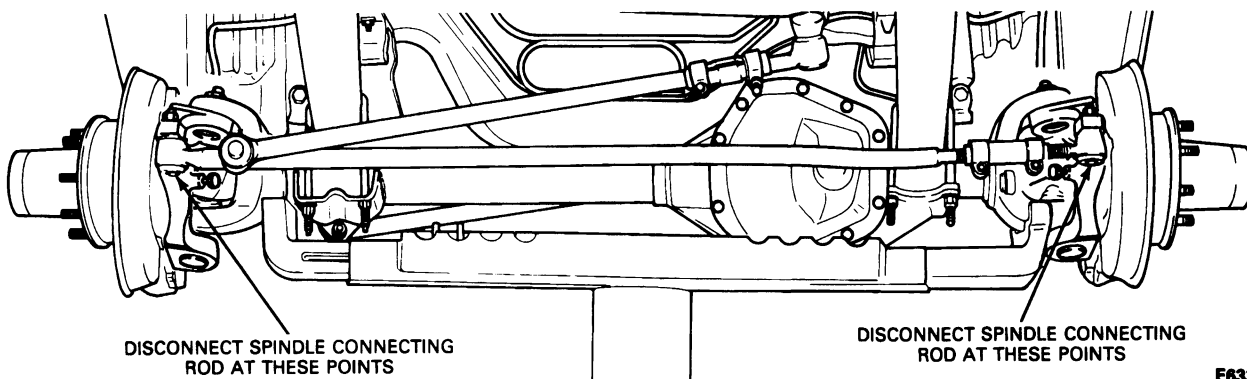
CAUTION: After removal, the brake caliper must be wired to the spring or otherwise supported to prevent suspending the caliper by the flexible hose. Allowing the caliper to hang by the flexible hose could result in brake line failure. If caliper suspension is not practical, remove it according to the procedures outlined in the Body / Chassis Manual, Section 06-03.

4. Remove the washers and nuts securing the stabilizer links to the stabilizer bar. Disconnect the stabilizer links from the stabilizer bar.
5. If required, remove the U-bolts and bolts and nuts retaining the stabilizer bar and mounting brackets to the axle and remove the stabilizer bar.

Front Stabilizer Bar Assembly**E6336-2A**

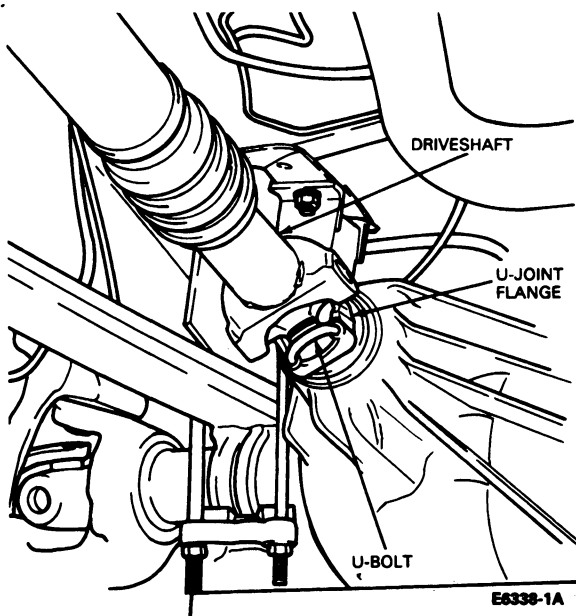
REMOVAL AND INSTALLATION (Continued)

6. Remove the cotter pins and castellated nuts securing the spindle connecting rod to the steering knuckles. Separate the connecting rods from the steering knuckles using Pitman Arm Puller T64P-3590-F. Wire the steering linkage to the spring.

Spindle Connecting Rod Attachment Locations

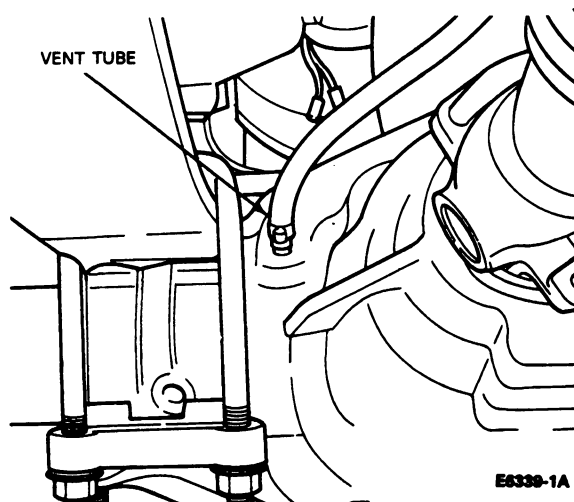
E6337-B

7. Remove the two nuts and U-bolts from the front driveshaft U-joint flange.
 8. Disconnect the driveshaft from the front axle pinion flange. Securely wire the driveshaft to the frame.
- NOTE: Mark yoke and driveshaft with a marking paint pen for assembly in the same position.



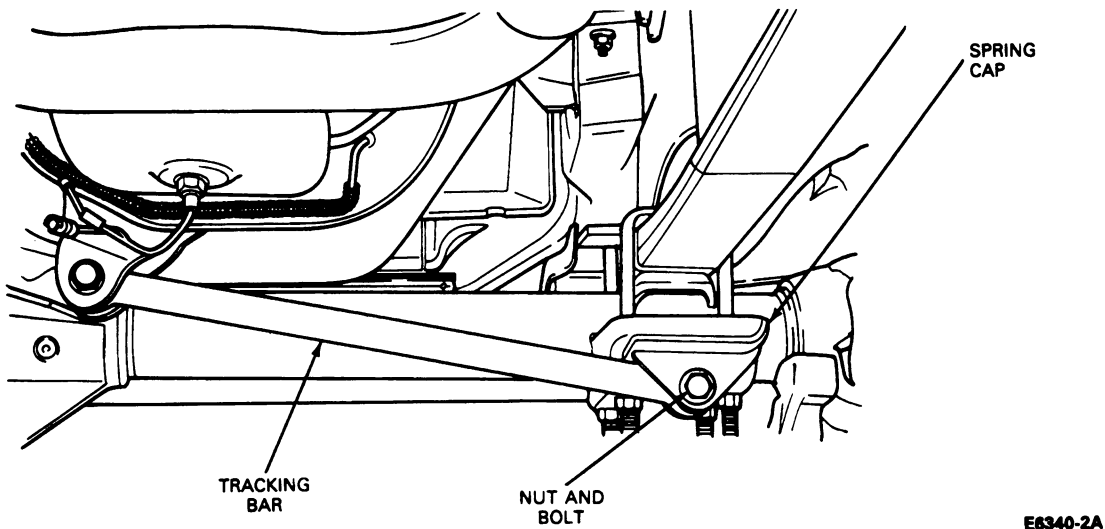
E6338-1A

9. Disconnect the vent tube at the axle housing. Plug the vent fitting.



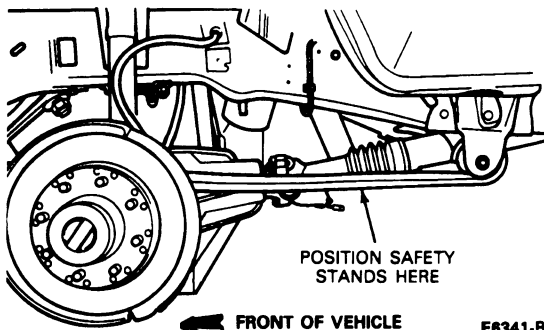
E6339-1A

10. On the right hand side of the vehicle, remove the nut and bolt, and disconnect the tracking bar from the right hand spring cap.

REMOVAL AND INSTALLATION (Continued)**Tracking Bar**

E6340-2A

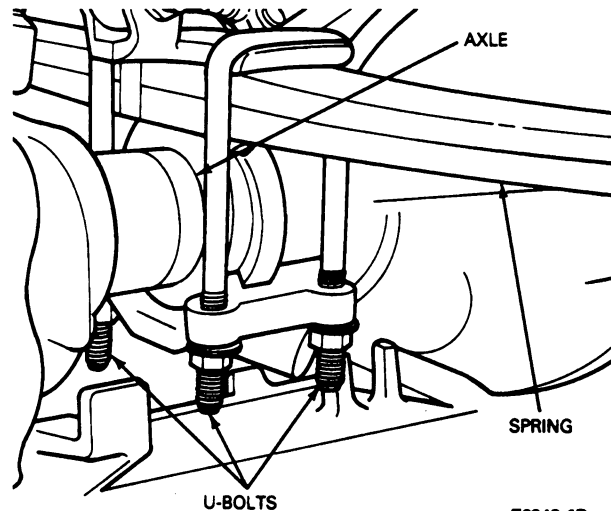
11. Carefully lower the twin-post hoist until the vehicle is approximately three feet from the floor.
12. Position safety stands on the front leaf springs about halfway between the front axle leaf spring and the rear mounting shackle. Lower the vehicle so the springs rest on the safety stands.



E6341-B

WARNING: BEFORE PROCEEDING, MAKE SURE THAT THE VEHICLE IS SECURELY SUPPORTED.

13. Support the axle under the differential carrier with a suitable jack, such as Rotunda Tool 077-00008 or equivalent.
14. Remove the U-bolts and nuts securing the axle to the spring.
15. Carefully lower the axle from the vehicle.
16. If required, place the axle in a differential carrier repair stand, such as Rotunda Tool 014-00257 or equivalent.



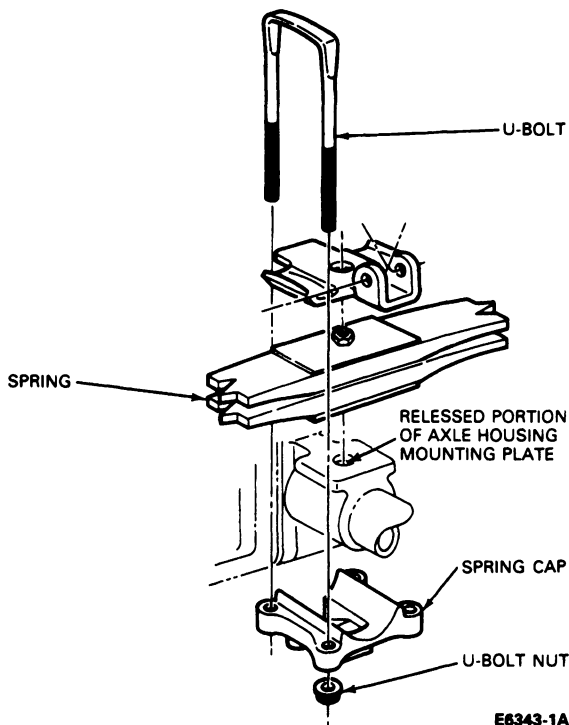
E6342-1B

Installation

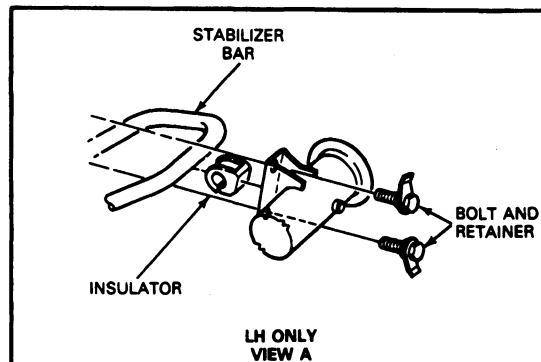
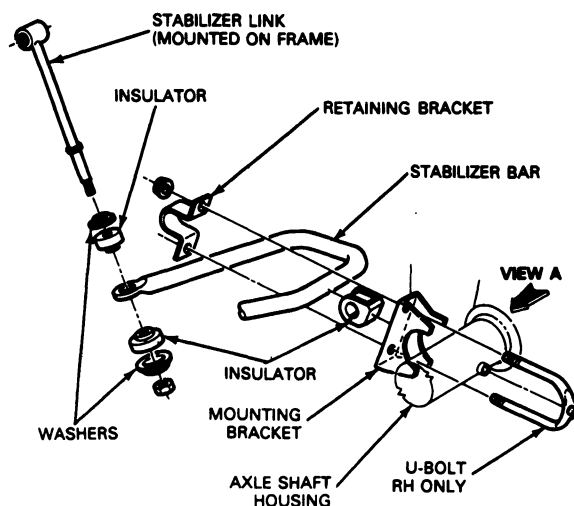
1. With the axle supported under the differential carrier by a suitable transmission jack, carefully raise the axle to the vehicle. Make sure that the retaining bolt head protruding from the leaf spring plate seats in the recessed portion of the axle spring mounting plate.
2. Install the nuts, U-bolts and spring caps securing the axle to the spring. Tighten to specifications listed at the end of this section.

REMOVAL AND INSTALLATION (Continued)

3. Remove jacks and raise the vehicle to a suitable working height. Remove safety stands.



4. Connect the driveshaft to the front axle pinion flange, secure with nuts and U-bolts and tighten to torque specifications listed at the end of this section. Refer to Section 05-01 for procedure.
5. On the right hand side of the vehicle, connect the tracking bar to the spring cap, secure with nut and bolt. Tighten to specifications listed at the end of this section.
6. Connect the vent tube to the axle housing.
7. Connect the spindle connecting rods to the steering knuckles. Secure the connecting rod ends with castellated nuts. Tighten to specifications listed at the end of this section. Install cotter pins. If necessary, advance nut to next castellation to install cotter pin.
8. Connect stabilizer link to stabilizer bar. Tighten nuts and washers to specifications listed at the end of this section.
9. If removed, position stabilizer bar and mounting brackets on axle shaft housing and tighten to specifications listed at the end of this section.



E6344-1A

10. Install brake calipers and rotors as described in Section 06-03.
11. Install the wheel and tire assemblies on the vehicle.
12. Lower the vehicle to the ground.

Drive Pinion Oil Seal**Removal**

NOTE: The drive pinion oil seal can be replaced without removing the axle assembly from the vehicle. Compounded or synthetic rubber seals do not require soaking.

1. Raise the vehicle on a hoist or raise the front end of the vehicle with a jack. Install safety stands under the frame rails and lower the jack or hoist far enough to allow the axle to drop into the rebound position for working clearance.
2. Mark U-joint flange and driveshaft prior to removing. Remove the nuts and two U-bolts from the front axle U-joint flange and disconnect the driveshaft from the front axle pinion flange. Wire the driveshaft to the frame.

REMOVAL AND INSTALLATION (Continued)

3. Using Companion Flange Holding Tool T57T-4851-B to hold the pinion companion flange, remove the pinion shaft nut.
4. Using Companion Flange Remover Tool T65L-4851-B remove the companion flange.
5. Using Seal Remover TOOL-1175-AC in combination with Slide Hammer T50T-100-A remove the pinion oil seal.

Installation

1. Clean the pinion oil seal seat. Drive the seal into the housing using Pinion Seal Replacer T83T-4676-A. Coat the seal lip of the new seal with a small amount of Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent. **Do not put sealer on the sealing lip.**

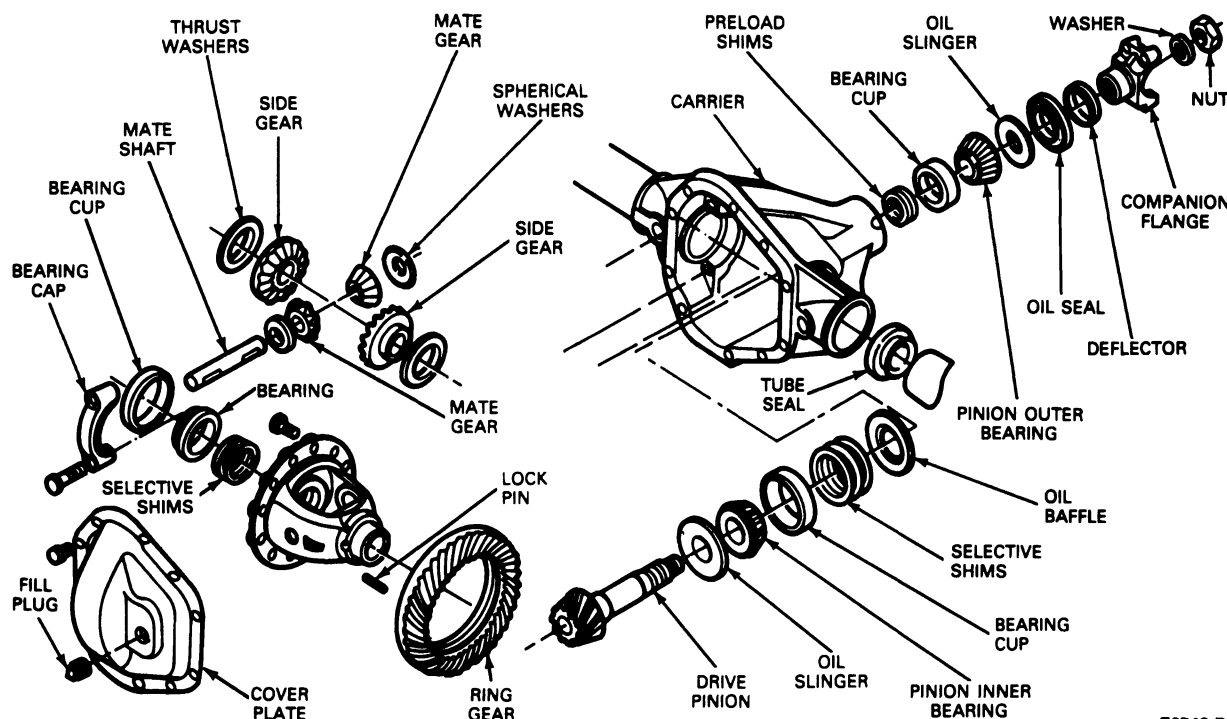
2. Coat the inside of the pinion flange with a small quantity of Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent and install the flange on the pinion shaft using Companion Flange Replacer TOOL-4858-E or equivalent.
3. Install a new pinion attaching nut on the pinion shaft. Tighten to specifications listed at the end of this section.
4. Connect the driveshaft to the front axle pinion flange and align marks made prior to removal. Secure with nuts and U-bolts and tighten to specifications listed at the end of this section.
5. Raise the vehicle, remove the safety stands and then lower the vehicle to road position. Check the level of axle lubricant and add the specified lubricant as necessary.

DISASSEMBLY AND ASSEMBLY**Pinion, Drive Gear and Differential Case Carrier****Disassembly**

1. Remove the front axle from the vehicle as outlined in Front Axle Removal and Installation in this section.
2. Remove the axle shafts as outlined in the Removal and Installation portion of this section.

Differential Assembly

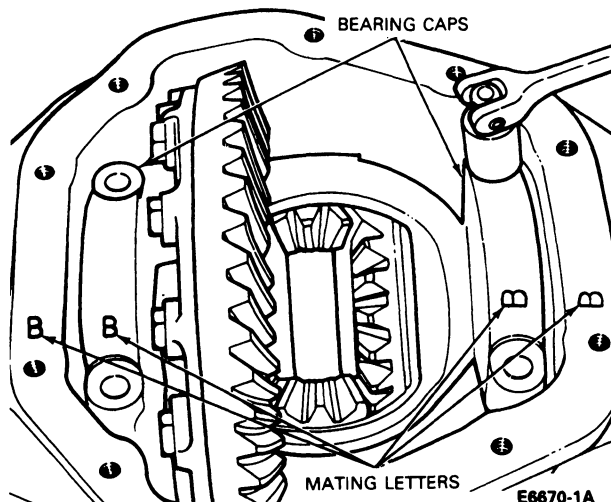
3. Position suitable container under differential carrier. Remove cover plate and drain lubricant from axle. The lubricant will drain out as the cover plate is removed. Tip carrier to allow lubricant to drain completely.
4. Remove any residual gasket material from carrier mating surface. Also clean cover face of carrier, making sure it is free of any nicks or burrs.
5. Loosen capscrews and remove bearing caps.



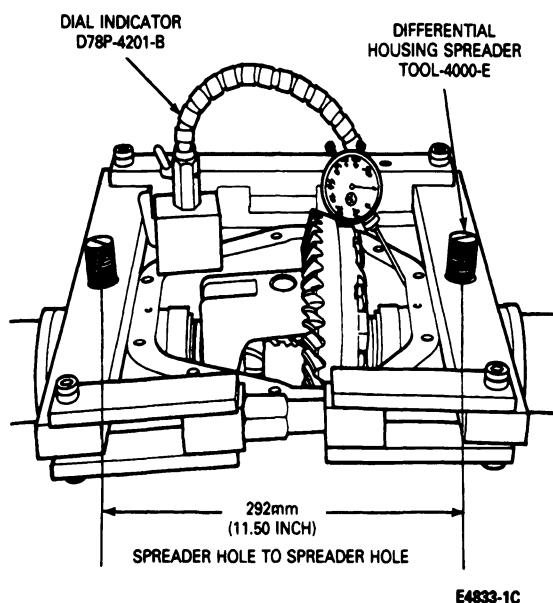
E6848-D

DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: Mating letters are stamped on bearing caps and carrier. This is important at time of assembly as they are to be assembled exactly as removed. Letters are in vertical and horizontal positions.



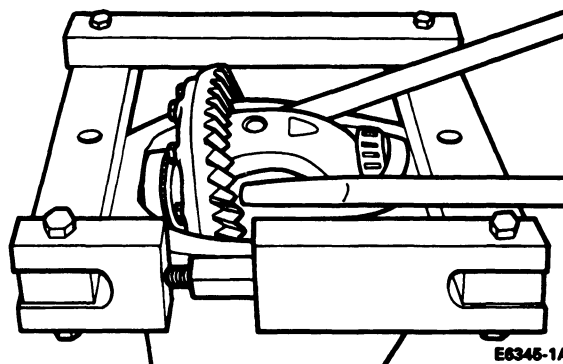
6. Place Differential Housing Spreader TOOL-4000-E on the case. Install Dial Indicator D78P-4201-B or equivalent on the carrier housing. Do not spread housing more than 0.38mm (0.015 inch).



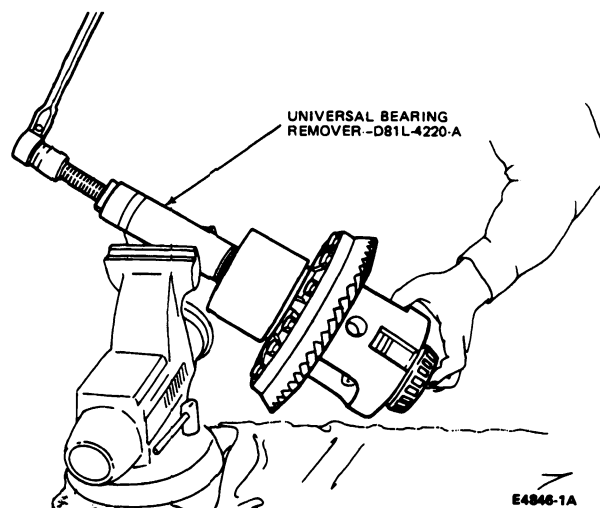
7. Pry differential case from carrier with two pry bars. After differential case has been removed, remove spreader.

NOTE: Use caution to avoid damage to ring and pinion.

Mark or tag bearing cups for correct positioning during assembly.



8. Remove differential bearings with special tool Pinion and Carrier Bearing Puller D81L-4220-A. Place tool in a vise when removing bearing. Wire shims, bearing cup and bearing cone together. Identify from which side they were removed. (Ring gear side or opposite side.) If shims are damaged, replace during assembly.
9. Reposition case in puller and remove other bearing cone as described above. Replace bearings whenever they are removed from the carrier.

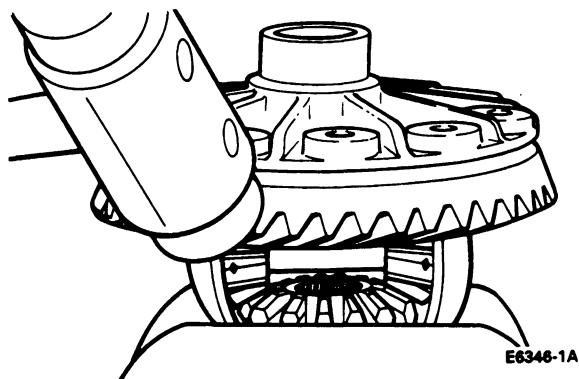


10. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked when it falls from the differential carrier.

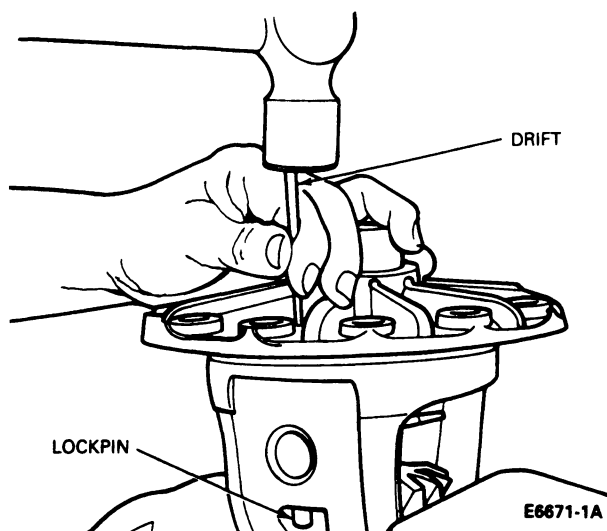
DISASSEMBLY AND ASSEMBLY (Continued)

11. Place case in vise. Remove ring gear bolts. Tap ring gear with a rawhide hammer to free it from the case. Remove case and ring gear from vise.

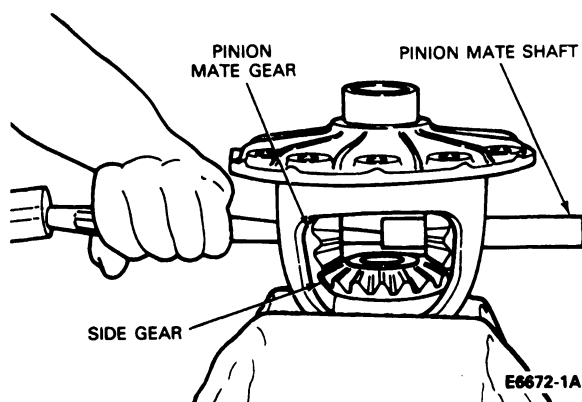
NOTE: Whenever removing the ring gear bolts, always replace with new bolts upon assembly.



12. Replace case in vise and use a small drift to drive out the lockpin that secures the pinion mate shaft.

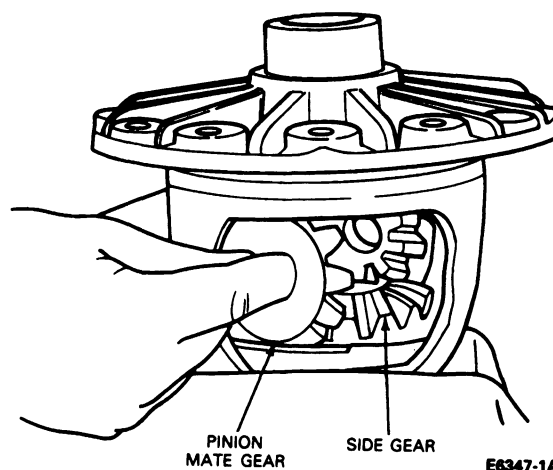


13. Remove pinion mate shaft with drift.



14. To remove side gears and pinion mate gears, rotate the side gears. This will allow the pinion mate gears to turn to the opening of the case.
15. Remove pinion mate gears and the spherical washers behind the gears.
16. Lift out side gears and thrust washers.
17. Inspect all parts, including the machined surfaces of the case itself.

NOTE: If excessive wear is visible on all parts, it is suggested that the complete differential assembly be replaced. If any one of the gears are to be replaced, REPLACE AS A SET.



18. Turn nose of carrier in a horizontal position, remove pinion nut. Hold end yoke or flange with Companion Flange Holding Tool T57T-4851-B or equivalent and remove pinion nut and washer.
19. Remove end yoke or flange with Companion Flange Remover T65L-4851-B. If end yoke or flange shows wear in the area of the seal contact, replace.
20. Remove pinion by tapping with a rawhide hammer. Catch the pinion with your hand to prevent it from falling to the ground and being damaged.

NOTE: On the spline end of the pinion, there are bearing preload shims. These shims may stick to the pinion or bearing or even fall out. These shims are to be collected and kept together since they will be used later in assembly. Try not to damage shims. If shims are damaged, replace with new ones. Shims are available in thicknesses of:

Pinion Preload Shims

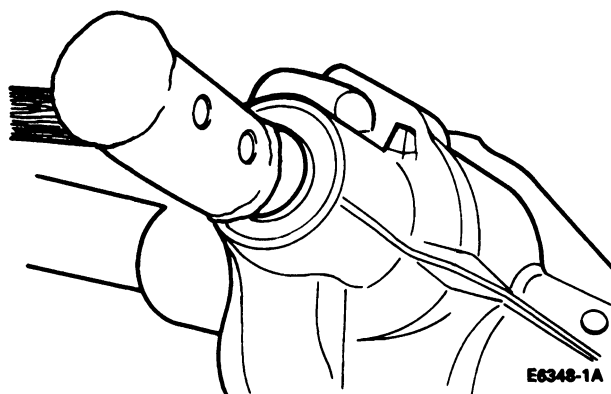
Available Thicknesses	
mm	In
.36	.014
.41	.016
.46	.018
.51	.020

(Continued)

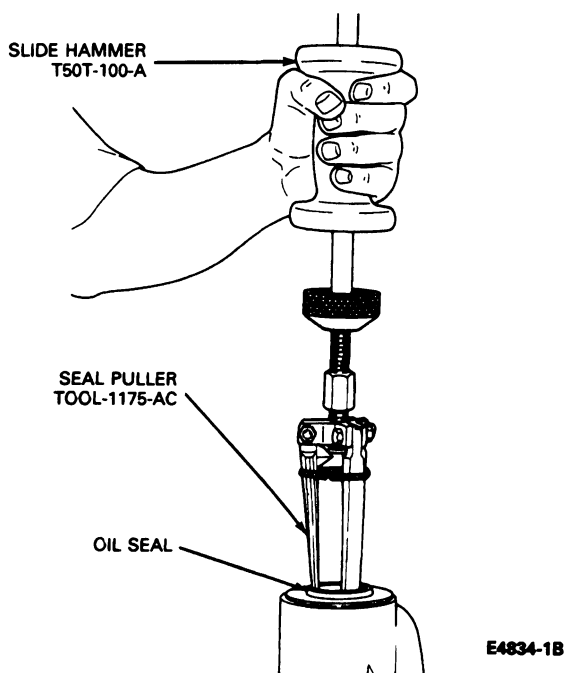
DISASSEMBLY AND ASSEMBLY (Continued)**Pinion Preload Shims (Cont'd)**

Available Thicknesses	
mm	In
.56	.022
.76	.030
.38	.015
.53	.021
.58	.023
.25	.010

NOTE: Service kit has 10 shims of various thicknesses.



21. Pull out pinion seal with Bearing Cup Puller T77F-1102-A and Impact Slide Hammer T50T-100-A. Discard seal. **REPLACE WITH NEW ONE AT TIME OF ASSEMBLY.** Remove bearing cone and outer oil slinger.



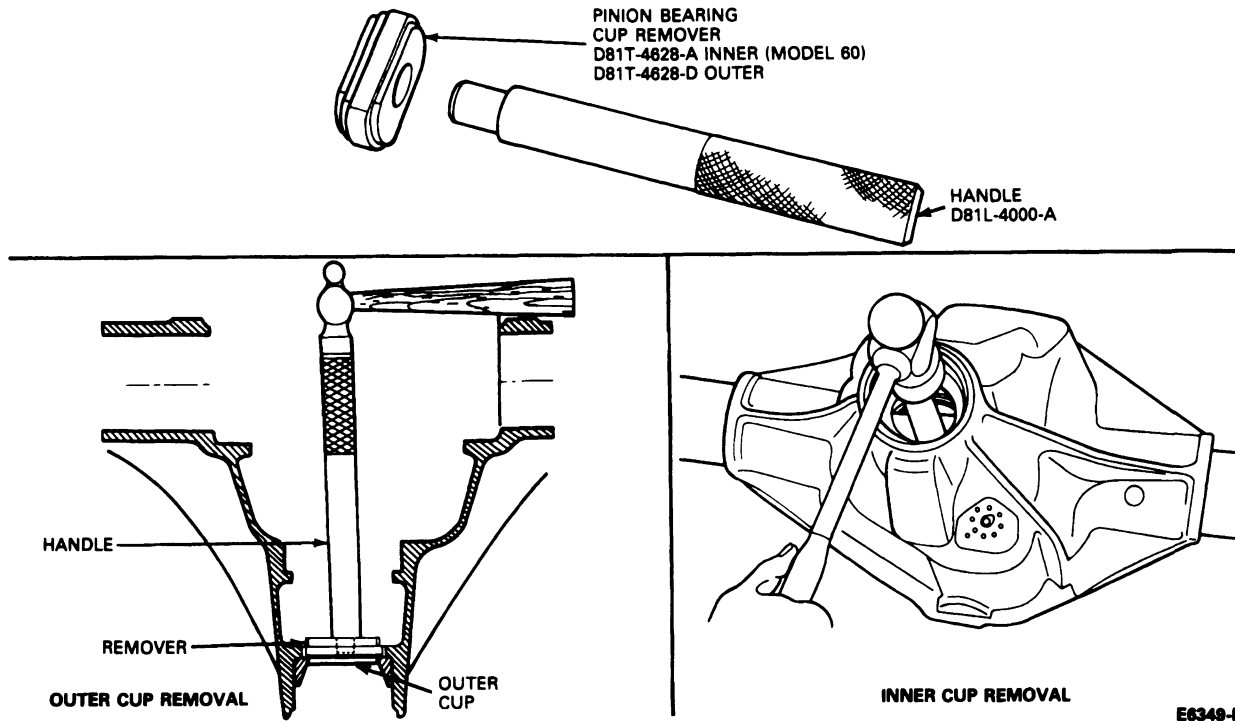
22. Turn nose of carrier down. Remove outer pinion bearing cup with Pinion Bearing Cup Remover D81T-4628-D and Driver Handle D81L-4000-A or their equivalents. Locate driver on back edge of cup; drive cup out of carrier.

CAUTION: Do not nick carrier bore.

NOTE: The inner carrier section may vary in pinion bore depth due to the possibility of the need for either a baffle or slinger or both.

23. Remove the inner bearing cup with Pinion Bearing Cup Remover D81T-4628-A and Driver Handle D81L-4000-A or equivalents.

NOTE: Shims are located between the bearing cup and carrier bore and may also include an oil baffle. If shims and baffles are bent or nicked, replace at time of assembly. Wire shim stacks together and measure each. If stack has to be replaced, replace with same thickness.

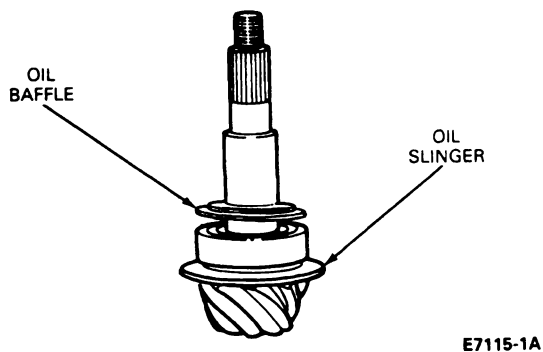
DISASSEMBLY AND ASSEMBLY (Continued)**Bearing Cup Removal**

E6349-B

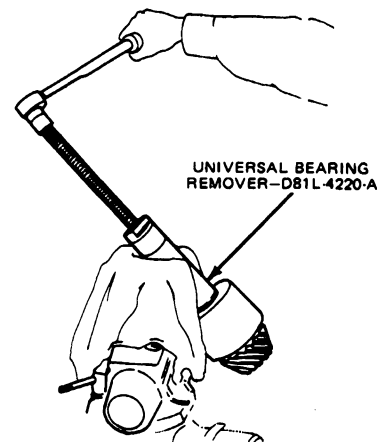
NOTE: Both baffle and slinger are part of the pinion adjustment shims and are to be kept intact for assembly.

The baffle serves the same purpose as a dam, to assure the pinion bearings are maintained with lubricant.

The slinger serves the purpose of assisting the lubricant to flow up through the oil channels to lubricate the pinion bearings. If used, they are part of the pinion setting adjustment.

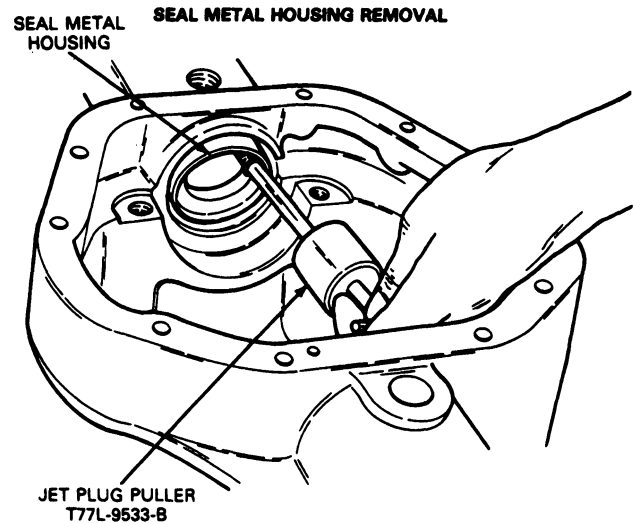
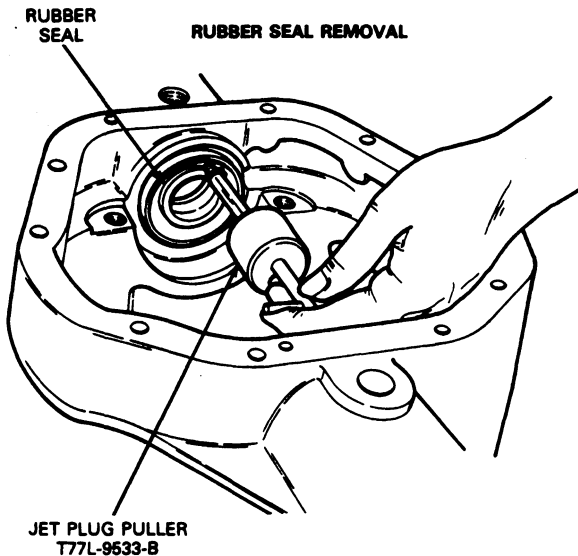


24. Remove bearing from pinion with Pinion and Carrier Bearing Puller D81L-4220-A or equivalent. Bend the slinger as required to obtain clearance for remover tool installation. Discard the slinger.



DISASSEMBLY AND ASSEMBLY (Continued)

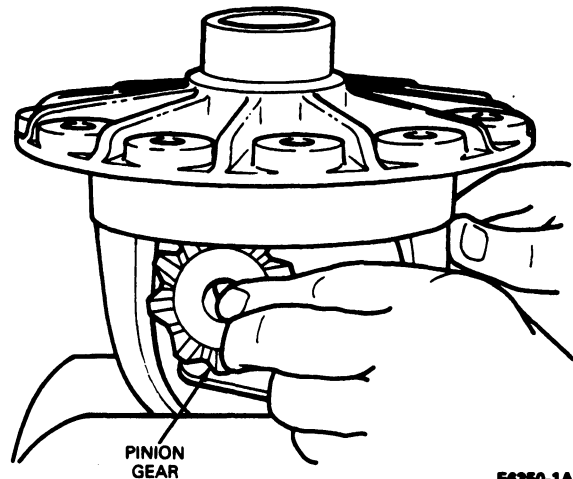
25. If required, remove the inner axle shaft seals with Jet Plug Remover T77L-9533-B. Thread the remover tool into the rubber seal, remove and discard seal. Thread the remover tool into the metallic seal housing, remove and discard seal housing.

INNER AXLE SHAFT SEAL REMOVAL

E6549-2A

Differential Case**Assembly**

1. Place differential case in vise. Apply grease, High Temperature 4x4 Front Axle and Wheel Bearing Lubricant E8TZ-19590-A (ESA-M1C198-A) or equivalent, to new side gear thrust washers and to hubs and thrust face of the new side gears.
2. Assemble both side gears. Apply grease to new spherical washers and new pinion mate gears. Assemble new pinion mate gears and washers.
3. Assemble both side gears and thrust washers, hold in place with hand, then assemble the pinion mate gears and washers to hold the side gears in place.
NOTE: An easy way to assemble the side gears and pinion mate gears is to have all parts lubricated before assembly.
4. Rotate the side gears until the holes of the washers and pinion gears line up with the holes of the case. If the gears cannot be rotated by hand, install one of the axle shafts into the side gear spline and use a pipe wrench to turn the shaft.

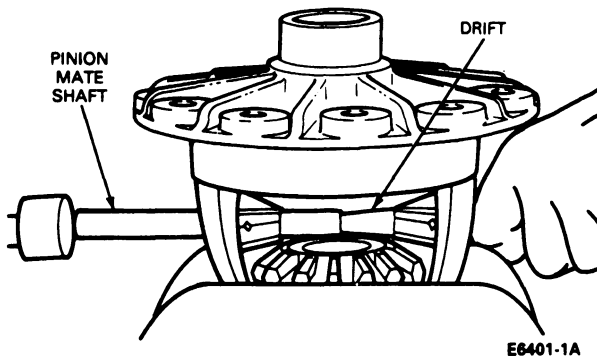


E6350-1A

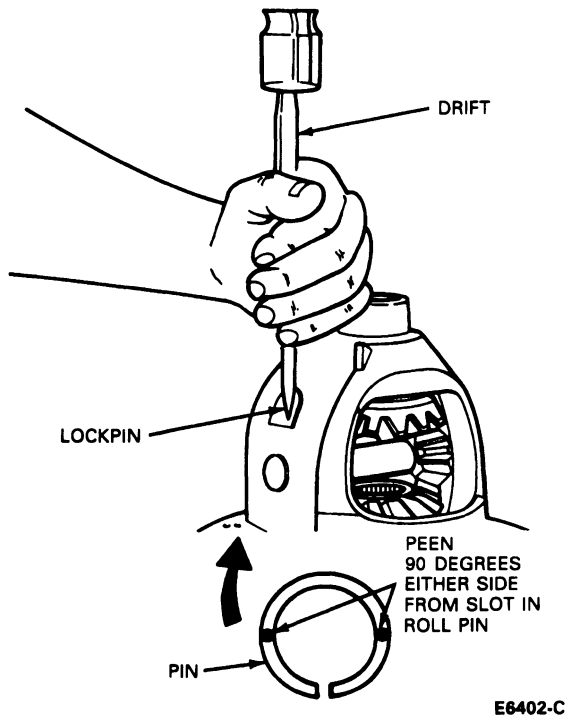
5. Use a drift to line up the holes with those of the differential case.

DISASSEMBLY AND ASSEMBLY (Continued)

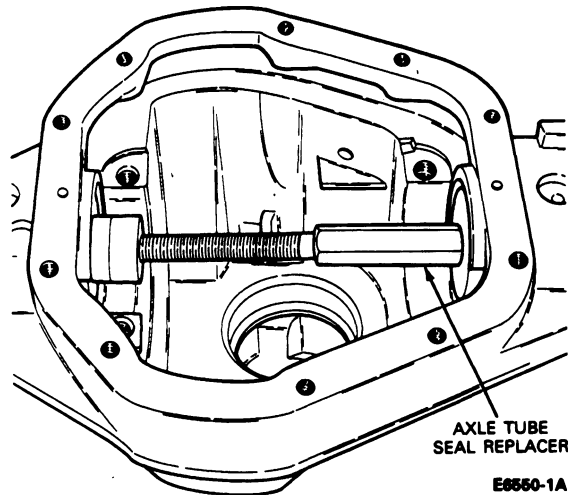
6. Assemble pinion mate shaft, drive on shaft to remove drift. Align lockpin hole of the shaft with the lockpin hole of the case.



7. Assemble lockpin (roll pin). Peen metal of case over pin to lock in two places 180 degrees apart.



8. Make sure flange face of the case is free of nicks or burrs. Assemble ring gear to case. Line up holes of the ring gear with those of the case. Use new ring gear bolts. Draw up bolts alternately and evenly. Tighten grade 8 ring gear bolts to 136-162 N·m (100-120 ft-lb). Tighten grade 9 ring gear bolts to 169-183 N·m (125-135 ft-lb).
9. Place the inner axle seals in the axle tube housing. Press both seals in at the same time with an appropriate installation tool. Make sure seals are pressed in straight and not cocked in the bore. Coat the lips of the seals with High Temperature 4x4 Front Axle and Wheel Bearing Lubricant E8TZ-19590-A (ESA-M1C198-A) or equivalent.
10. Install Master Differential Bearings Tool D81T-4222-D or equivalent onto case. Remove all nicks, burrs, dirt, etc., from hubs to allow bearings to rotate freely.

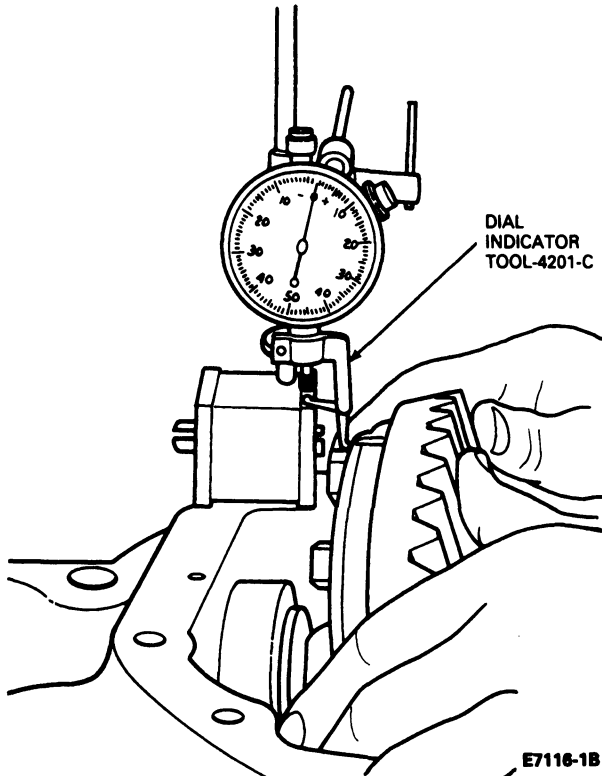


11. Assemble differential case into carrier (less pinion). Mount Dial Indicator D78P-4201-B or equivalent with a magnetic base as shown. Locate tip of indicator on flat surface of one of the ring gear bolt spot faces.

DISASSEMBLY AND ASSEMBLY (Continued)

12. Force differential assembly as far as possible in the direction towards the indicator. With force still applied, set indicator at zero.

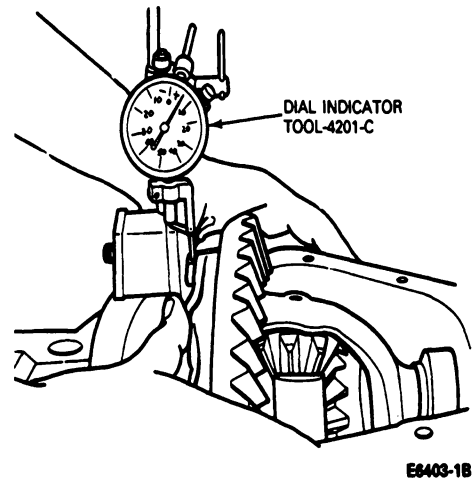
NOTE: Dial indicator should have a minimum travel capability of 5.08mm (0.200 inch).



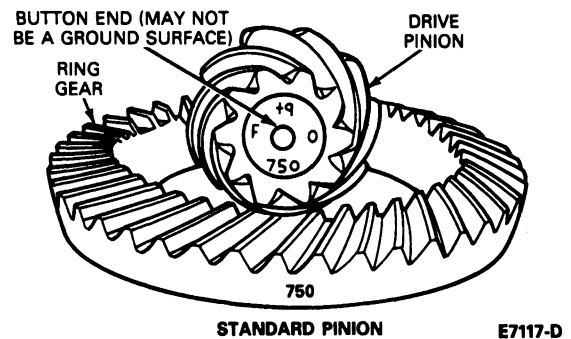
13. Force the differential assembly as far as it will go in the opposite direction. Repeat these steps until you have obtained the same reading. Record the reading of the indicator. This will be the total amount of shims required (less preload) and will be calculated later during assembly.

14. After making sure the readings are correct, remove indicator and differential assembly from housing. **DO NOT REMOVE MASTER BEARINGS FROM DIFFERENTIAL CASE AT THIS TIME.**

This reading is the total differential case end play which will be needed in Step 6 of Assembly of Differential into Housing in this section.



NOTE: Ring gears and pinions are supplied in matched sets only. Matching numbers on both the pinion and ring gear are etched for verification. If a new gear set is being used, verify the numbers of each pinion and ring gear before proceeding with assembly.



The distance from the centerline of the ring gear to the backface of the pinion (Model 60) is 127mm (5.000 inch).

On the button of each pinion, there is etched a plus (+) number, a minus (-) number, or a zero (0) number which indicates the best running position for each particular gear set. This dimension is controlled by the shimming behind the inner pinion bearing cup.

NOTE: Do not use the button of the pinion for pinion positioning. The button of the pinion is no longer a ground surface.

For example, if a pinion is etched a plus m+8 (+3), this pinion would require 0.08mm (0.003 inch) less shims than a pinion etched "0". This means by removing shims, the mounting distance of the pinion is increased, which is just what m+8 (+3) indicates. Or if a pinion is etched m-8 (-3), we would want to add 0.08mm (0.003 inch) more shims than would be required if the pinion were etched "0". By adding 0.08mm (0.003 inch) shims, the mounting distance of the pinion was decreased, which is just what m-8 (-3) indicated.

DISASSEMBLY AND ASSEMBLY (Continued)

If the old ring and pinion set is to be reused, measure the old shim pack and build a new shim pack to this same dimension. If a baffle and slinger is used in the axle assembly, it is considered as part of the shim pack.

To change the pinion adjustment, shims are available in thicknesses of 0.08, 0.13 and 0.25mm (0.003, 0.005 and 0.010 inch).

NOTE: If baffle or slinger is bent or mutilated, it should be replaced.

Measure each shim separately with a micrometer and add together to get the total shim pack thickness from the original buildup.

If a new gear set is being used, notice the (+) or (-) etching on both the old and new pinion and adjust the thickness of the new shim pack to compensate for the difference of these two figures.

For example, if the old pinion reads m+5 (+2) and the new pinion is m-5 (-2), add 0.10mm (0.004 inch) shims to the original shim pack.

Old Pinion Marking	New Pinion Marking (English)								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

TE4091A

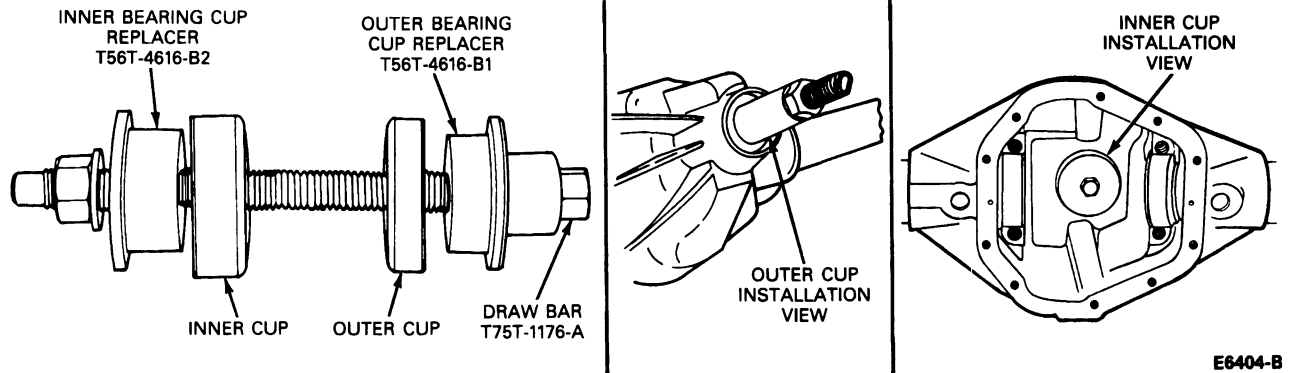
Old Pinion Marking	New Pinion Marking (Metric)								
	-10	-8	-5	-3	0	+3	+5	+8	+10
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	-.03
+5	+.15	+.13	+.10	+.08	+.05	+.03	0	-.03	-.05
+3	+.13	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08
0	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10
-3	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13
-5	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15
-8	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18
-10	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18	-.20

TE4092A

Pinion Bearing Cup Installation

1. Place the preload shims and baffle, if required, under the inner cup as shown.
2. Place the inner and outer bearing cups into the carrier bore.
3. Place the Inner Bearing Cup Replacer Tool T56T-4616-B2 on the inner bearing cup.

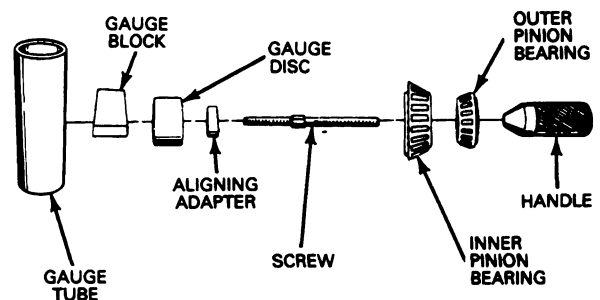
4. Place the Outer Bearing Cup Replacer Tool T56T-4616-B1 on the outer bearing cup.
5. Install the Threaded Drawbar T75T-1176-A into the replacer tools. Tighten the drawbar to install the cups into the carrier bore.

DISASSEMBLY AND ASSEMBLY (Continued)**Pinion Bearing Cup Installation****Depth Gauge Check**

NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium India oilstone to ensure correct readings.

1. Refer to the chart below for the correct tools for the particular axles.
2. Place a new inner pinion bearing over the proper aligning adapter and insert into the pinion bearing retainer assembly. Place the outer pinion bearing (new or used if in good condition) into the bearing cup and assemble the handle onto the screw and hand-tighten. Note the 3/8 inch square drive in the handle to be used for obtaining the proper pinion bearing preload. Tighten to preload of 2.26-4.51 N·m (20-40 in-lb).
3. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten capscrews to 109-122 N·m (80-90 ft-lb).
4. Using a feeler gauge tool or shims, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge directly along the gauge block to ensure a correct reading.

NOTE: The feeler gauge fit between the gauge tube and the gauge block should be a slight drag-type feeling. Make sure shims or feeler gauges are free of dirt to ensure a correct reading.

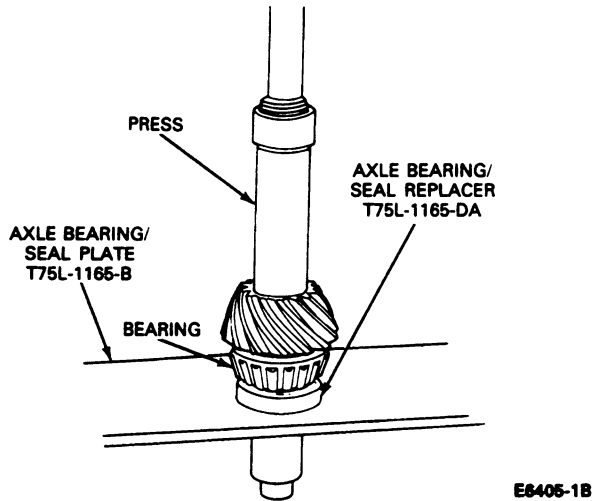


Description	Number
Handle	T76P-4020-A11
Screw	T80T-4020-F43
Gauge Block	T80T-4020-F42
Aligning Adapter	T76P-4020-A3
Gauge Disc	T78P-4020-A15
Gauge Tube	D80T-4020-F48

CE6653-1B

DISASSEMBLY AND ASSEMBLY (Continued)**Pinion Bearing Preload and Final Depth Check**

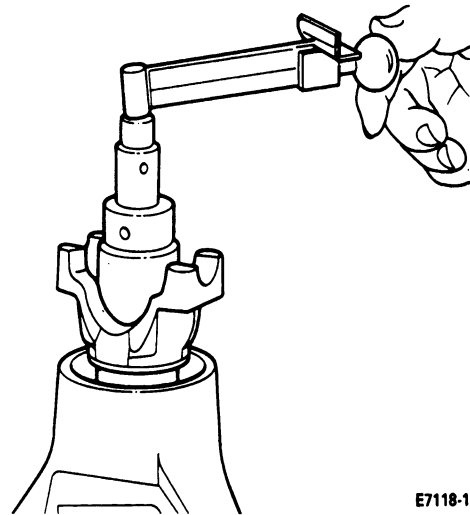
1. Assemble slinger (if used) onto pinion. Assemble bearing cone using Axle Bearing / Seal Plate T75L-1165-B and Axle Bearing / Seal Replacer T75L-1165-DA.



2. Assemble outer bearing cone, slinger and oil seal into housing. Coat the oil seal with grease. Install the drive pinion oil seal with Pinion Seal Replacer T56T-4676-B. After installation, make sure the garter spring did not pop out. If the garter spring pops out, remove and replace seal.



3. Assemble pinion preload shims onto pinion and install housing.
4. Assemble end yoke, washer and old pinion nut. Tighten nut to specifications listed at the end of this section.
5. Using an N-m (in-lb) torque wrench, rotate pinion. The torque required to rotate the pinion should be between 2.26-4.51 N-m (20-40 in-lb). To increase preload, remove shims from drive pinion. To decrease preload, add shims to pinion.
6. If rotating torque is within specifications, remove nut and install new pinion nut and tighten to specifications listed at the end of this section.

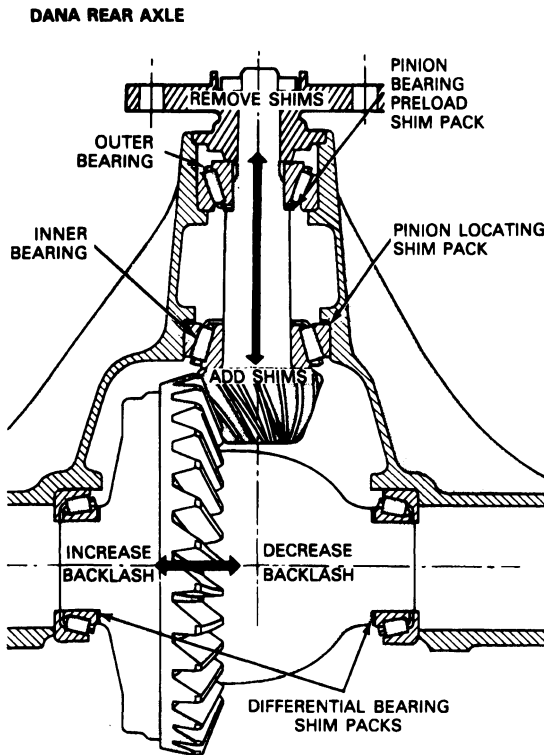


The illustration shows the arrow in the pinion pointing in two directions.

- The arrow pointing toward the end yoke indicates by removing pinion position shims, the distance from the centerline of the axle to the pinion mounting surface (back face of pinion) is increased giving a plus reading.
- The arrow pointing toward the drive pinion indicates by adding pinion shims, the distance from the centerline of the axle to the pinion button is decreased, giving a minus reading.
- The pinion bearing preload shim pack does not affect the pinion depth setting.
- However, pinion position shim change will affect pinion preload. If position of pinion is changed, the preload shim pack must be changed in the same amount in order not to change preload.

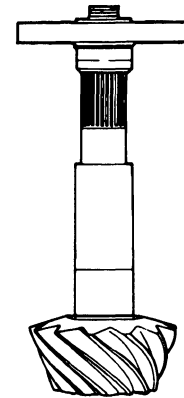
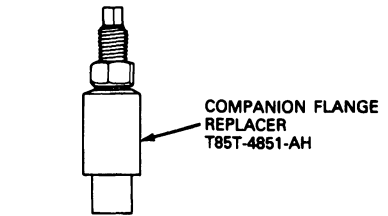
DISASSEMBLY AND ASSEMBLY (Continued)

- The arrows on the ring gear show the method for increasing or decreasing ring gear backlash by inserting or removing differential bearing shims.



E6406-C

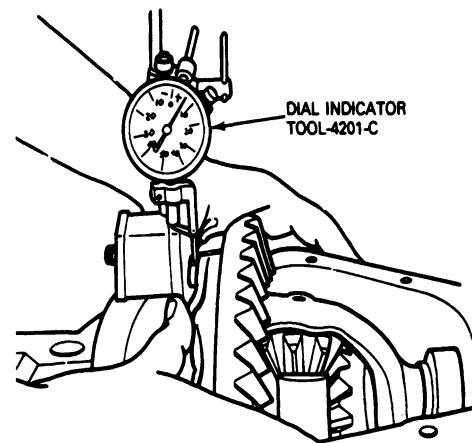
7. Install the yoke with Companion Flange Replacer T85T-4851-AH or equivalent, if necessary to draw the drive pinion up to engage the nut.
8. Install the washer and nut and tighten nut to torque specification listed at the end of this section.



E4852-1B

Assembly of Differential Into Housing**Ring Gear and Pinion Backlash**

1. Place differential assembly into housing. Differential master bearings should still be assembled to case.
2. Set up Dial Indicator TOOL-4201-C. Force ring gear into mesh with the pinion. Rock ring gear to allow the teeth of the gears to mesh. With force still applied to the differential case, set indicator at zero.



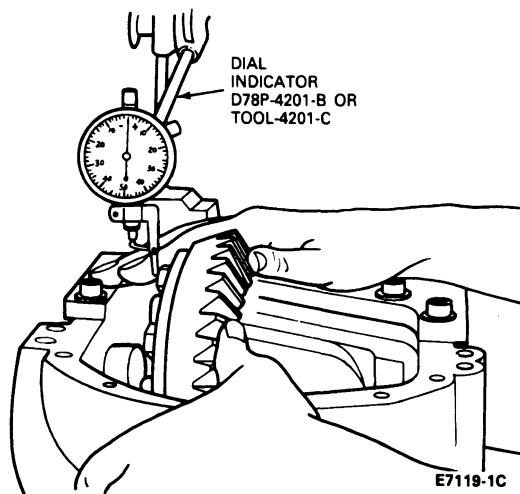
E6403-1B

DISASSEMBLY AND ASSEMBLY (Continued)

3. Force the differential case (ring gear) away from the pinion gear to obtain an indicator reading. Repeat until the same reading is obtained each time.

NOTE: This reading will be the necessary amount of shims required between the differential case and differential bearings on the ring gear side.

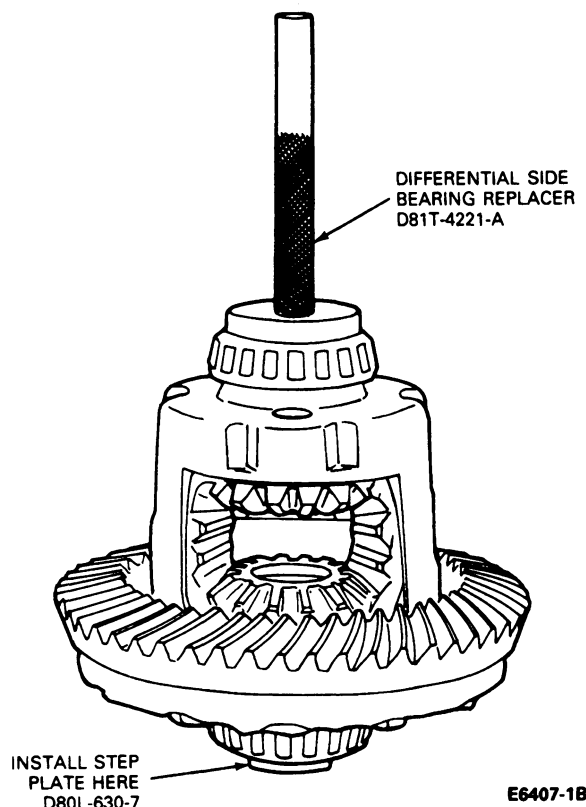
4. Remove indicator and differential case from the carrier.
5. Remove master bearings from differential case.



6. As determined in Step 3, place the required amount of shims on the ring gear hub of the differential case.

For example: if the reading in Step 3 was 1.14mm (0.045 inch), place 1.14mm (0.045 inch) amount of shims on the hub of the ring gear side of the differential case.

7. Install the bearing cone on the ring gear side of the differential case. Drive the bearing onto the hub using Differential Bearing Cone Replacer D81T-4221-A or equivalent as shown.



8. To determine the correct amount of shims to be placed on the hub of the drive pinion side of the differential case, subtract the reading obtained in Step 3 from the total differential case end play. Total case end play was determined under Steps 10 and 11 of Differential Case Assembly. When this amount is determined, add 0.36mm (0.015 inch) to the amount. This is the required amount of shims to be placed on the hub of the drive pinion side of the differential case.

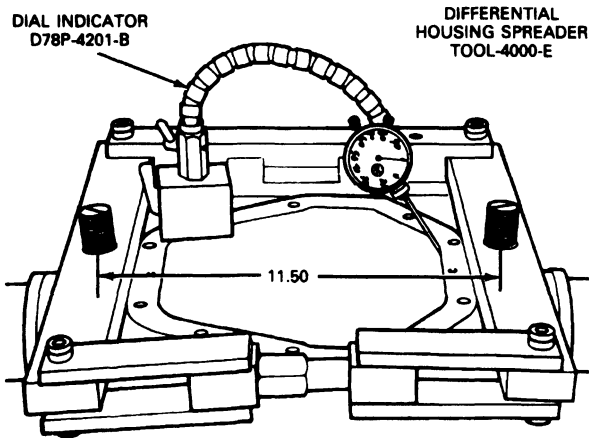
For example, Total Differential Case End Play was 2.30mm (0.091 inch). The reading in Step 3 was 1.14mm (0.045 inch), and when subtracted from 2.30mm (0.091 inch) gives 1.16mm (0.046 inch). 0.36mm (0.015 inch) is added to give 1.52mm (0.061 inch) amount of shims to be placed on the hub of the drive pinion side of the differential case.

9. Place the required amount of shims on the hub of the drive pinion side of the differential case.
10. Install the bearing cone on the hub of the drive pinion side of the differential case. Place Step Plate Adapter D80L-630-7 or equivalent for Model 60 axles on the ring gear side bearing to protect the bearing during installation of the drive pinion side bearing.
11. Place the bearing on the drive pinion side hub and drive it on using Differential Bearing Cone Replacer D81T-4221-A or equivalent.

DISASSEMBLY AND ASSEMBLY (Continued)

12. Install spreader and indicator to carrier. Remove indicator.

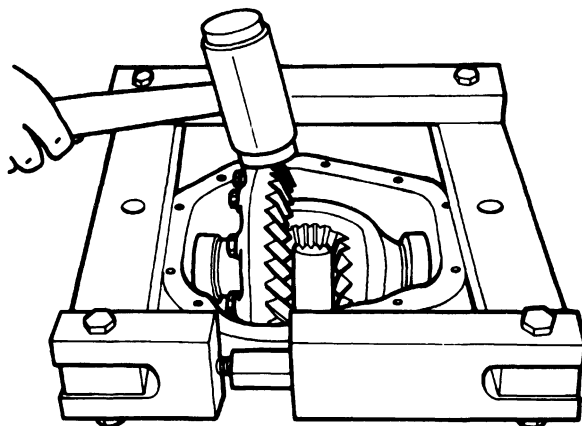
CAUTION: Do not spread carrier over 0.38mm (0.015 inch).



SPREADER MUST ACCOMMODATE 292mm
(11.50 INCH) DISTANCE BETWEEN ϕ OF
HOLE TO ϕ OF HOLE

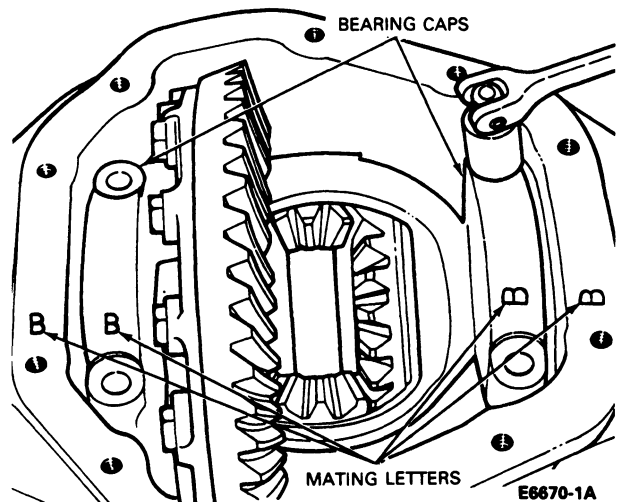
E8074-1B

13. Assemble differential bearing cups to differential bearing cones.
14. Install differential assembly into carrier. Use a rawhide hammer to seat differential assembly into crossbore of carrier.
- NOTE: Avoid nicking the teeth of the ring gear and pinion during assembly.
15. Remove the spreader from the differential case.



E8018-1A

16. Install bearing caps. Make sure the letters stamped on the caps correspond with those on the carriers. Tighten bearing cap screws to specifications listed at the end of this section.



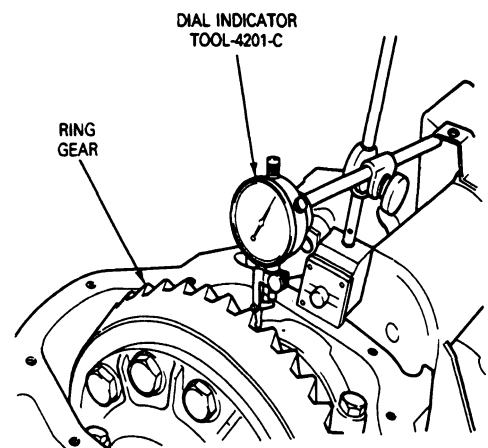
17. Check ring gear and pinion backlash in three equally spaced points with dial indicator.

Backlash tolerance is 0.13-0.23mm
(0.005-0.009 inch) and cannot vary more than
0.05mm (0.002 inch) between points checked.

High backlash is corrected by moving the ring gear closer to the pinion.

Low backlash is corrected by moving ring gear away from the pinion.

These corrections are made by switching shims from one side of the differential case to the other.



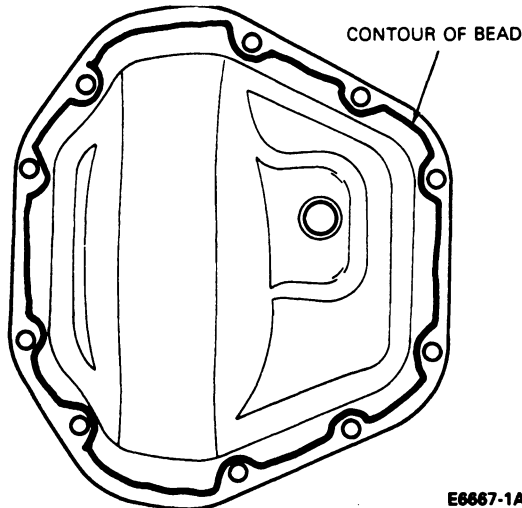
E7500-1B

18. Obtain a gear tooth contact pattern. Check as outlined under Gear Tooth Contact Pattern Check in this section prior to complete reassembly.
19. The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

Sealant material must meet specifications of D6AZ-19562-AA or -BB (ESB-M4G92-A) or equivalent.

DISASSEMBLY AND ASSEMBLY (Continued)

Apply RTV Silicone Rubber Sealer D6AZ-19562-AA or -BA (ESB-M4G92-A) or equivalent to cover plate surface. Make sure the sealer bead (3.18-6.35mm [1/8 to 1/4 inch] wide) is laid on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.



E6667-1A

20. Install two cover screws into cover at 8 o'clock and 2 o'clock positions. Use these two holes to guide cover plate into position on the carrier. Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lb).

Allow one hour curing time before filling carrier with the proper amount of specified lubricant and vehicle operation.

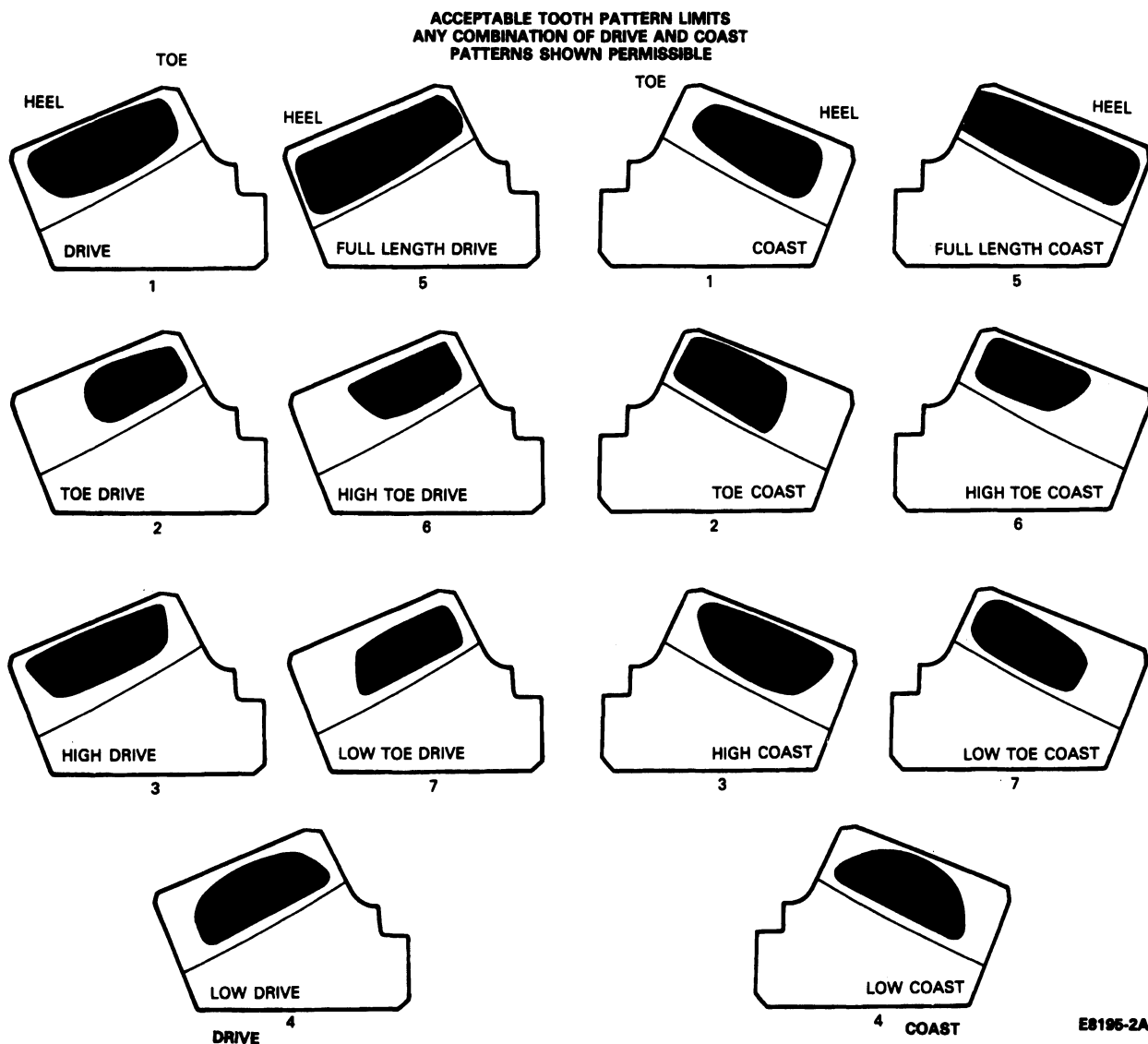
21. Install the axle shafts as described under Axle Shaft in the Removal and Installation portion of this section.
22. Connect the steering linkage to the steering knuckle.

Gear Tooth Contact Pattern Check

1. When rolling a teeth pattern, use a special marking compound (tube) to obtain gear tooth mesh contact pattern.
2. To check the gear tooth contact, paint the gear teeth with the special marking compound.
NOTE: A mixture that is too wet will run and smear, too dry a mixture cannot be pressed out from between the teeth.
3. Rotate ring gear (use a box wrench on the ring gear attaching bolts as a lever) several complete revolutions in both directions or until a clear tooth contact pattern is obtained.

DISASSEMBLY AND ASSEMBLY (Continued)

4. Certain types of gear tooth contact patterns on the ring gear indicate incorrect adjustment. Incorrect adjustment can be corrected by readjusting the ring gear and / or the pinion.

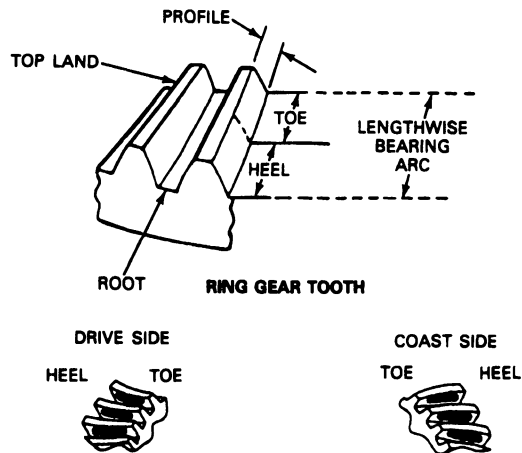


5. The previous illustration shows acceptable tooth patterns for all axles. In general, desirable tooth patterns should have the following characteristics:
- The drive pattern should be fairly well centered on the tooth.
 - The coast pattern should be fairly well centered on the teeth.

- Some clearance between the pattern and the top of the tooth is desirable.
- There should be no hard lines where the pressure is high.

DISASSEMBLY AND ASSEMBLY (Continued)

6. An individual gear set need not conform exactly to the ideal pattern to be acceptable. Any combination of drive and coast patterns shown is acceptable.



**PATTERN INTERPRETATION
(RING GEAR)**

NORMAL OR DESIRABLE PATTERN. THE DRIVE PATTERN SHOULD BE CENTERED ON THE TOOTH. THE COAST PATTERN SHOULD BE CENTERED ON THE TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD BE SOME CLEARANCE BETWEEN THE PATTERN AND THE TOP OF THE TOOTH.

THE TOE OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE END TOWARDS THE CENTER. THE HEEL OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE OUTER END. THE TOP LAND OF A GEAR TOOTH IS THE SURFACE OF THE TOP OF THE TOOTH.





E8196-1A

7. Since each gear set rolls a characteristic pattern, the patterns shown are considered acceptable and should be used as a guide. The drive pattern is rolled on the convex side of the tooth, and the coast pattern is rolled on the concave side.

The movement of tooth contact patterns with changes in shimming can be summarized as follows:

- Thinner shim, with the backlash set to specification, moves the pinion farther from the ring gear.
- Thicker shim, with the backlash set to specification, moves the pinion closer to the ring gear.

NOTE: When making pinion position changes, shims should be changed in the range of .05mm (.002 inch) to .10mm (.004 inch) until correct pattern has been obtained.

DRIVE SIDE		COAST SIDE		
HEEL	TOE	TOE	HEEL	
		BACKLASH CORRECT. THINNER PINION POSITION SHIM REQUIRED.		
		BACKLASH CORRECT. THICKER PINION POSITION SHIM REQUIRED.		

THICKER PINION POSITION SHIM WITH THE BACKLASH CONSTANT MOVES THE PINION CLOSER TO THE RING GEAR.

DRIVE PATTERN MOVES DEEPER ON THE TOOTH (FLANK CONTACT) AND SLIGHTLY TOWARD THE TOE.

COAST PATTERN MOVES DEEPER ON THE TOOTH AND TOWARD THE HEEL.

THINNER PINION POSITION SHIM WITH THE BACKLASH CONSTANT MOVES THE PINION FURTHER FROM THE RING GEAR.

DRIVE PATTERN MOVES TOWARD THE TOP OF THE TOOTH (FACE CONTACT) AND TOWARD THE HEEL.

COAST PATTERN MOVES TOWARD THE TOP OF THE TOOTH AND SLIGHTLY TOWARD THE TOE.

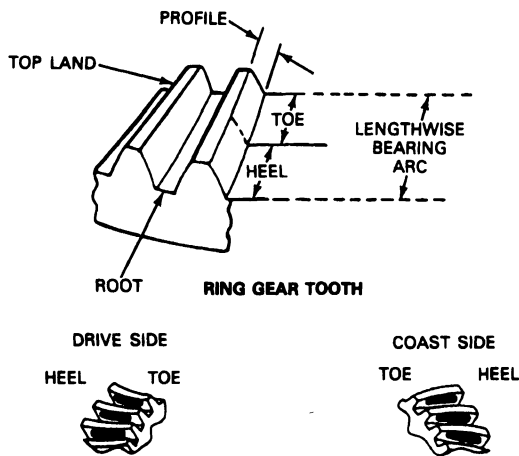
E8197-1A

8. If the pinion positioning shims are correct:
- decreasing backlash moves the ring gear closer to the pinion. Drive pattern (convex side of gear) moves slightly lower and toward the toe. Coast pattern (concave side of gear) moves lower and toward the toe.

DISASSEMBLY AND ASSEMBLY (Continued)

- increasing backlash moves the ring gear away from the pinion. Drive pattern moves slightly higher and toward the heel. Coast pattern moves higher and towards the heel.

NOTE: If the patterns are not correct, make the changes as indicated. The differential case and drive pinion will have to be removed from the carrier housing to change a shim.



PATTERN INTERPRETATION
(RING GEAR)

NORMAL OR DESIRABLE PATTERN. THE DRIVE PATTERN SHOULD BE CENTERED ON THE TOOTH. THE COAST PATTERN SHOULD BE CENTERED ON THE TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD BE SOME CLEARANCE BETWEEN THE PATTERN AND THE TOP OF THE TOOTH.

THE TOE OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE END TOWARDS THE CENTER. THE HEEL OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE OUTER END. THE TOP LAND OF A GEAR TOOTH IS THE SURFACE OF THE TOP OF THE TOOTH.

E8198-1A

- Check ring gear backlash by installing a dial indicator on the carrier housing. Check ring gear and pinion backlash at three equally spaced points on the ring gear.

NOTE: Backlash tolerance is 0.13-0.23mm (0.005-0.009 inch) and cannot vary more than 0.08mm (0.003 inch) between the three points.

- If backlash is high, the ring gear must be moved closer to the pinion, by moving shims too the ring gear side to the opposite side.

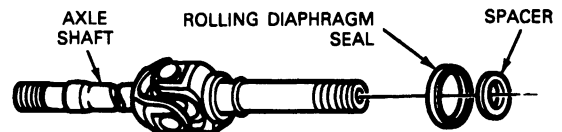
- If backlash is low, the ring gear must be moved away from the pinion by moving shims from the ring gear side to the opposite side.

NOTE: When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .10mm (.004 inch), the shim pack should be changed by .15mm (.006 inch) as a starting point. The actual amount of backlash change obtained will vary depending upon the ratio and gear size.

Axle Shaft

Disassembly

- Remove the axle shaft as described under Axle Shaft in the Removal and Installation portion of this section.
- If installed, remove the spacer from the axle shaft.
- Remove the rubber Rolling Diaphragm Seal from the axle shaft.



E6654-D

- Remove the snap rings that retain the bearings in the yoke and axle shaft.
- Position U-Joint Tool T74P-4635-C on the shaft and press the bearings out of the yoke. If the bearing cannot be pressed completely out of the yoke, remove the bearing with vise grip or channel lock pliers. Mark the yoke and shaft so they can be assembled in the same position.
- Re-position the U-Joint Tool T74P-4635-C to press on the spider to remove the bearing from the opposite side of the yoke.
- Remove the yoke from the spider.

Assembly

- Position the spider in the axle shaft and press the bearing 6mm (1/4 inch) below the axle shaft surface using Pinion Bearing Cone Remover D79L-462 1-A or equivalent.
- Remove the tool and install a new snap ring.
- Start a new bearing on the opposite side of the axle shaft.
- Install the U-Joint Tool and press the bearing until the snap ring of the opposite bearing contacts the axle shaft.
- Remove the tool and install a new snap ring.

DISASSEMBLY AND ASSEMBLY (Continued)

6. Install the yoke on the spider in position marked during disassembly.
7. Install two new bearings and snap rings in the yoke and spider in the same manner as the axle shaft.
8. Check the U-joint for freedom of movement. If a binding condition results, tap the ears of the axle shaft sharply to relieve the binding. **DO NOT INSTALL AN AXLE SHAFT IF THE U-JOINT SHOWS SIGNS OF BINDING.**
9. Install the rubber Rolling Diaphragm Seal on the axle shaft. The lip of the seal should face towards the spindle.

ADJUSTMENTS**Front Wheel Bearing Adjustment**

Refer to Section 05-02L for front wheel bearing adjustment procedures.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Lb-Ft
Pinion Shaft Nut	298-379	220-280
Differential Bearing Cap Capscrews	109-122	80-90
Ring Gear Bolts / Nuts	136-162	100-120
Ring Gear Bolts / Nuts Grade 9, C7 Lines on Bolt Head	169-183	125-135
Oil Filler Plug	28-40	20-30
U-Joint U-Bolt Nuts	21-27	15-20
Cover-To-Housing Bolts	41-54	30-40
Tracking Bar Nut & Bolt	221-275	163-203
Stabilizer Link Nut	28-48	21-33

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Stabilizer Bar U-Bolt	65-92	48-68
Spindle Connecting Rod-To-Steering Knuckle Castellated Nut	95-135	70-100
Stabilizer Bar Bracket U-Bolt	65-92	48-68
Lower Ball Joint Nut	203	150 ^a
Upper Ball Joint Nut	95	70 ^a
Spindle-To-Steering Knuckle Nuts	68-81	50-60
Outer Locknut	217-277	160-205
Capscrews — 6 Torx®-Head	4.0-6.0	35-50 In-Lb

- a Requires specific tightening sequence for proper installation. Refer to ball joint installation procedure in this section for procedure.

DANA AXLE ADJUSTMENTS

Description	Specification	Description	Specification
Backlash Between Ring Gear and Pinion	0.13-0.23 mm (0.005-0.009 inch)	Pinion Bearing Preload (with new bearings)	1.7-3.95 N-m (15-35 in-lbs)
Backlash Maximum Variation Between Teeth	0.05 mm (0.002 inch)		

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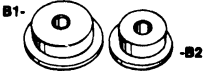
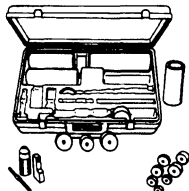


AXLE LUBRICANT CAPACITIES

Axle Model	Ford Specification	Approx. Capacities		
		U.S. Pts.	Imp. Pts.	Liters
60	Hypoid Gear Lubricant, C6AZ-19580-E (CESW-M2C105-A) or equivalent	5.8	4.8	2.8







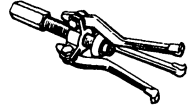
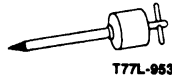
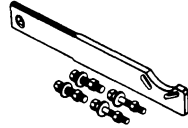

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SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number	Description
D78P-4201-B	Dial Indicator
D80L-100-H	Actuator Pin
D80L-100-W	Bridge Assembly
D80L-100-T	Collet (1-1/2 to 1-3/4 inch)
D80T-4020-F48	Gauge Tube
D81L-4000-A	Driver Handle
D81T-4020-F54	Final Check Gauge Block
D81L-4220-A	Pinion and Carrier Bearing Puller
D81T-4221-A	Differential Bearing Cone Replacer
D81T-4222-D	Master Differential Bearings Tool
D81T-4628-A	Pinion Bearing Cup Remover
D81T-4628-D	Pinion Bearing Cup Remover
D85T-1197-A	Spanner Locknut Wrench
D81T-3010-A1	Ball Joint Remover/Replacer (Inside)
D81T-3010-A3	Ball Joint Remover/Replacer (Middle)
D81T-3010-A4	Ball Joint Remover/Replacer (Outside)
D81T-3010-A5	Receiver Cup
D80L-630-7	Step Plate Adapter

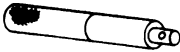
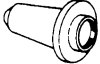
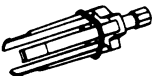



Tool Number/ Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T56T-4616-B Inner and Outer Bearing Cup Replacer Tool	 T56T-4616-B
T79P-4020-A Pinion Depth Gauge Set	 T79P-4020-A
T56T-4676-B Pinion Seal Replacer	 T56T-4676-B
T57T-4851-B Companion Flange Holding Tool	 T57T-4851-B

(Continued)




Tool Number/ Description	Illustration
T64P-3590-F Pitman Arm Puller	 T64P-3590-F
T65L-4851-B Companion Flange Remover	 T65L-4851-B
T74P-4635-C U-Joint Tool	 T74P-4635-C
T75L-1165-B Axle Bearing / Seal Plate	 T75L-1165-B
T75L-1165-DA Axle Bearing / Seal Replacer	 T75L-1165-DA
T75T-1176-A Threaded Drawbar	 T75T-1176-A
T77F-1102-A Bearing Cup Puller	 T77F-1102-A
T77L-9533-B Jet Plug Remover	 T77L-9533-B
T78P-4851-A Holding Tool	 T78P-4851-A
T80T-4000-R Bearing Replacer	 T80T-4000-R

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT **(Continued)**

Tool Number / Description	Illustration
T80T-4000-W Driver Handle	 T80T-4000-W
T83T-4676-A Pinion Seal Replacer	 T83T-4676-A
TOOL-1175-AC Seal Remover	 TOOL-1175-AC
TOOL-4000-E Differential Housing Spreader	 TOOL-4000-E
TOOL-4201-C Dial Indicator	 TOOL-4201-C
TOOL-4858-E Companion Flange Replacer	 TOOL-4858-E

(Continued)

Tool Number / Description	Illustration
T92T-4000-A Spindle Seal Replacer	 T92T-4000-A
T92T-3010-A Ball Joint Remover / Replacer (Outside)	 T92T-3010-A
T92T-3010-B Ball Joint Remover / Replacer (Inside)	 T92T-3010-B

ROTUNDA EQUIPMENT

Tool Number	Description
014-00257	Differential Repair Stand
077-00008	Low Lift Transmission Jack

SECTION 05-02K Axle, Front Drive, Dana Models 44 and 50

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS.....	05-02K-33	DISASSEMBLY AND ASSEMBLY (Cont'd.)	
DESCRIPTION AND OPERATION		Drive Pinion Preload Check.....	05-02K-27
Automatic Locking Hubs Operation (Standard		Gear Tooth Contact Pattern Check	05-02K-30
on Bronco and F-150 4x4	05-02K-8	Total Differential Case End Play	05-02K-23
Free Running Position, Manual Locking		REMOVAL AND INSTALLATION	
Hubs	05-02K-8	Axle Housing Pivot Bushing (IFS Front Drive	
Front-Wheel Drive Manual Hub	05-02K-7	Axle)	05-02K-20
Lock Position	05-02K-8	Dana Four Wheel Drive Front Axle.....	05-02K-8
DIAGNOSIS AND TESTING.....	05-02K-8	Left Differential Seal	05-02K-20
DISASSEMBLY AND ASSEMBLY		Right Slip-Yoke and Stub Shaft Assembly,	
Bearing Cup and Drive Pinion		Carrier, Carrier Oil Seal, and Bearing	05-02K-17
Installation.....	05-02K-27	Spindle, Right and Left Shaft and Joint	
Cardan-Type U-Joints	05-02K-21	Assembly	05-02K-14
Carrier	05-02K-21	Steering Knuckle.....	05-02K-12
Depth Gauge Check.....	05-02K-26	SPECIAL SERVICE TOOLS	05-02K-33
Differential Case	05-02K-28	SPECIFICATIONS.....	05-02K-33
Differential Case Assembly to Carrier	05-02K-28	VEHICLE APPLICATION	05-02K-1
Drive Pinion Installation	05-02K-24		

VEHICLE APPLICATION

F-150-250 4x4 and Bronco Vehicles

DESCRIPTION AND OPERATION

Three types of Dana front-drive axles are available for Ford light truck application. The Dana 44-IFS (Independent Front Suspension) is available on Bronco and F-150 4x4. The Dana 44-IFS-HD (Independent Front Suspension — Heavy Duty) is available on F-250 4x4. The Dana 50-IFS (Independent Front Suspension) is available on F-250 4x4 equipped with Heavy Duty Front End option or F-250 SuperCab vehicles.

All axles are basically alike with some differences between the three. The 44-IFS is on vehicles equipped with front coil springs. The 44-IFS-HD and 50-IFS are on vehicles equipped with front leaf springs.

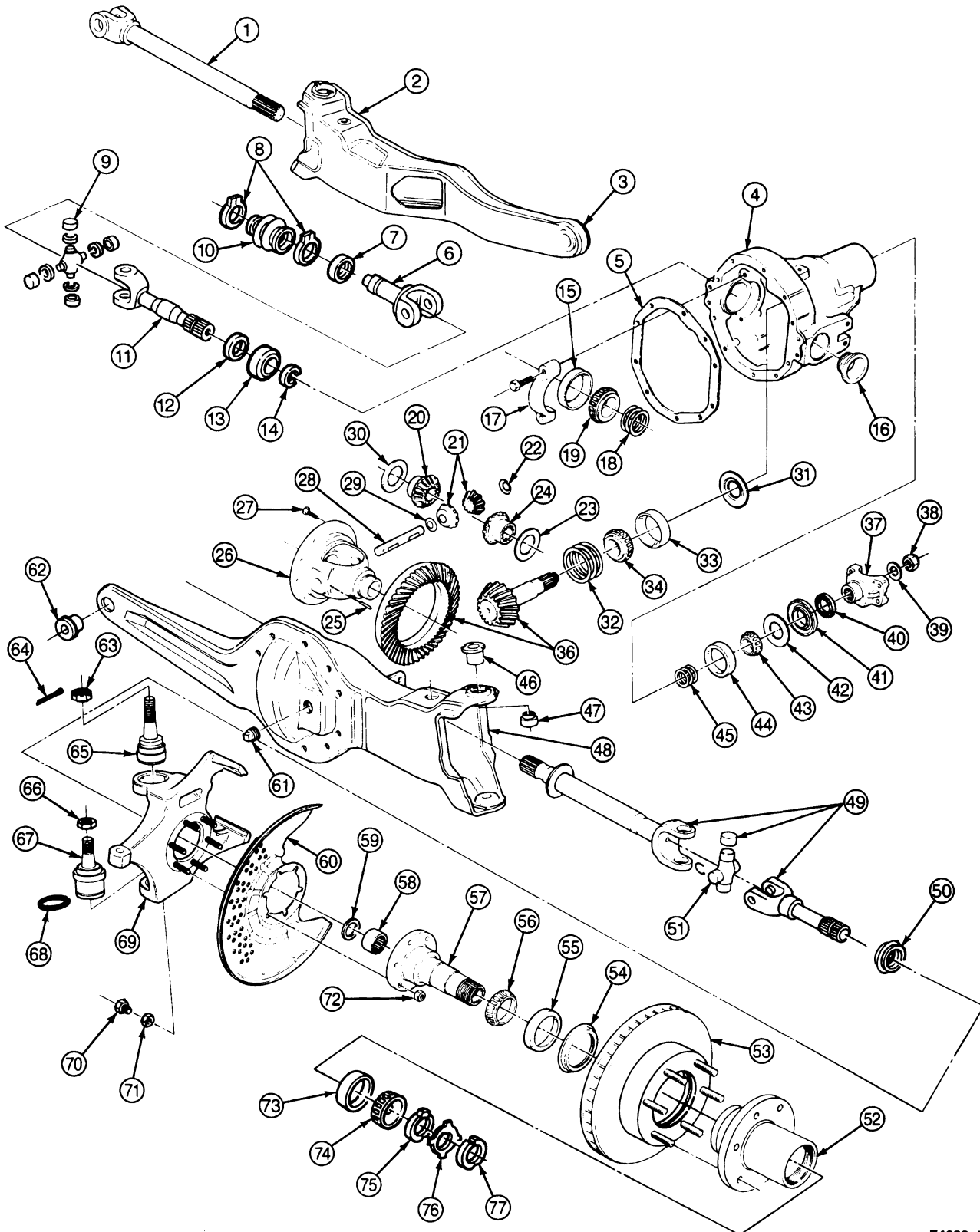
The 44-IFS may be equipped with either automatic hubs or manual hublocks. The 44-IFS-HD and 50-IFS axles are equipped with manual locking hubs only.

The front axle is of the integral carrier-housing, hypoid-gear type, in which the centerline of the drive pinion is mounted above the centerline of the ring gear.

On IFS front driving axles, the cover on the front of the carrier housing is integral with the left axle arm assembly. A metal tag, stamped with the gear ratio and part number is secured to the housing by one of the carrier mounting bolts (Section 05-00).

DESCRIPTION AND OPERATION (Continued)

Dana 44-IFS Front Drive Axle, Bronco and F-150 4x4 with Automatic Hub Locks



E4099-J

DESCRIPTION AND OPERATION (Continued)

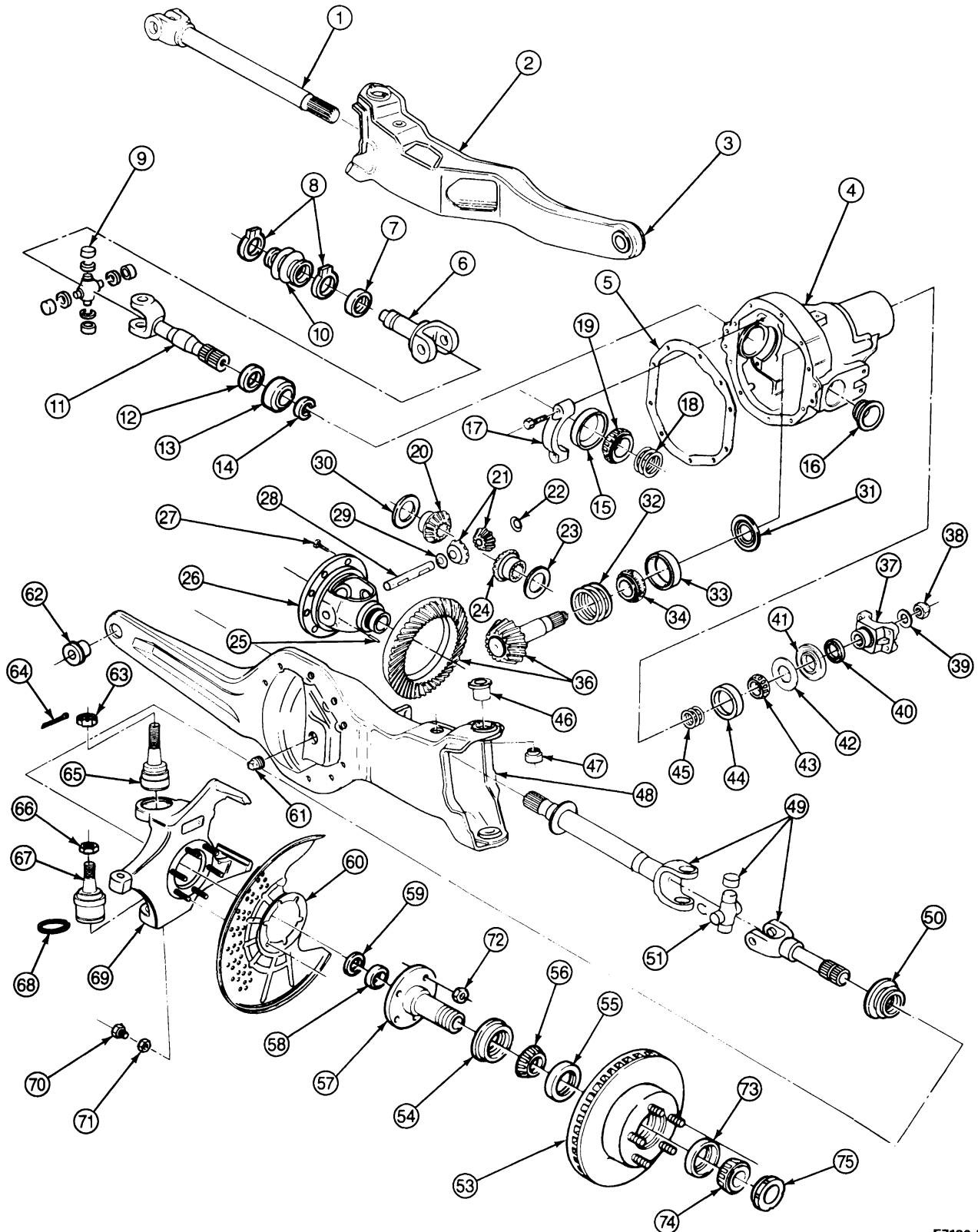
Item	Part Number	Description
1	3219	Shaft (RH)
2	—	Axle Arm Assembly
3	38177	Pivot Bushing
4	3010	Housing
5	4036	Gasket (form in place)
6	—	Slip Shaft
7	4A460	Seal
8	802857	Keystone Clamp
9	3249	Universal Joint Kit
10	3A429	Boot
11	3M387	Shaft
12	—	Oil Seal
13	—	Bearing
14	—	C-Clip
15	4222	Cup
16	3254	Seal
17	—	Cap
18	4067	Shim
19	4221	Cone and Roller
20	4236	Side Gear
21	4215	Differential Pinion Gears
22	4230	Washer
23	4228	Washer
24	4236	Side Gear
25	357228-S	Bolt
26	4204	Case Assembly
27	350672-S	Bolt
28	4211	Differential Pinion Shaft
29	4230	Washer
30	4228	Washer
31	4670	Baffle (inner Rear)
32	4672	Shim
33	4628	Cup
34	4630	Cone and Roller
36	4209	Ring Gear and Drive Pinion
37	4851	Flange Assembly
38	351126-S	Nut
39	356504-S	Washer
40	4859	Deflector

(Continued)

Item	Part Number	Description
41	4676	Seal
42	4670	Slinger (Outer)
43	4621	Cone and Roller
44	4616	Cup
45	4109	Shim
46	3B404	Camber Adjuster
47	—	Weldnut
48	3B404	Camber Adjuster
49	3219 (RH) 3220 (LH)	Shaft Assembly
50	—	Seal
51	3249	Universal Joint Kit
52	—	Hub
53	—	Rotor
54	1175	Wheel Seal
55	4222	Cup
56	4221	Cone and Roller
57	3105	Spindle
58	3123	Bearing
59	1175	Seal
60	2K004 (RH) 2K005 (LH)	Shield
61	87747-S2	Filler Plug
62	3B177	Pivot Bushing
63	3A049	Nut
64	72035-S	Pin
65	3B102	Joint Assembly
66	—	Nut
67	3B102	Joint Assembly
68	—	Snap Ring
69	3130 (RH) 3131 (LH)	Steering Knuckle
70	373912-S	Stop Screw
71	33925-S	Jam Nut
72	35704	Nut
73	4222	Cup
74	4221	Cone and Roller
75	1195	Locknut
76	1198	Retainer
77	1197	Locknut
78	1C245	Thrust Washer

DESCRIPTION AND OPERATION (Continued)

Dana 44-IFS Front Drive Axle, Bronco and F-150 4x4 with Manual Hub Locks



E7130-E

DESCRIPTION AND OPERATION (Continued)

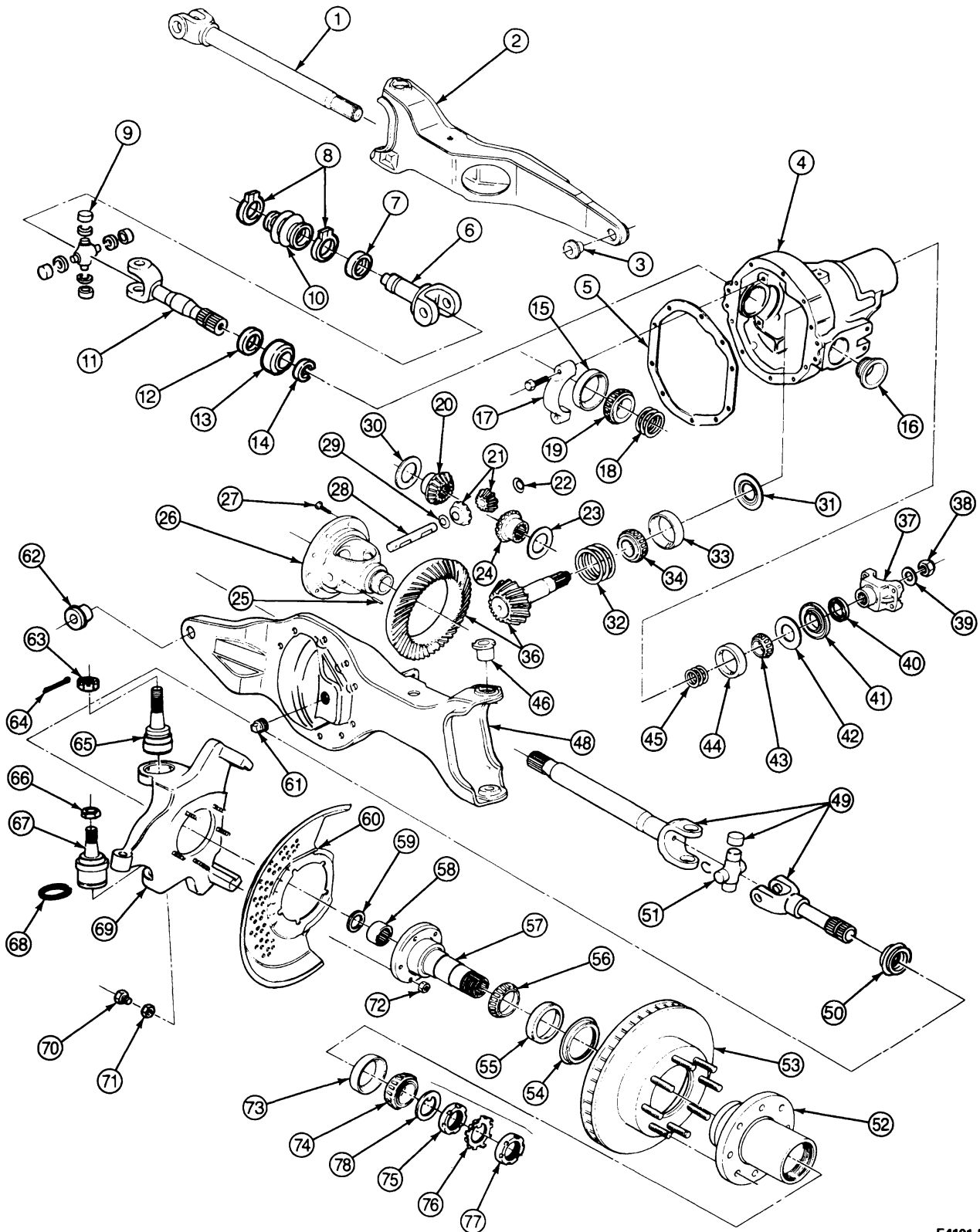
Item	Part Number	Description
1	3219	Shaft (RH)
2	—	Axle Arm Assembly (RH)
3	3B177	Pivot Bushing
4	3010	Housing
5	4036	Gasket (form in place)
6	—	Slip Shaft
7	4A460	Seal
8	802857	Keystone Clamp (2)
9	3249	Universal Joint Kit
10	3A429	Boot
11	3M387	Shaft
12	—	Oil Seal
13	—	Bearing
14	—	C-Clip
15	4222	Cup
16	3254	Seal
17	—	Cap
18	4067	Shim
19	4221	Cone and Roller
20	4236	Side Gear
21	4215	Differential Pinion Gears
22	4230	Washer
23	4228	Washer
24	4236	Side Gear
25	357228-S	Bolt
26	4204	Case Assembly
27	350672-S	Bolt
28	4211	Differential Pinion Shaft
29	4230	Washer
30	4228	Washer
31	4670	Baffle (inner Rear)
32	4672	Shim
33	4628	Cup
34	4630	Cone and Roller
36	4209	Ring Gear and Drive Pinion
37	4851	Flange Assembly
38	351126-S	Nut

(Continued)

Item	Part Number	Description
39	356504-S	Washer
40	4859	Deflector
41	4676	Seal
42	4670	Slinger (Outer)
43	4621	Cone and Roller
44	4616	Cup
45	4109	Shim
46	3B404	Camber Adjuster
47	—	Weldnut
48	3B404	Camber Adjuster
49	3219 (RH) 3220 (LH)	Shaft Assembly
50	—	Seal
51	3249	Universal Joint Kit
53	—	Hub and Rotor
54	1175	Wheel Seal
55	4222	Cup
56	4221	Inner Wheel Bearing
57	3105	Spindle
58	3123	Bearing
59	1175	Seal
60	2K004 (RH) 2K005 (LH)	Shield
61	87747-S2	Filler Plug
62	3B177	Pivot Bushing
63	3A049	Nut
64	72035-S	Pin
65	3B102	Joint Assembly
66	—	Nut
67	3B102	Joint Assembly
68	—	Snap Ring
69	3130 (RH) 3131 (LH)	Steering Knuckle
70	373912-S	Stop Screw
71	33925-S	Jam Nut
72	35704	Nut
73	4222	Cup
74	4221	Outer Wheel Bearing
75	1195	Adjusting Nut

DESCRIPTION AND OPERATION (Continued)

Dana 50-IFS Front Drive Axle, F-250 HD 4x4



E4101-H

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	32 19	Shaft (RH)
2	—	Axle Arm Assembly (RH)
3	3B 177	Pivot Bushing
4	30 10	Housing
5	40 36	Gasket (form in place)
6	—	Slip Shaft
7	4A 460	Seal
8	802857	Keystone Clamp (2)
9	32 49	Universal Joint Kit
10	3A 429	Boot
11	3M 387	Shaft
12	—	Oil Seal
13	—	Bearing
14	—	C-Clip
15	42 22	Cup
16	32 54	Seal
17	—	Cap
18	40 67	Shim
19	42 21	Cone and Roller
20	42 36	Side Gear
21	42 15	Differential Pinion Gears
22	42 30	Washer
23	42 28	Washer
24	42 36	Side Gear
25	357228-S	Bolt
26	42 04	Case Assembly
27	350672-S	Bolt
28	42 11	Differential Pinion Shaft
29	42 30	Washer
30	42 28	Washer
31	46 70	Baffle (inner Rear)
32	46 72	Shim
33	46 28	Cup
34	46 30	Cone and Roller
36	42 09	Ring Gear and Drive Pinion
37	48 51	Flange Assembly
38	35 1126-S	Nut

(Continued)

Item	Part Number	Description
39	356504-S	Washer
40	48 59	Deflector
41	46 76	Seal
42	46 70	Slinger (Outer)
43	46 21	Cone and Roller
44	46 16	Cup
45	4 109	Shim
46	3B 404	Camber Adjuster
48	3B 404	Camber Adjuster
49	32 19 (RH) 32 20 (LH)	Shaft Assembly
50	—	Seal
51	32 49	Universal Joint Kit
53	—	Hub and Rotor
54	1 175	Wheel Seal
55	42 22	Cup
56	42 21	Inner Wheel Bearing
57	3 105	Spindle
58	3 123	Bearing
59	1 175	Seal
60	2K004 (RH) 2K005 (LH)	Shield
61	87747-S2	Filler Plug
62	3B 177	Pivot Bushing
63	3A 049	Nut
64	72035-S	Pin
65	3B 102	Joint Assembly
66	—	Nut
67	3B 102	Joint Assembly
68	—	Snap Ring
69	3 130 (RH) 3 131 (LH)	Steering Knuckle
70	3739 12-S	Stop Screw
71	33925-S	Jam Nut
72	35704	Nut
73	42 22	Cup
74	42 21	Outer Wheel Bearing
75	1 195	Adjusting Nut

Front-Wheel Drive Manual Hub

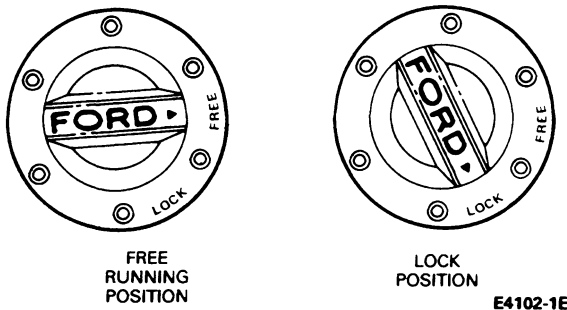
For service procedures on front hubs, refer to Section 05-02L.

The manual locking hub is optional equipment for the Dana front axle of the Bronco and F-150-250 4x4. It is the internal locking type. The automatic locking hubs are standard on F-150 4x4 and Bronco.

DESCRIPTION AND OPERATION (Continued)**Lock Position**

When the transfer case is to be shifted into the position for driving the front axle, the pointer on the center bar of the hub must point to the pointer over the word LOCK on the hub lock cap. If the clutch teeth do not engage with the knob turned to this position, the clutch teeth are butted and a slight movement of the wheel in either direction will complete the lock. The front axle will now drive the wheels. Do not operate in four-wheel drive with the hubs disengaged.

MANUAL LOCKING HUBS

**Free Running Position, Manual Locking Hubs**

When the transfer case is to be shifted into the position for driving the rear axle only, turn the pointer on the center bar of the hub so it points to the pointer over the word FREE on the hub lock cap. This will disengage the clutch teeth and thus unlock the wheel hubs from the axle shafts. The wheels will turn freely on the axles.

Make sure that the transfer case is shifted into two-wheel drive position before disengaging the free running hubs.

If difficulty is experienced in disengagement of the free running hubs, a slight movement of the vehicle in either direction with the transfer case in two-wheel drive position, will reduce driveline wrap-up and ease disengagement.

Automatic Locking Hubs Operation (Standard on Bronco and F-150 4x4)

Four-Wheel Drive — The vehicle must be stopped when you first shift into four-wheel drive. Place the transmission in neutral and the transfer case selector in the 4L position. The hub locks will automatically engage when the vehicle is driven. The transfer case may then be shifted between 2H and 4H with the vehicle moving, as long as the automatic hub locks remain engaged. The hubs will remain engaged until the disengage sequence is performed.

Two-Wheel Drive — Place the transfer case in the 2H position. To disengage the automatic hub locks, shift the transmission to move the vehicle in the opposite direction (forward or reverse) and drive a minimum of 3m (10 feet) in a straight line.

CAUTION: Never shift from 2H to 4H with the automatic hub locks disengaged while the vehicle is in motion.

CAUTION: If it is necessary to shift to or from 4L, bring the vehicle to a full stop before doing so.

DIAGNOSIS AND TESTING

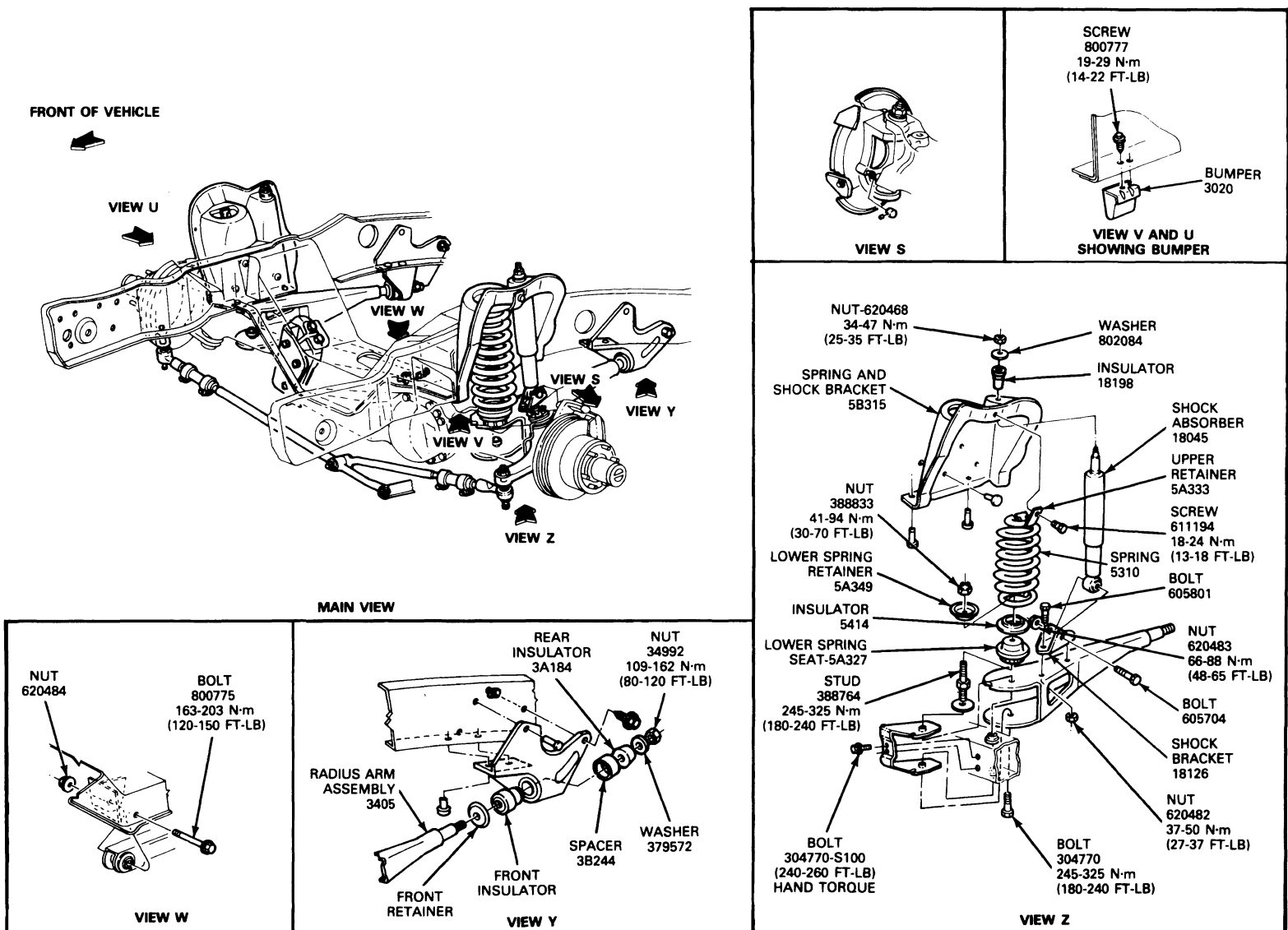
Refer to Section 05-00 for diagnosis and testing procedures.

REMOVAL AND INSTALLATION**Dana Four Wheel Drive Front Axle****F-150 4x4 and Bronco With Coil Springs****Removal**

1. Raise the vehicle on a hoist or jack and install safety stands under the radius arm brackets.
2. Remove the wheel and tire assembly and brake caliper. Refer to Section 06-03.
3. On vehicles equipped with 4-wheel Anti-lock Brakes, remove the ABS sensor from the knuckle. Refer to section 06-09B in the Body / Chassis Manual for procedure.
4. Disconnect the steering linkage from the steering knuckles according to the procedures in Section 11-03.
5. Remove front driveshaft. Refer to Section 05-01.
6. Remove front stabilizer bar. Refer to Section 04-01B.
7. Position jack under axle arm assembly and remove the upper coil spring retainers. Remove spring lower retainer bolt. Lower the jack and remove the coil spring, spring cushion and lower spring seat.
8. Disconnect the shock absorber at the radius arm and upper mounting bracket.
9. Remove the stud and spring seat at radius arm and axle arm. Remove bolt securing upper attachment to axle arm radius arm to lower attachment axle arm.
10. Disconnect the vent tube at the differential housing and discard the hose clamps. Remove the vent fitting and install a 1/8-inch pipe plug.
NOTE: Make sure shipping plug has been removed from vent tube. A plugged vent tube can cause leakage past seals or sealant materials.
11. Remove the pivot bolt securing the right axle arm assembly to crossmember.

REMOVAL AND INSTALLATION (Continued)

F-150 4x4 and Bronco with Coil Springs



E4103-D

REMOVAL AND INSTALLATION (Continued)

12. Remove and discard the keystone clamps and remove the boot from the shaft.
13. Remove the right drive axle assembly and pull the axle shaft from the slip shaft.
14. Position a jack under the differential housing. Remove the bolt securing the left axle assembly to the crossmember.
15. Remove the left hand drive axle assembly.

Installation

1. Raise the vehicle on a hoist or a jack. Position the left drive axle assembly on a jack and position to the radius arm. Secure the drive axle to crossmember with the pivot bolt. Tighten bolt to 163-203 N·m (120-150 ft-lb).
2. Using a jack, position the right axle assembly at the crossmember and radius arm. Install the boot on the shaft so the boot seats in the grooves.
3. Position new keystone clamps over the grooves on the boot and crimp the clamp with Keystone Clamp Pliers T63P-917 1-A or equivalent.
4. Align the axle shaft and install in slip shaft. Secure axle assembly to crossmember with pivot bolt. Tighten to 163-203 N·m (120-150 ft-lb).
5. Install vent fitting in differential housing. Connect vent tube to vent fitting using new hose clamps.
6. Position spring seat and install a new stud at axle arm and upper radius arm.
7. Install new bolt at axle assembly and lower radius arm. Tighten bolts to 245-325 N·m (180-240 ft-lb).
8. Position coil spring insulator and coil spring on lower spring seat. Install nut and tighten to 41-94 N·m (30-70 ft-lb).
9. Position jack under axle assembly and raise coil spring into position. Install upper spring retainer and screw. Tighten to 18-24 N·m (13-18 ft-lb).
10. Lower the jack.
11. Connect shock absorbers to upper and lower frame brackets.
12. On vehicles equipped with 4-wheel Anti-lock Brakes, install the ABS sensor on the knuckle. Refer to section 06-09B in the Body / Chassis Manual for procedure.
13. Install brake caliper and wheel and tire assembly.

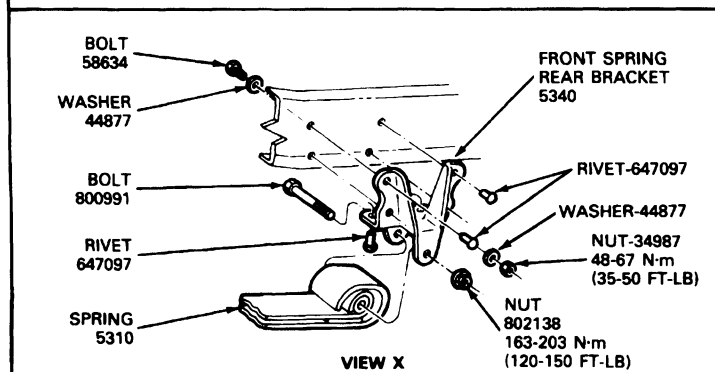
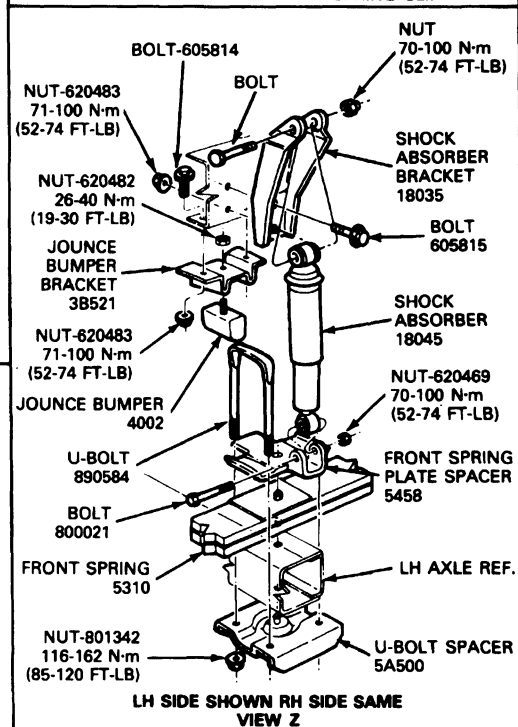
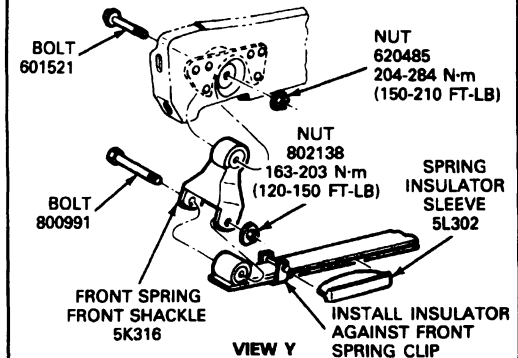
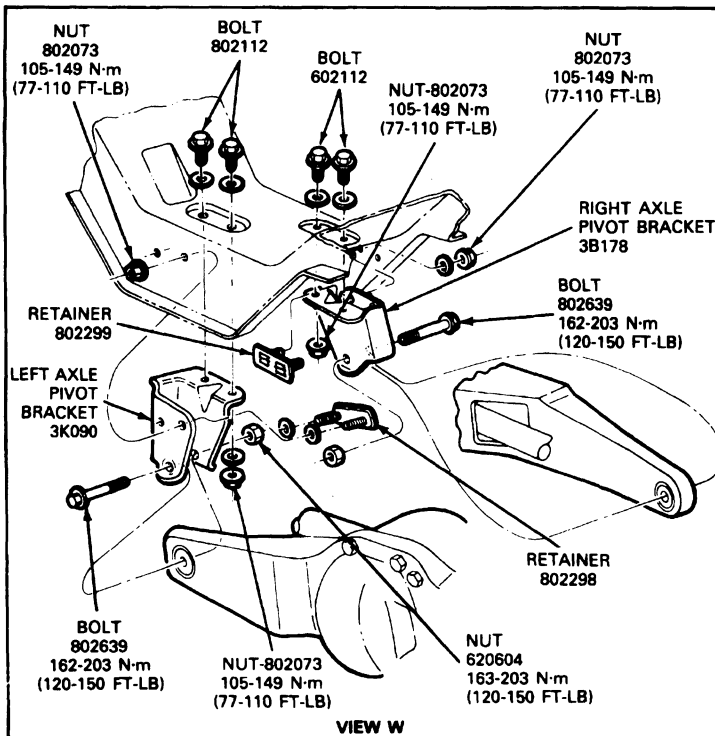
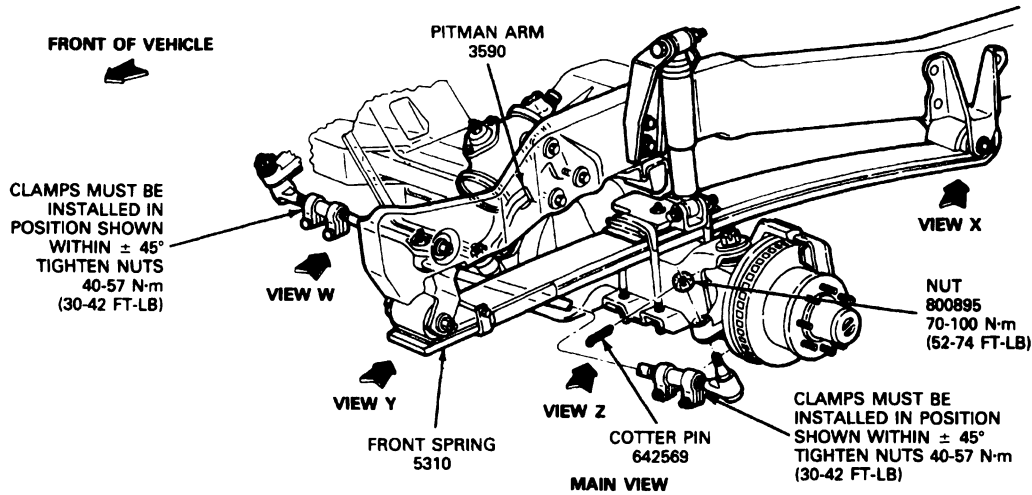
14. Connect the steering linkage as outlined in Section 11-03.
15. Install the stabilizer bar. Refer to Section 04-01B.
16. Install the front driveshaft. Refer to Section 05-01.
17. Lower the vehicle. Check and adjust camber and toe-in according to Section 04-00.

F-250 4x4, Leaf Spring Front Suspension**Removal**

1. Raise vehicle on a hoist or jack and install safety stands.
2. Remove the wheel and tire assemblies, and brake calipers. Refer to Section 06-03.
CAUTION: Do not let the caliper hang with it's weight on the brake hose or the hose may become stretched or twisted.
3. Disconnect the steering linkage from the steering knuckles. Refer to Section 11-03.
4. Remove front stabilizer bar. Refer to Section 04-01B.
5. Remove front driveshaft. Refer to Section 05-01.
6. Position jack under right hand axle assembly. Remove the two U-bolts securing the shock absorber mounting plate and leaf springs to axle arm.
7. Disconnect the vent tube at the differential housing. Remove the vent fitting and install a 1/8-inch pipe plug or a vacuum fitting cap.
8. Remove and discard the keystone clamps and remove the boot from the shaft.
9. Remove the pivot bolt that secures the right hand axle assembly to crossmember.
10. Remove the right axle assembly. Pull the axle shaft out of the slip shaft.
11. Position the jack under the left hand axle assembly. Remove the two U-bolts securing the shock absorber mounting plate and leaf spring to tube and yoke assembly.
12. Position a jack under the differential housing.
13. Remove the pivot bolt securing the left hand axle assembly to crossmember. Remove the left axle assembly.

REMOVAL AND INSTALLATION (Continued)

F-250 4x4, Leaf Spring Front Suspension



E5098-2D

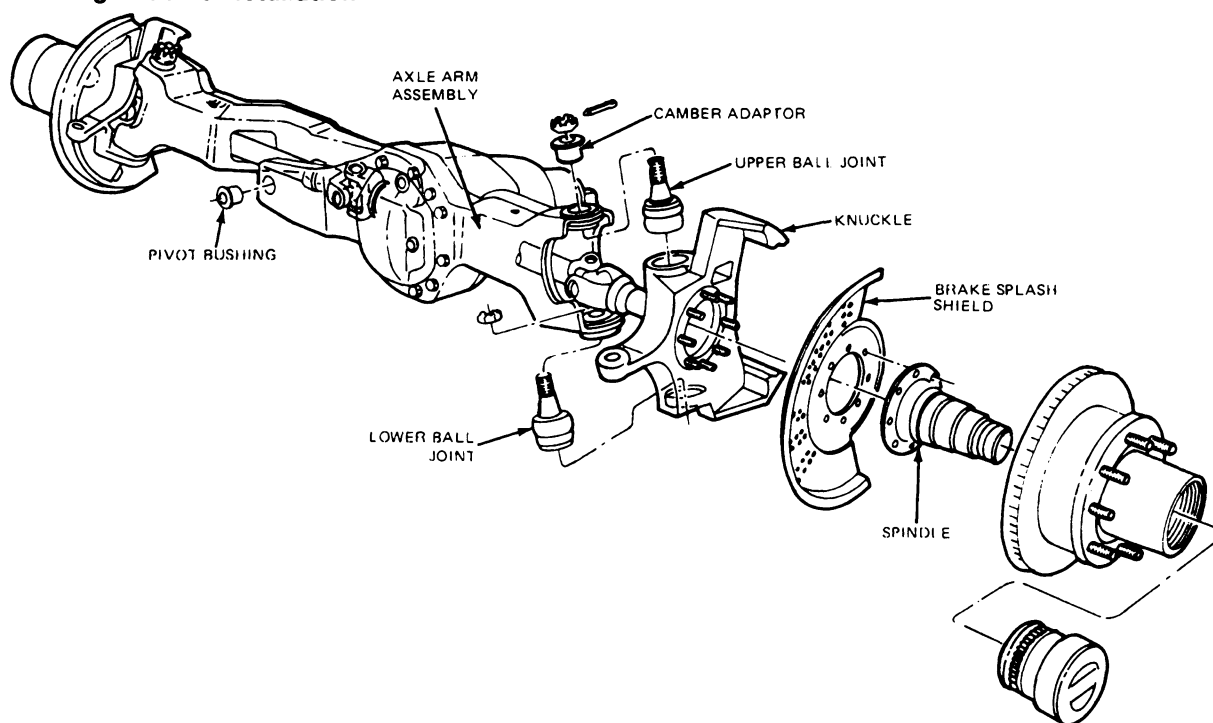
REMOVAL AND INSTALLATION (Continued)**Installation**

1. Raise vehicle on a hoist or a jack and position left axle assembly at leaf spring assembly. Install the pivot bolt that secures the axle assembly to the crossmember.
2. Secure the shock absorber mounting plate to the leaf spring and axle assembly with the two U-bolts. Tighten bolts to 116-162 N·m (85-120 ft-lb).
3. Position new keystone clamps over the grooves on the boot and crimp the clamp with Keystone Clamp Pliers T63P-9171-A.
4. Align the axle shaft and install in slip shaft. Position the right hand axle assembly at crossmember. Install the boot on the shaft so the boot seats in the grooves. Install the pivot bolt that secures the axle assembly to crossmember. Tighten bolt to 163-203 N·m (120-150 ft-lb).
5. Install shock absorber mounting plate, leaf spring and axle assembly using two U-bolts. Tighten bolts to 116-162 N·m (85-120 ft-lb).
6. Install vent fitting to differential housing and connect vent tube to vent using a new hose clamp.
7. Connect the steering linkage. Refer to Section 11-03.
8. Install brake caliper and wheel and tire assembly. Refer to Section 06-03.
9. Install front driveshaft. Refer to Section 05-01.
10. Install front stabilizer bar. Refer to Section 04-01B.
11. Check and adjust caster, camber and toe-in.

Steering Knuckle**Removal**

1. Remove the spindle and the right and left shaft and joint assembly as described in this section.

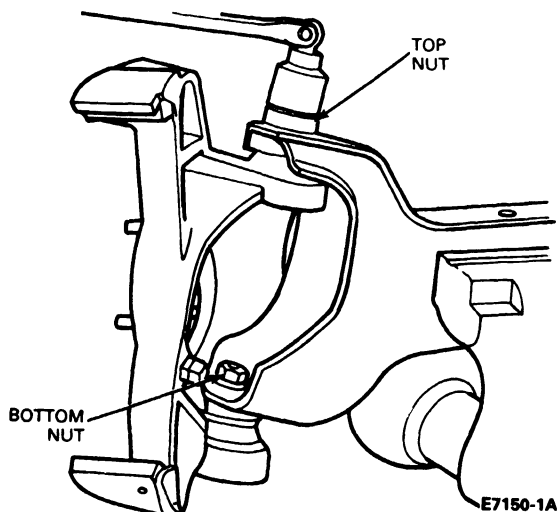
2. Disconnect the steering linkage, if necessary, from the knuckle. Refer to Section 11-03.

Steering Knuckle Installation

E4105-28

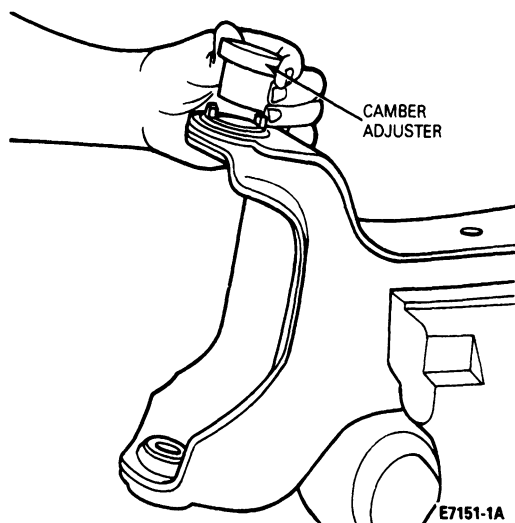
REMOVAL AND INSTALLATION (Continued)

3. Remove the cotter pin from the top ball joint stud. Loosen the nut on the top stud and the bottom nut inside the knuckle. Remove the top nut.

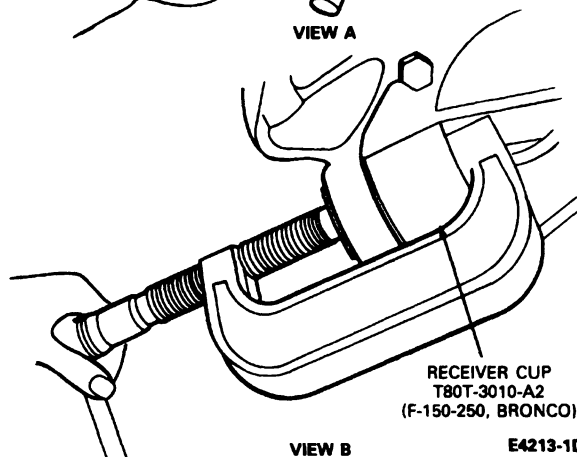
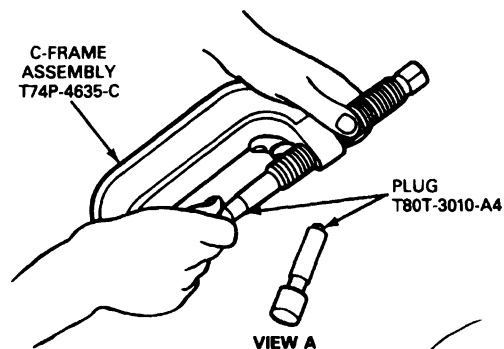


4. Sharply hit the top stud with a plastic or rawhide hammer to free the knuckle from the axle arm. Remove and discard bottom nut. Use new nut upon assembly.
5. Remove camber adjuster by hand or if difficulty is encountered use Pitman Arm Puller T64P-3590-F.

Note the orientation of the camber adjuster to make sure of the same camber setting.



6. Place knuckle in vise and remove snap ring from bottom ball joint socket if so equipped.
7. Remove plug from C-Frame Assembly T74P-4635-C and replace with Plug T80T-3010-A4 (View A).



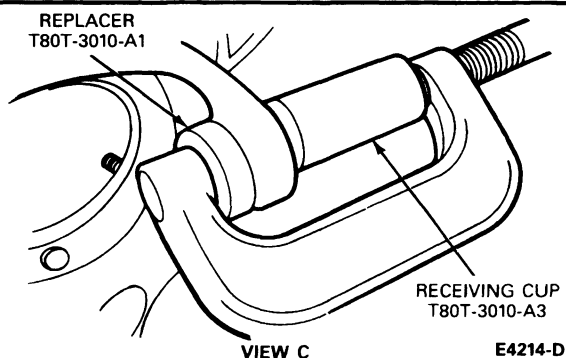
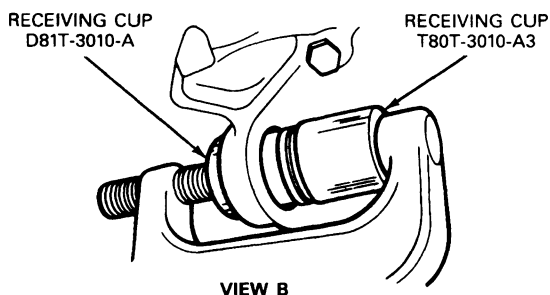
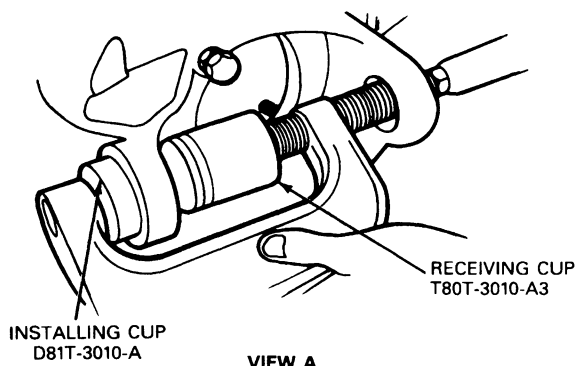
8. Assemble C-Frame Assembly and Receiving Cup T80T-3010-A2 for F-150 and F-250 as shown in View B.
9. Turn forcing screw clockwise until lower ball joint is removed from steering knuckle.
10. Repeat procedure and remove upper ball joint.

Installation

1. Clean steering knuckle bore and insert lower ball joint as straight as possible.

REMOVAL AND INSTALLATION (Continued)

2. Assemble C-Frame Assembly, Ball Joint Receiving Cup T80T-3010-A3 and Installing Cup D81T-3010-A or equivalent as shown in View A to replace the lower ball joint on the F-150-250 and Bronco (Dana 44).



3. Assemble C-Frame, Receiving Cup T80T-3010-A3 and Receiving Cup D81T-3010-A or equivalent as shown in View B, to replace the lower ball joint on the Dana 50.
4. Turn forcing screw clockwise until ball joint is firmly seated.

NOTE: If ball joint cannot be installed to the proper depth, realignment of Receiving Cup T80T-3010-A3 will be necessary. Install the snap ring on the lower ball joint.

5. To install upper ball joint, assemble the C-Frame, Receiving Cup T80T-3010-A3 and Replacer T80T-3010-A1 as shown in View C and repeat Step 4.
6. Assemble knuckle to axle arm assembly. Install camber adjuster on top ball joint stud with the arrow pointing outboard for "positive" camber, pointed inboard for "negative" camber.
7. Install new nut on bottom socket finger-tight. Install and tighten nut on top socket finger-tight. Tighten bottom nut to 47 N·m (35 ft-lb).
8. Tighten top nut to 136 N·m (100 ft-lb), then advance nut until castellation aligns with cotter pin hole. Install cotter pin.
NOTE: Do not loosen top nut to install cotter pin.
9. Retighten bottom nut to 150 N·m (110 ft-lb).
10. Install the spindle and the right and left shaft and joint assembly as described in this section.

Spindle, Right and Left Shaft and Joint Assembly

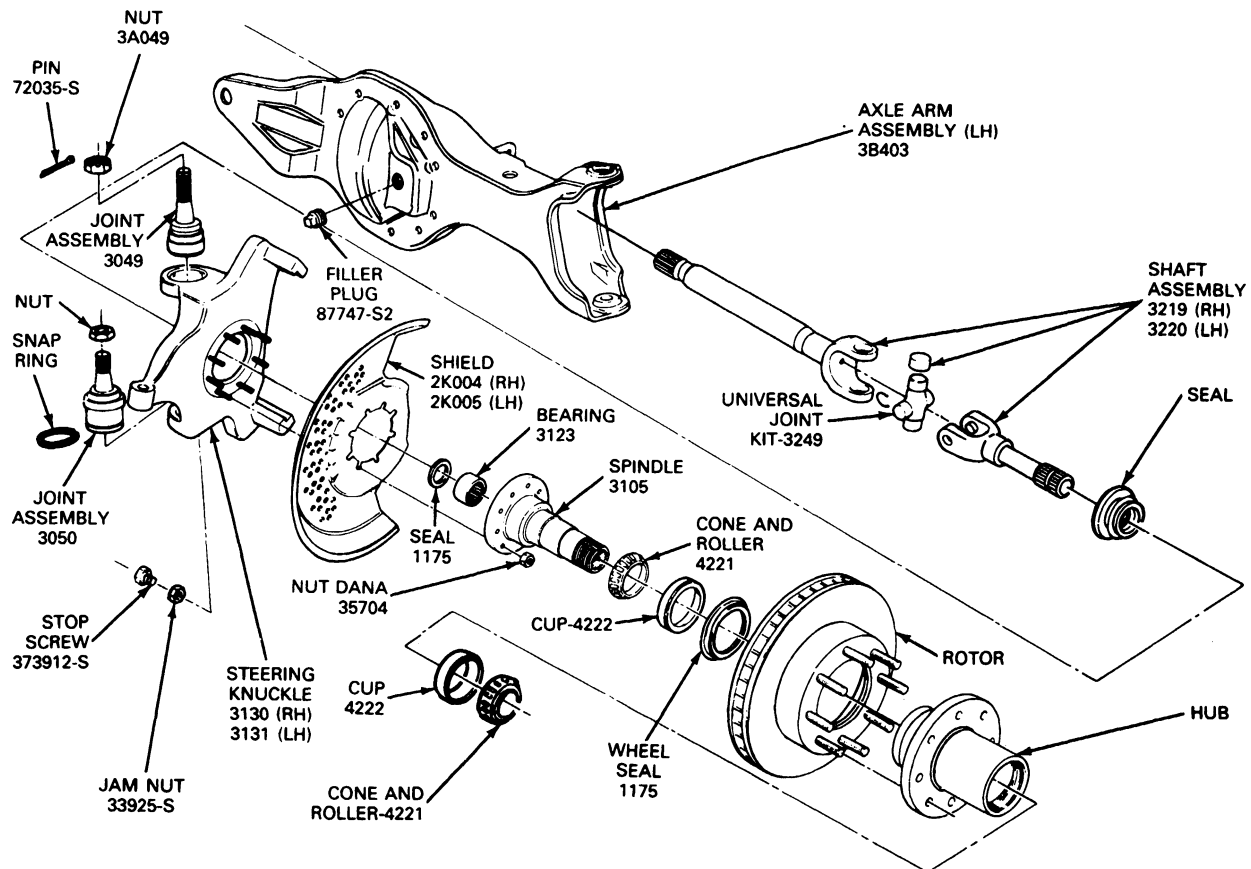
Removal

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire assembly. Refer to Section 04-04.
3. On vehicles equipped with 4-wheel Anti-lock Brakes, remove the ABS sensor from the steering knuckle. Refer to section 06-09B in the Body / Chassis Manual for procedures.
4. Remove the caliper as described in Section 06-03. Securely wire the caliper to the frame.

CAUTION: After removal, the caliper must be wired to the frame or otherwise supported to prevent suspending the caliper by the flexible hose. If securing the caliper is not practical, disconnect the brake hose from the caliper. Plug the hose end to prevent fluid loss and entry of air into the system. Upon caliper installation, bleed the brake system as described in Section 06-00, Brake, General, Hydraulic.

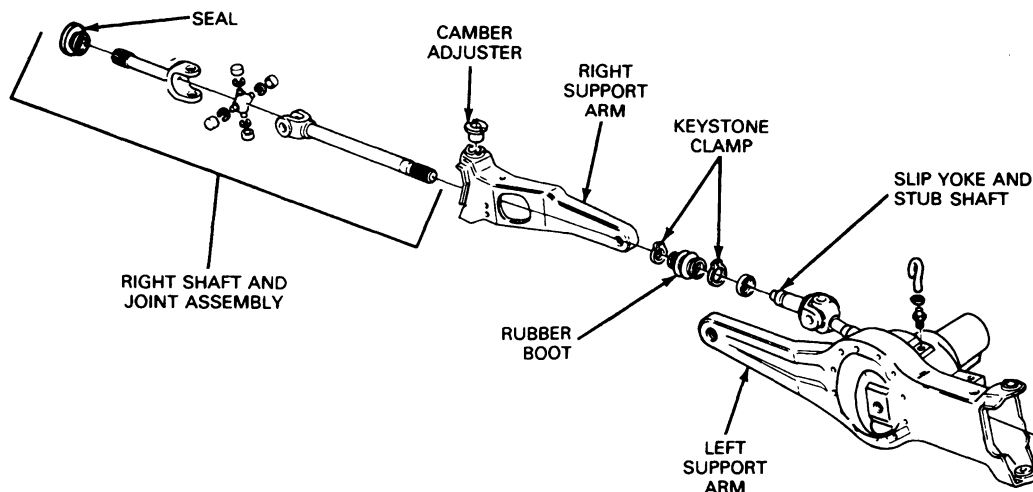
REMOVAL AND INSTALLATION (Continued)

Spindle and Left Shaft and Joint Installation, Typical



E7131-2A

Right Shaft and Joint Assembly Installation, Typical



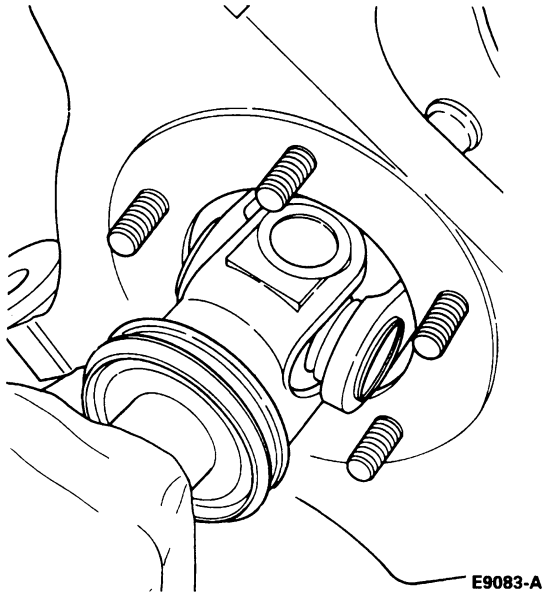
E5372-2C

5. Remove hub locks, wheel bearings, and lock nuts per Section 05-02L.
6. Remove the hub and rotor assembly and outer bearing from the spindle.

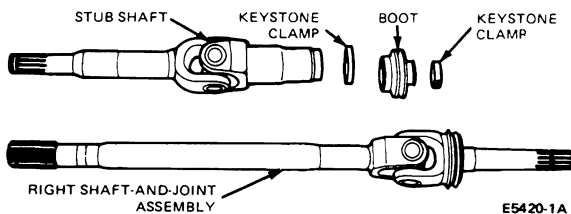
7. Remove the nuts retaining the spindle to the steering knuckle. Tap the spindle with a nylon or rawhide hammer to jar the spindle from the knuckle. Remove the splash shield.

REMOVAL AND INSTALLATION (Continued)

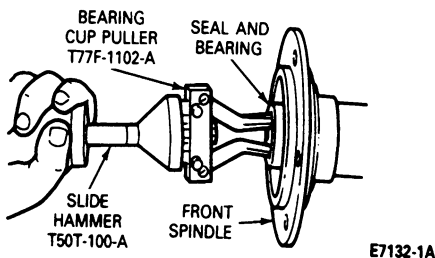
8. On the left side of the vehicle remove the shaft and joint assembly by pulling the assembly out of the carrier.



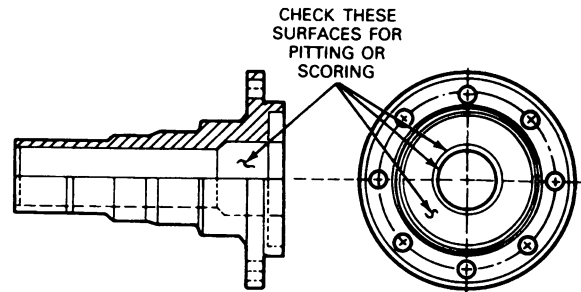
9. On the right side of the carrier, remove and discard the keystone clamp from the shaft and joint assembly and the stub shaft.
10. Slide the rubber boot onto the stub shaft and pull the shaft and joint assembly from the splines of the stub shaft.



11. Place the spindle in a vise on the second step of the spindle. Wrap a shop towel around the spindle or use a brass-jawed vise to protect the spindle.
12. Remove the oil seal and needle bearing from the spindle with Slide Hammer T50T-100-A and Bearing Cup Puller T77F-1102-A.



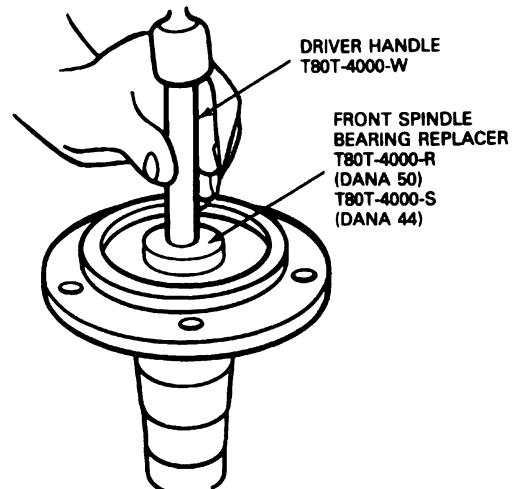
13. Inspect the sealing surfaces of the spindle for severely corroded, pitted, worn or galled sealing surfaces. Replace spindle if damaged.



14. Inspect the outer shaft of the axle shaft assembly for corroded, pitted, worn or galled surfaces in the inner oil seal and/or needle bearing areas. If damaged, replace the outer shaft. Repair axle shaft U-joint. Refer to Section 05-01.

Installation

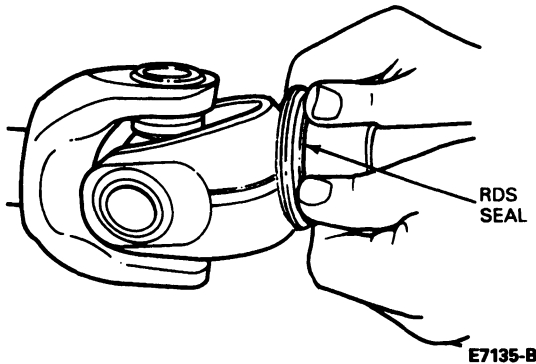
1. Clean all dirt and grease from the spindle bearing bore. Bearing bores must be free from nicks and burrs.
2. Install a new needle bearing with writing facing outward in the spindle bore with Spindle Bearing Replacer T80T-4000-R on the Dana 50, or T80T-4000-S for the Dana 44 and Driver Handle T80T-4000-W.



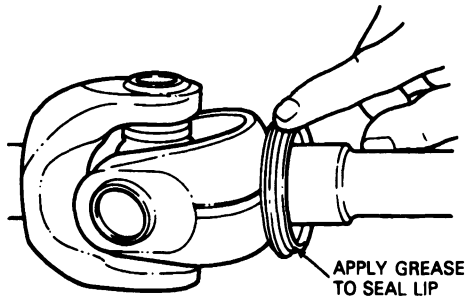
3. Install a new needle bearing seal with the seal lip directed away from the spindle. Pack bearing and spindle hub seal with grease. Install seal with Seal Replacer T80T-4000-T and Driver Handle T80T-4000-W.

REMOVAL AND INSTALLATION (Continued)

4. Install the RDS Seal on the axle shaft. The lip of the seal should face toward the spindle.



5. Lightly coat the thrust face of the seal in the spindle bore and the RDS Seal on the axle shaft with High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A (ESA-M1C198-A) or equivalent.



6. On the right side of the carrier, install the rubber boot and new keystone clamps on the stub shaft slip-yoke.

NOTE: Since the splines on the shaft are phased, there is only one way to assemble the right shaft and joint assembly through the knuckle and into the slip-yoke.

7. Align the missing spline in the slip-yoke barrel with the gapless male spline on the shaft and joint assembly.
8. Slide the right shaft and joint assembly through the knuckle and into the slip-yoke making sure the splines are fully engaged.
9. Slide the boot over the assembly and crimp the keystone clamp using Keystone Clamp Pliers T63P-9171-A.
10. On the left side of the carrier slide the shaft and joint assembly through the knuckle and engage the splines on the shaft in the carrier.
11. Install the splash shield and spindle onto the steering knuckle, both sides. Install and tighten the spindle nuts to 81 N-m (60 ft-lb) for Model 50 axle or 47 N-m (35 ft-lb) for Model 44 axle.
12. Install the hub and rotor on the spindle. Install the outer wheel bearing into the cup. Refer to section 05-02L.
- NOTE:** Make sure the grease seal lip totally encircles the spindle.
13. Install the wheel bearing, locknut, thrust bearing, snap ring and locking hubs per Section 05-02L.
14. Install the disc brake caliper. Refer to Section 06-03.
15. On vehicles equipped with 4-wheel Anti-Lock Brakes, install the ABS sensor on the steering knuckle. Refer to Section 06-09B in the Body / Chassis Manual for procedure.

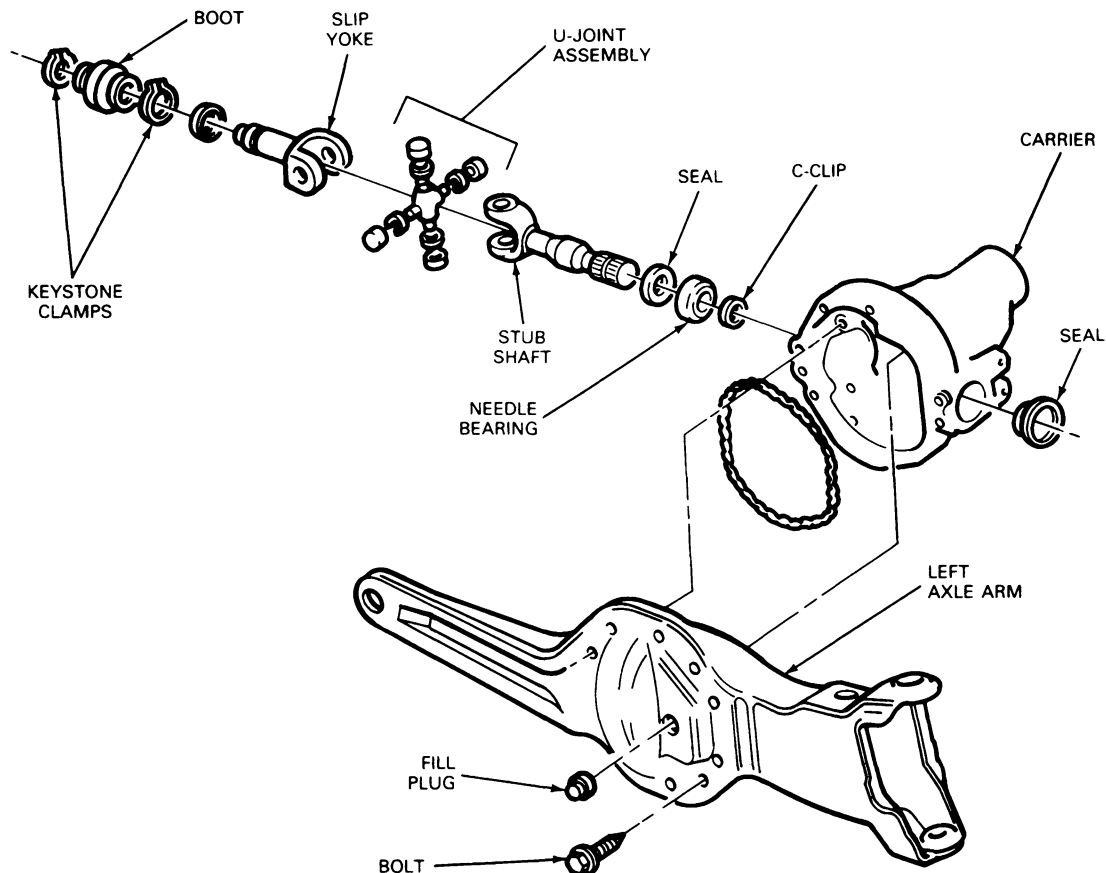
Right Slip-Yoke and Stub Shaft Assembly, Carrier, Carrier Oil Seal, and Bearing

Removal

1. Remove the nuts and U-bolts connecting the driveshaft to the yoke. Disconnect the driveshaft from the yoke. Wire the driveshaft out of the way, so it will not interfere in the carrier removal process.

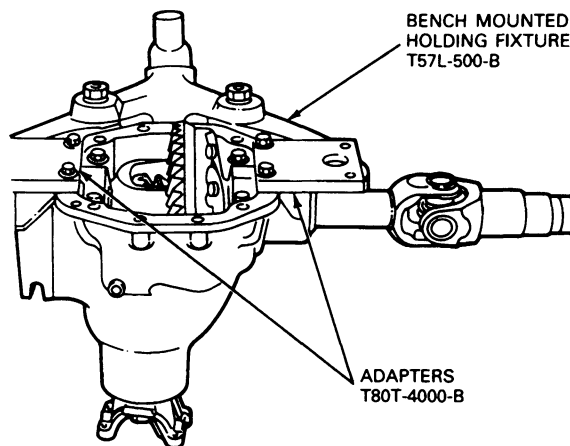
REMOVAL AND INSTALLATION (Continued)

Right Slip-Yoke and Stub Shaft Assembly, Carrier, Carrier Oil Seal and Bearing



E7138-2A

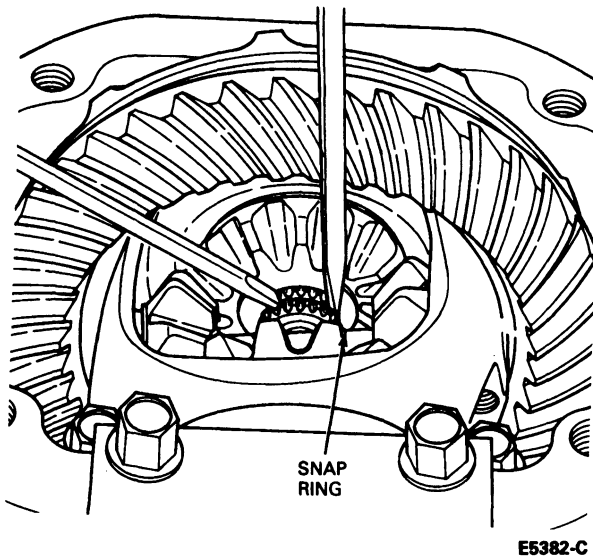
2. Remove both spindles and the left and right shaft and U-joint assemblies as described in the Removal and Installation portion of this section under Spindle and Right and Left Shaft and U-Joint Assemblies.
3. Support the carrier with a suitable jack and remove the bolts retaining the carrier to the support arm.
NOTE: Position a drain pan under the carrier assembly to catch the lubricant when the carrier is separated from the arm.
4. Separate the carrier from the support arm. Remove the carrier from the vehicle.
5. Place the carrier in a Bench Mounted Holding Fixture T57L-500-B and Adapters T80T-4000-B.



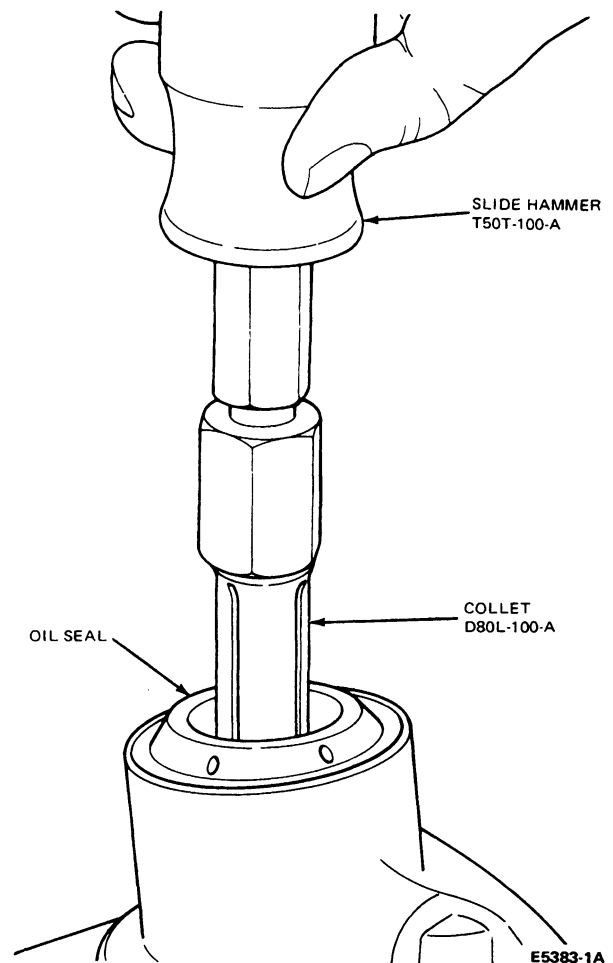
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REMOVAL AND INSTALLATION (Continued)

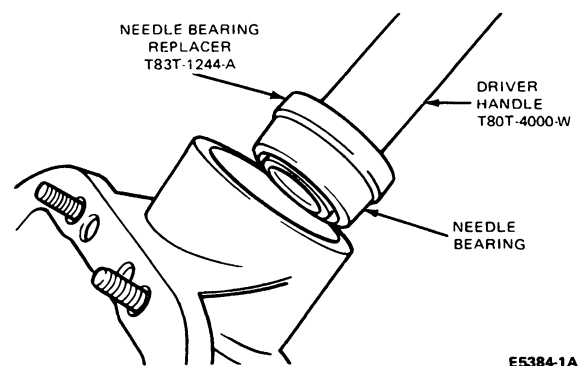
6. Rotate the slip-yoke and shaft assembly so the open side of the snap ring is exposed as shown. Remove the snap ring from the shaft.



7. Remove the slip-yoke and shaft assembly from the carrier.
8. Remove the oil seal and caged needle bearings at the same time, using Slide Hammer T50T-100-A and Collet (part of Blind Hole Puller Set) D80L-100-A or equivalents as shown. Discard the seal and needle bearing.

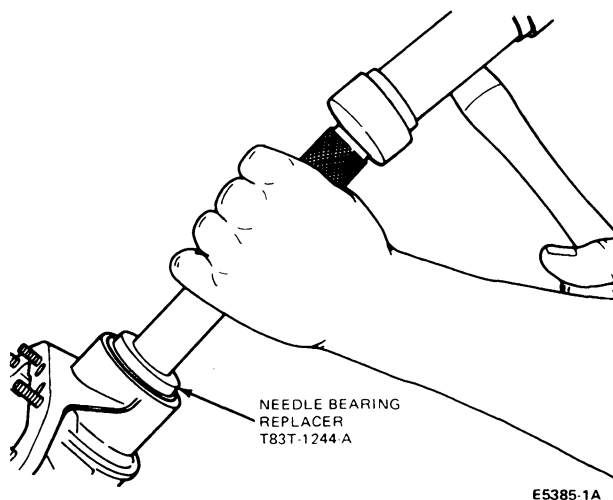
**Installation**

1. Make sure the bearing bore is free from nicks and burrs. Install a new caged needle bearing on Needle Bearing Replacer T83T-1244-A with the manufacturer name and part number facing outward toward the tool. Drive the needle bearing until it is seated in the bore.



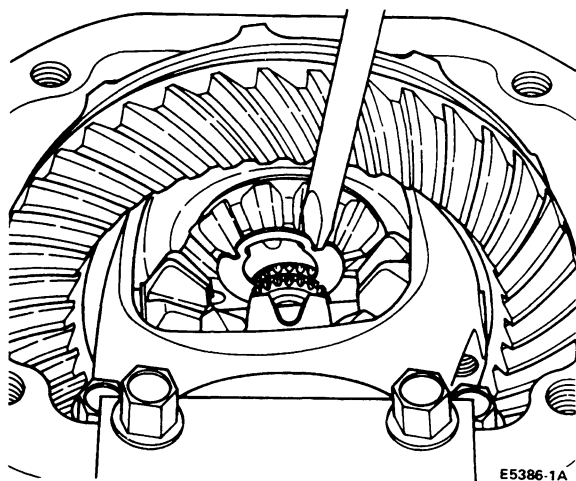
REMOVAL AND INSTALLATION (Continued)

2. Coat the seal with High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A (ESA-M1C198-A) or equivalent. Drive the seal into the carrier using Needle Bearing Replacer T83T-1244-A.



3. Install the slip-yoke and shaft assembly into the carrier so the groove in the shaft is visible in the differential case.
4. Install the snap ring in the groove in the shaft. Force the snap ring into position with a screwdriver as shown. Remove the carrier from the holding fixture.

NOTE: Do not tap on the center of the snap ring. This may damage the snap ring.



5. Clean all traces of gasket RTV sealant from the surfaces of the carrier and support arm and make sure the surfaces are free from dirt and oil.
6. Apply a bead of Silicone Rubber D6AZ-19562-AA (clear) or -BA (black) (ESB-M4G92-A and ESE-M4G195-A) or equivalent, in a bead 6mm (1/4-inch) wide.

NOTE: The bead should be continuous and should not pass through or outside the holes.

NOTE: The carrier must be installed on the support arm within five minutes after applying the RTV sealant.

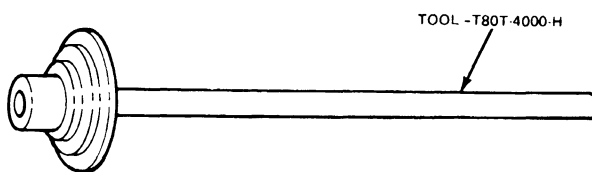
7. Position the carrier on a suitable jack. Install carrier in position on the support arm using guide pins to align. Install the attaching bolts and hand-tighten. Tighten the bolts in a clockwise or counter-clockwise pattern to 54 N·m (40 ft-lb).
8. Install support arm tab bolts to side of carrier. Tighten bolts to 135 N·m (100 ft-lb).
9. Install both spindles and the left and right shaft and joint assemblies as described in the removal and installation portion of this section.
10. Connect the driveshaft to the yoke. Install the nuts and U-bolts and tighten to 11-20 N·m (8-15 ft-lb).

Left Differential Seal**Removal**

1. Remove the spindle and left shaft assembly as described in this section.
2. Pull out the seal with the appropriate Puller Tool T58L-101-B. Remove and discard seal.

Installation

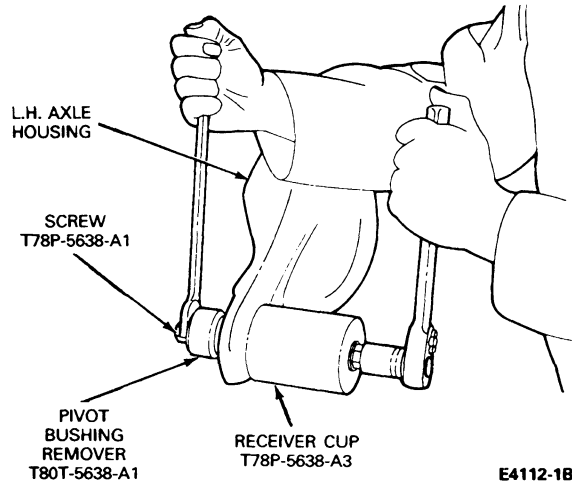
1. Lightly coat a new seal with High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A (ESA-M1C198-A) or equivalent.
2. Install seal on the Differential Axle Seal Replacer T80T-4000-H.
3. Slide the seal and tool into the carrier housing bore. Seat the seal with a nylon or rawhide hammer.
4. Install the spindle and left shaft assembly as described in this section.

**Axle Housing Pivot Bushing (IFS Front Drive Axle)****Removal**

1. Remove axle as described in this section under Front Drive Axle Removal and Installation.

REMOVAL AND INSTALLATION (Continued)

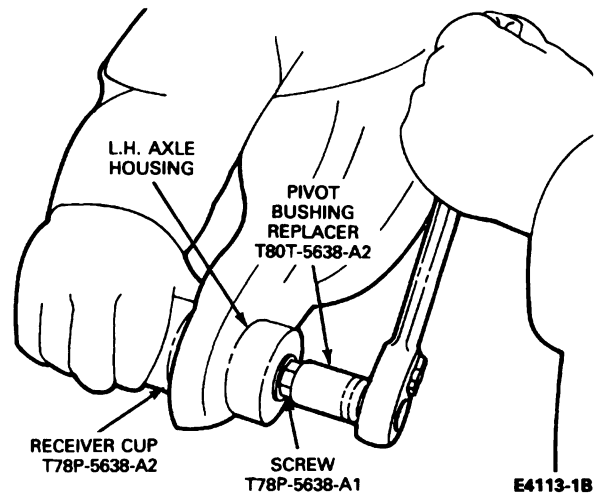
2. Install Forcing Screw T78P-5638-A1, Bushing Remover T80T-5638-A1 and Receiver Cup T78P-5638-A3 onto the pivot bushing. Turn the forcing screw and remove the pivot bushing.



E4112-1B

Installation

1. Place pivot bushing in axle housing. Install Receiver Cup T78P-5638-A2, Forcing Screw T78P-5638-A1 and Bushing Replacer T80T-5638-A2 into housing and install bushing.
2. Install the axle as described in this section under Front Driving Axle Installation.



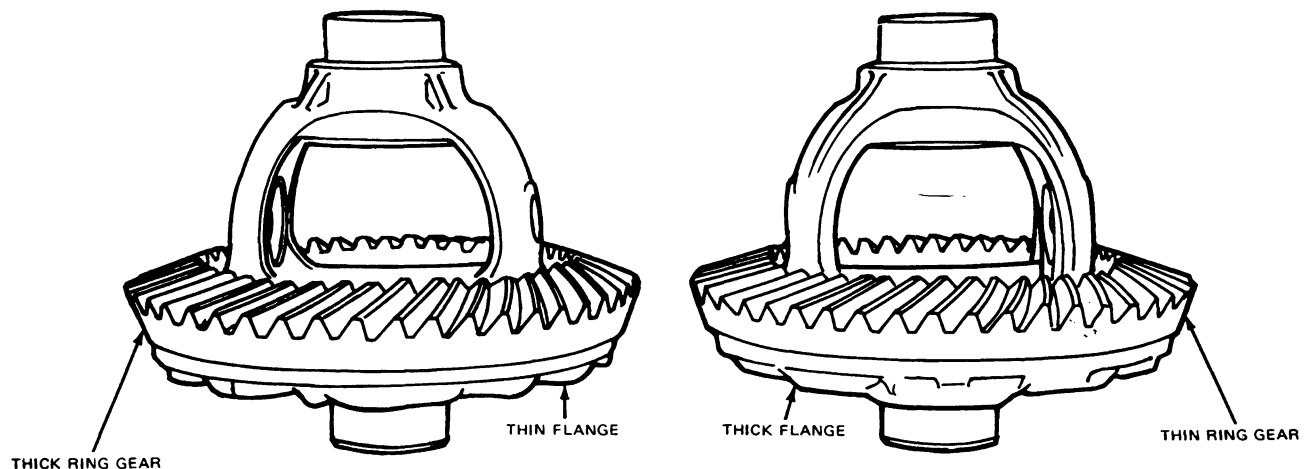
E4113-1B

DISASSEMBLY AND ASSEMBLY**Cardan-Type U-Joints**

For disassembly and assembly procedures for cardan-type U-joints refer to Section 05-01.

Carrier

NOTE: 44 Series front drive axle ratios 2.72 to 1 up to 3.73 to 1 incorporate a thick differential case flange and a thin ring gear. Ratios 3.92 to 1 up to 4.09 to 1 incorporate a thin differential case flange and a thick ring gear.



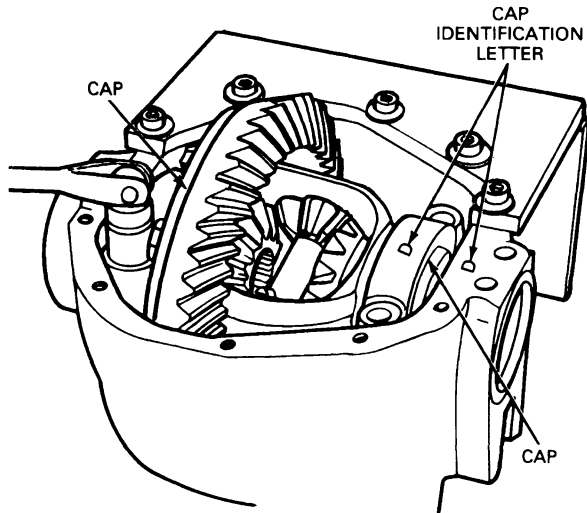
E4844-2A

DISASSEMBLY AND ASSEMBLY (Continued)

Disassembly

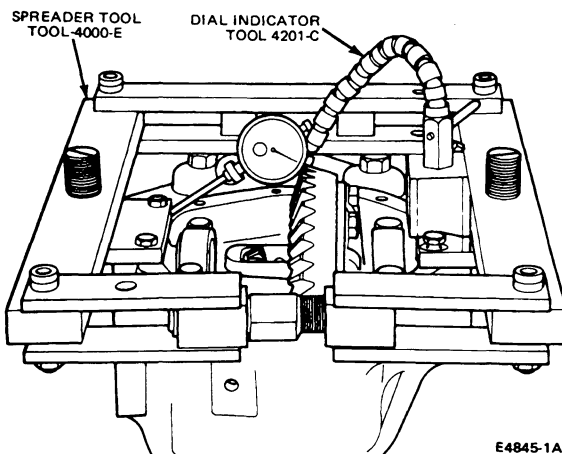
1. Remove carrier as described in this section.
2. Place the carrier in a holding fixture, remove and clean all gasket surfaces and remove the bearing caps.

Note the matched numbers or letters stamped on the cap and carrier. These numbers or letters must be matched upon assembly.



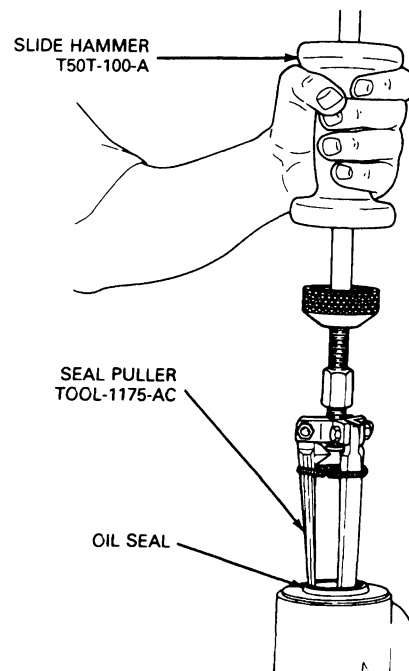
E7152-C

3. Mount Differential Housing Spreader TOOL-4000-E and Differential Housing Spreader Adapter T80T-4000-B on carrier. Place a Dial Indicator TOOL-4201-C on the carrier and spread the housing. **Do not spread the carrier over 0.25mm (0.010 inch).**



E4845-1A

4. Remove the differential case from the carrier. It may be necessary to pry the case from the carrier with pry bars. Use caution to avoid damaging any machined surfaces. Remove and tag bearing cups to indicate from which side of the carrier they were removed. Remove the spreader tool.
5. Turn the nose of the carrier up. Hold the end yoke with Holding Tool T78P-4851-A and remove the pinion nut and washer from the pinion shaft.
6. Remove the end yoke with Yoke Remover T65L-4851-B. If the yoke shows any signs of wear in the area of seal contact, replace the yoke.
7. Remove the drive pinion by tapping on the drive pinion shaft with a rawhide or nylon hammer. Catch the pinion to prevent damage to the pinion.
CAUTION: Be careful not to damage the pinion bearing preload shims located on the splined end of the pinion. If damaged, replace with shims of equal thickness. Do not lose the shims.
8. Remove the drive pinion oil seal from the carrier bore by using Bearing Cup Puller T77F-1102-A and Slide Hammer T50T-100-A. Replace the oil seal with a new seal during assembly.

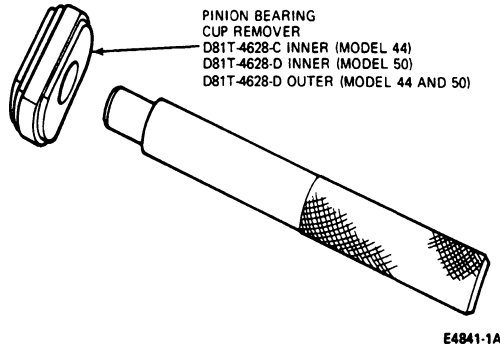


E4834-1B

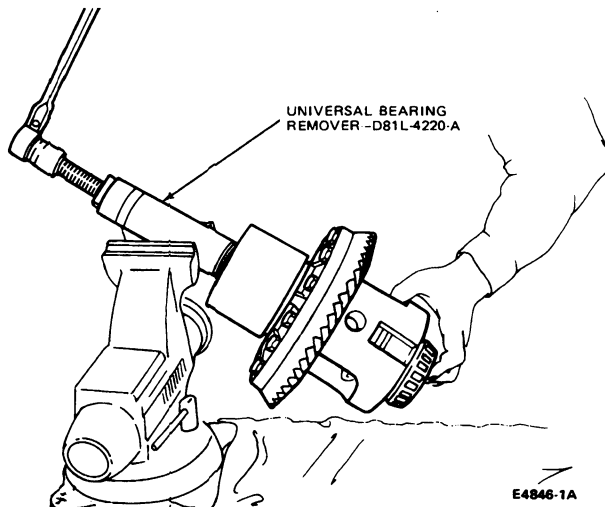
9. Remove the outer pinion bearing and the oil slinger from the carrier input bore.
10. Remove the pinion bearing preload shims. Remove all shims from the carrier. Replace any damaged shims during assembly. Shims are available in thicknesses of 0.08, 0.13, 0.25 and 0.76mm (0.003, 0.005, 0.010 and 0.030 inch).

DISASSEMBLY AND ASSEMBLY (Continued)

11. Remove the inner pinion bearing cup and baffle using Pinion Bearing Cup Remover D81T-4628-C (Model 44 axles) or D81T-4628-D (Model 50 axles) and Driver Handle D81L-4000-A or equivalents. Drive the bearing cup out of the bore.



12. Turn the nose of the carrier down and remove the outer pinion bearing cup. Drive the cup from the carrier using Pinion Bearing Cup Remover D81T-4628-D (Model 44 and 50 axles) and Driver Handle D81L-4000-A or equivalent.
13. Remove the differential case bearings and shims from the case. Place Step Plate D80L-630-5 or equivalent under bearing to protect the bearing. Install Universal Bearing Remover D81L-4220-A (or equivalent) and remove the bearing as shown. Turn the case over and remove the other bearing.



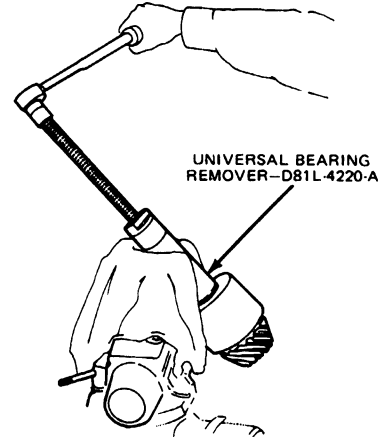
14. Wire the shims, bearing cup and cone together and identify from which side of the differential case they were removed. If any shims are damaged, replace with new shims upon assembly.
15. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked, after it is free from the case. Place the case in a vise. Remove the ring gear bolts. Tap the ring gear with a rawhide hammer to free it from the case. Remove the case and ring gear from the vise.
- NOTE:** Whenever removing the ring gear bolts, discard the bolts and replace with new bolts upon assembly.

16. Remove the bearing and selective shims from the drive pinion with Universal Bearing Remover D81L-4220-A or equivalent.
17. Inspect all parts for damage and replace as required.

NOTE: Shims are located between the pinion gear head and the inner bearing cone. Be careful not to damage the shims when removing the bearing cone. If any shims are damaged, measure the thickness and replace with shims of equal thickness.

SELECTIVE SHIM SIZES

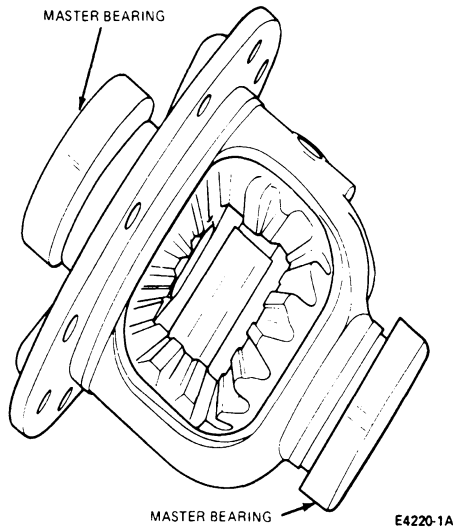
MM	Inches
1.35	.053
1.40	.055
1.45	.057
1.50	.059
1.55	.061
1.60	.063
1.65	.065
1.70	.067
1.75	.069
1.80	.071
1.85	.073

**Total Differential Case End Play****Assembly**

1. Attach the ring gear to the differential case using new bolts. Tighten bolts alternately and evenly to 81 N·m (60 ft-lb) for grade 8 bolts or 122 N·m (90 ft-lb) for grade 9 bolts.

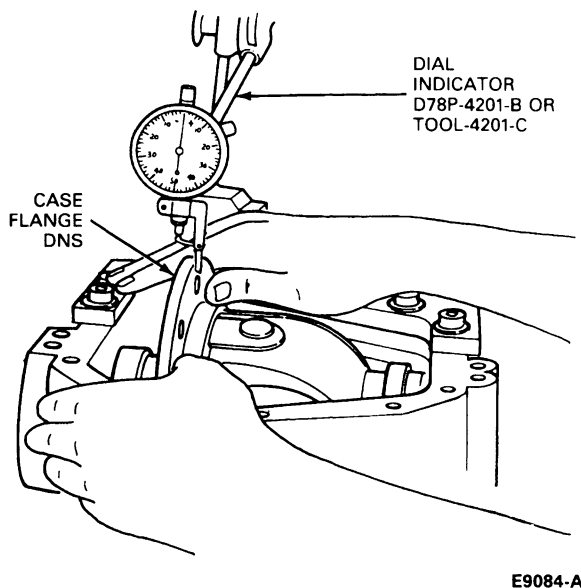
DISASSEMBLY AND ASSEMBLY (Continued)

2. Clean the trunnions on the differential and install the Master Differential Bearings D81T-4222-B for Model 44 axles, or D81T-4222-C for Model 50 axles or equivalents onto the differential case. Remove all burrs and nicks from hubs so master bearings rotate freely.



3. Place the differential case into carrier (without pinion). The differential case should move freely in the carrier. Mount Dial Indicator D78P-4201-B or TOOL-4201-C or equivalent against the differential case flange as shown. Locate the tip of the indicator on the flat surface of one ring gear bolt.
4. Force the differential case toward the dial indicator as far as possible and zero the dial indicator with force still applied.

NOTE: Dial indicator should have a minimum travel capability of 5.08mm (0.200 inch).



5. Force the differential case away from the dial indicator as far as it will go. Repeat this procedure until the same reading is obtained. Record the dial indicator reading.

NOTE: This reading indicates the amount of shims needed behind the differential side bearings to take up total clearance between the differential bearing and case. This reading will be used under Pinion and Ring Gear Backlash.

6. Remove the differential case from the carrier. Do not remove the master differential bearings at this time.

Drive Pinion Installation

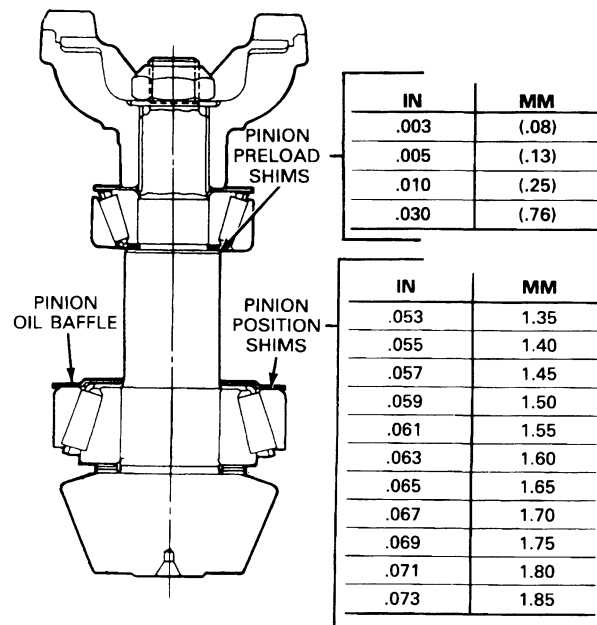
Two separate adjustments affect drive pinion and ring gear tooth contact.

1. Pinion depth (location)
2. Backlash.

The pinion locating shim pack is installed between the drive pinion inner bearing cone and the head of the pinion gear.

This shim pack and inner oil slinger and oil baffle controls the position of the pinion.

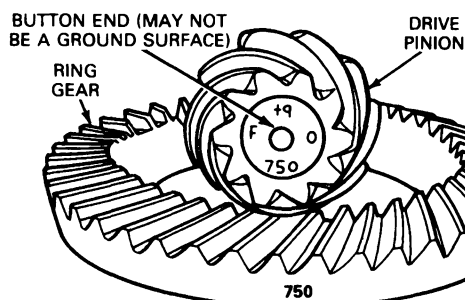
- Adding shims moves the pinion toward the ring gear.
- Removing shims moves the pinion away from the ring gear.



E4117-B

DISASSEMBLY AND ASSEMBLY (Continued)

Ring gears and pinions are supplied in matched sets with standard or metric markings.



STANDARD PINION

E7117-D

On the face of each drive pinion is marked a plus figure (+), a minus figure (-) or a zero (0). These figures indicate the position for each gear set. The position is determined by the amount of shims between the inner pinion bearing cup and carrier bearing bore. Refer to the charts.

Old Pinion Marking	New Pinion Marking (English)								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

TE4091A

Old Pinion Marking	New Pinion Marking (Metric)								
	-10	-8	-5	-3	0	+3	+5	+8	+10
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	-.03
+5	+.15	+.13	+.10	+.08	+.05	+.03	0	-.03	-.05
+3	+.13	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08
0	+.10	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10
-3	+.08	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13
-5	+.05	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15
-8	+.03	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18
-10	0	-.03	-.05	-.08	-.10	-.13	-.15	-.18	-.20

TE4092A

If the old ring and pinion shim pack is used, measure the slinger and baffle and each shim separately and add each shim measurement to total the original measurement. Replace the old shims with new shims that equal this measurement.

If a new ring and pinion is being installed, note the plus (+), minus (-) or zero (0) marking on the button of the pinion. Refer to the charts. Add or subtract shims, according to the chart to compensate for differences between the old and new pinion.

DISASSEMBLY AND ASSEMBLY (Continued)

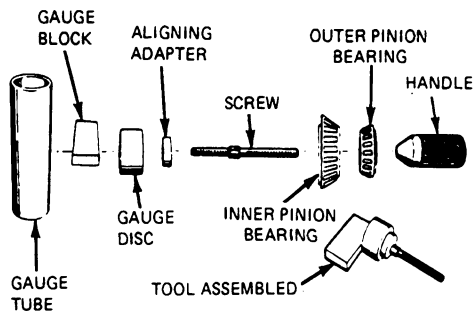
For example, if a new pinion is marked "positive" +3 (+8 metric) and an old pinion is marked "0", then .008mm (.003) less shim pack thickness is required between the inner bearing cone and the pinion head.

A new ring gear and drive pinion is always installed as a matched set and never separately. **Make sure that the same matching number appears on both the drive pinion and ring gear.**

Install the correct shim pack of the drive pinion and place the pinion in the carrier. Check pinion depth.

Depth Gauge Check

1. Refer to the illustration for the correct tools for the particular axles.

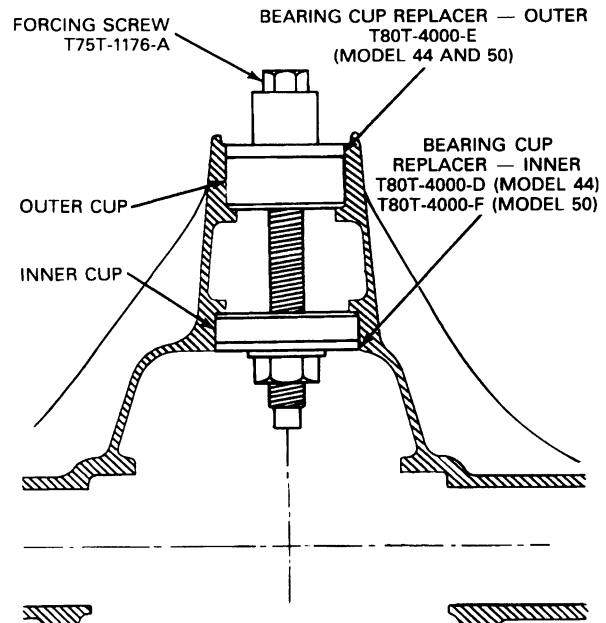


Tool	Tool Number	Axle Model 44	Axle Model 50
Aligning Adapter	T75P-4020-A2	X	X
Gauge Disc	T80T-4020-F40		X
	D80T-4020-F44	X	
Gauge Block	T80T-4020-F42	X	X
Screw	T80T-4020-F43	X	X
Handle	T76P-4020-A11	X	X
Gauge Tube	T80T-4020-F41		X
	D80T-4020-F47	X	

E4118-1B

NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium India oilstone to ensure no erroneous readings.

2. Install inner and outer pinion cups with Forcing Screw T75T-1176-A and Pinion Bearing Cup Replacers T80T-4000-D (inner cup) and T80T-4000-E (outer cup).



E4843-B

3. Place a new rear pinion bearing over the proper aligning adapter and insert into the pinion bearing retainer assembly.
4. Place the front pinion bearing (new or used if in good condition) into the bearing cup in the carrier and assemble the handle onto the screw and hand tighten.

Note the 3/8-inch square drive in the handle to be used for obtaining the proper pinion bearing preload.

5. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten to proper specifications listed at the end of this section. To preload the bearing, tighten the handle to 2.3-4.5 N·m (20-40 in-lb).
6. Using a feeler gauge tool or shims, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge or shims directly along the gauge block to insure a correct reading.

NOTE: The feeler gauge fit between the gauge tube and the gauge block should be a slight drag-type feeling.

7. After the correct shims or feeler gauge feel is obtained, check the reading and this is the thickness of shim required providing that upon inspection of the service pinion gear, the button is etched "0".

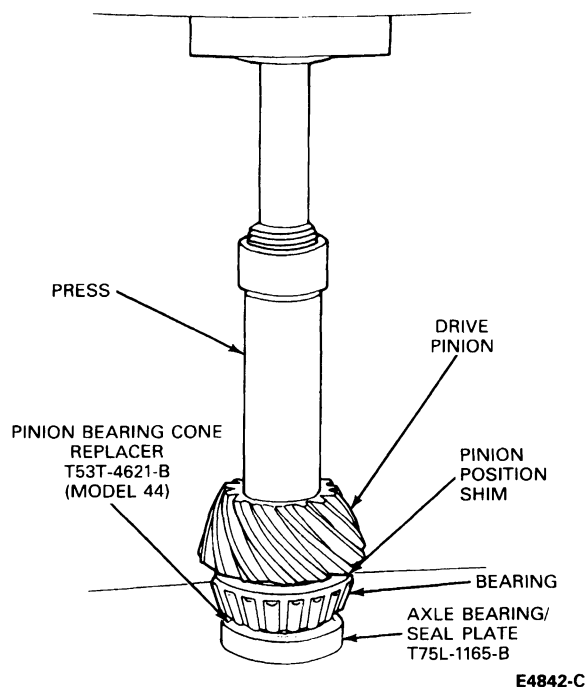
NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained in Step 6. For example: +2 (-0.002).

DISASSEMBLY AND ASSEMBLY (Continued)

If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained in Step 6. For example: -2 (+0.002).

In addition, use the exact same new rear pinion bearing used in the previous steps.

8. Measure shims with a micrometer to verify the shim size. Place the correct size selective shim on the pinion and press on the bearing. Use Pinion Bearing Cone Replacer T53T-4621-B for Model 44 Axles and Axle Bearing / Seal Plate T75L-1165-B as shown.



9. After following these procedures, continue to build the remaining components with proper pinion and differential bearing preload torques and ring gear backlash.

Bearing Cup and Drive Pinion Installation

1. Clean the bore. If installed, remove the cup.
2. Place the oil baffle first and the required amount of shims in the inner pinion bearing bore and drive the inner pinion bearing cup in place with Inner Pinion Bearing Cup Replacer T80T-4000-D (Model 44 axle) or T80T-4000-F (Model 50 axles) and Forcing Screw T75T-1176-A.

NOTE: Be careful not to cock the cup.

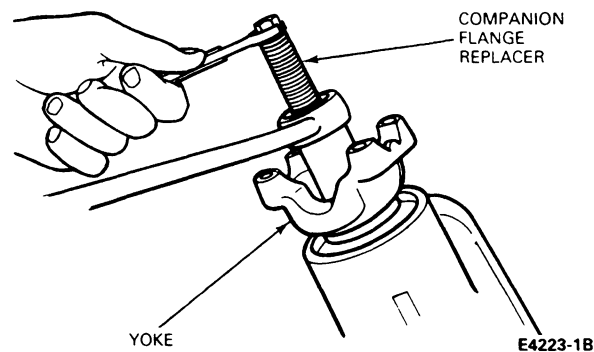
3. Place the outer pinion cup into the carrier and drive in place with Outer Pinion Bearing Cup Replacer (Model 44 and 50 axles) T80T-4000-E. Install Forcing Screw T75T-1176-A and draw the cups into the bore.

4. Lubricate the ends of outer pinion bearings rollers with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Install the outer bearing cone in place in outer bearing cup.
5. Install the inner bearing cone and pinion position shim on the pinion. Drive the bearing on the pinion shaft until fully seated using Pinion Bearing Cone Replacer T53T-4621-B (Model 44 axles) and Axle Bearing / Seal Plate T75L-1165-B.

Drive Pinion Preload Check

1. Measure original preload shims and replace with new shims of equal size.
2. Install the pinion into the carrier.
3. Install new preload shims over the pinion. Install the outer pinion bearing cone and oil slinger and seal.
4. Assemble end yoke, washer and deflector, on pinion shaft, and align with Companion Flange Replacer T83T-4851-A and Holding Tool T78P-4851-A to seat the yoke. Install an old pinion nut and tighten nut to 272-298 N-m (200-220 ft-lb).

NOTE: Use the old pinion nut until preload is verified. If rotating torque is within specification, then install the new pinion nut and tighten to specification.



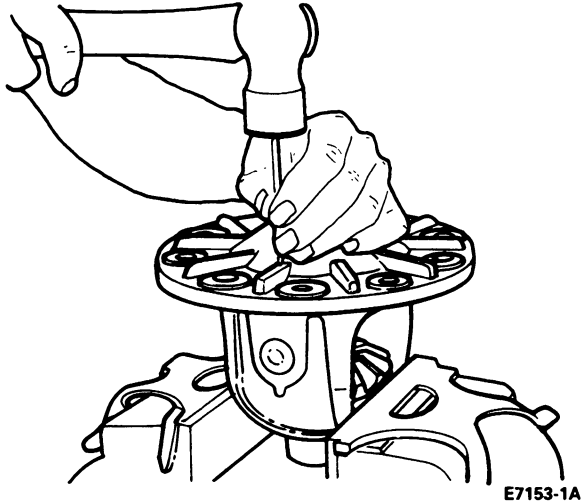
5. Rotate pinion nut with an inch-pound torque wrench. Rotating torque should be 2.26-4.51 N-m (20-40 in-lb).

NOTE: To increase preload, remove shims. To decrease preload, add shims.

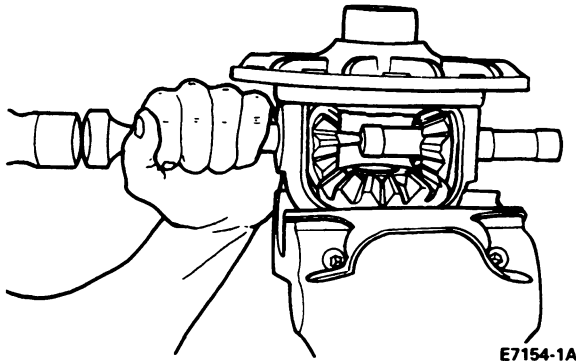
6. Install the yoke with Companion Flange Replacer T83T-4851-A. Install washer and nut and tighten nut to 272-298 N-m (200-220 ft-lb).

DISASSEMBLY AND ASSEMBLY (Continued)**Differential Case****Disassembly**

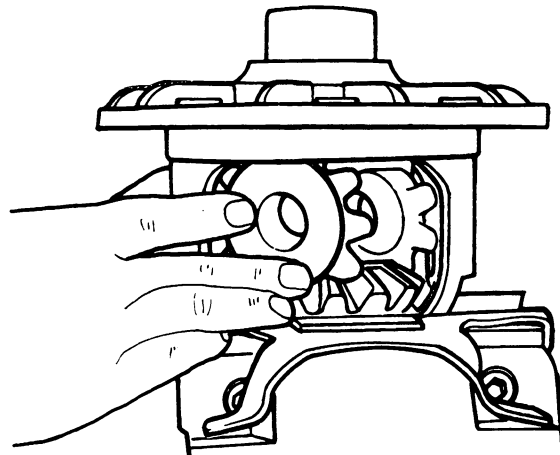
1. Place differential case in vise and drive out lock pin that retains the pinion mate shaft to case.



2. Remove drive pinion mate shaft with a drift.



3. Rotate the pinion mate gears and side gears until the pinion mate gears turn to the windows of the case. Remove pinion mate gears and spherical washers.
4. Lift side gears and thrust washers from case.

**Assembly**

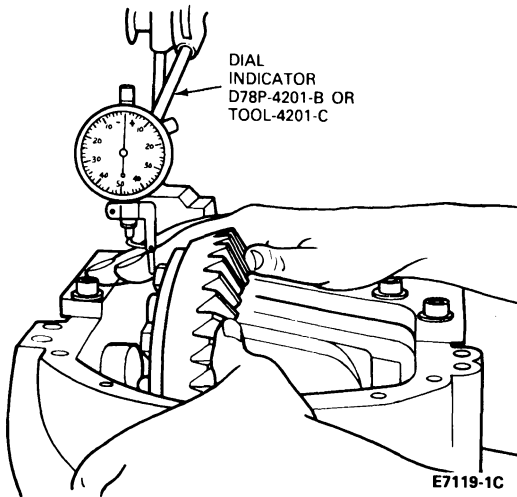
1. Inspect case parts for signs of wear. If wear exists on all parts, replace the entire differential case assembly. If one gear shows signs of wear, replace both pinion mate and side gears as a set.
2. Apply High Temperature 4x4 Axle Grease E8TZ-19590-A (ESA-M1C198-A) or equivalent to side gear thrust washers, hub and thrust face of side gears. Lubricate pinion mate gears and spherical washer with High Temperature 4x4 Axle Grease E8TZ-19590-A (ESA-M1C198-A) or equivalent.
3. Hold side gears in place in case with one hand and install pinion mate gears and spherical washers with other hand. Rotate the side gears and pinion mate gears until the holes in the washers and pinion mate gears line up exactly with the holes in the case.
4. Insert the pinion mate shaft in the case. Make sure the lock pin hole in the shaft lines up with the lock pin holes in the case.
5. Insert lock pin. Peen some metal of the case over the pin to lock in two places 180 degrees apart. Note the location of the slot in the lock pin. Peen 90 degrees from slot.

Differential Case Assembly to Carrier**Pinion and Ring Gear Backlash**

1. Assemble ring gear to differential case. Use new grade 9 bolts. Tighten bolts alternately and evenly to 139 N-m (85 ft-lb).
2. Place the differential case into position in the carrier. Master bearings should still be installed.

DISASSEMBLY AND ASSEMBLY (Continued)

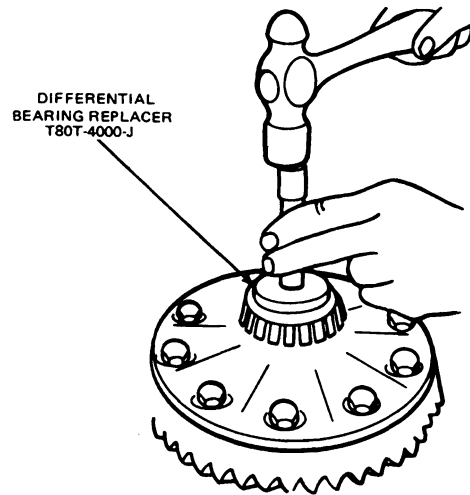
3. Force the differential case away from the drive pinion gear until it is completely seated against the cross bore face of the carrier. Position a dial indicator so the indicator tip rests on a differential case bolt. Zero the dial indicator.



4. Force ring gear against pinion gear. Rock ring gear slightly to make sure gear teeth are in contact. Then, force ring gear away from drive pinion gear, making sure the dial indicator returns to zero. Repeat this procedure until the dial indicator reading is the same.

NOTE: This reading reveals the amount of shims necessary between the differential case and differential bearing on the ring gear side.

5. Remove the differential case from the housing. Remove the master bearings from the case.
6. As determined in Step 4, place the required amount of shims on the ring gear hub of the differential case. For example, if the reading in Step 4 was 1.14mm (0.045 inch), place 1.14mm (0.045 inch) amount of shims on the hub of the ring gear side of the differential case.
7. Install the bearing cone on the hub of the ring gear side of the differential case. Drive the bearing onto the hub using Differential Side Bearing Replacer T80T-4000-J.



8. To determine the correct amount of shims to be placed on the hub of the drive pinion side of the differential case, subtract the reading obtained in Step 4 from the Differential Total Case End Play. Total Case End Play was determined in Steps 3 through 5 of Differential Total Case End Play. When this amount is determined, add 0.26mm (0.010 inch) to the amount. This is the required amount of shims to be placed on the hub of the drive pinion side of the differential case.

For example, total Case End Play was 2.30mm (0.091 inch). The reading in step 4 was 1.14mm (0.045 inch), and when subtracted from 2.30mm (0.091 inch) gives 1.16mm (0.046 inch), 0.26mm (0.010 inch) is added to give 1.42mm (0.056 inch) amount of shims to be placed on the hub of the drive pinion side of the differential case.
9. Place the required amount of shims on the hub of the drive pinion side of the differential case.
10. Install the bearing cone on the hub of the drive pinion side of the differential case. Place Step Plate D80L-630-5 or equivalent on the ring gear side bearing to protect the bearing.
11. Drive the bearing onto the hub of the drive pinion side of the differential case using Differential Side Bearing Replacer T80T-4000-J.
12. Install bearing cone on the pinion side of the differential case with Differential Side Bearing Replacer T80T-4000-J. Place the Pinion Bearing Cone Replacer T53T-4621-C on the ring gear bearing to prevent damage.
13. Install the differential bearing cups on the bearing cones.
14. With the spreader and dial indicator installed on the case, spread the carrier housing.

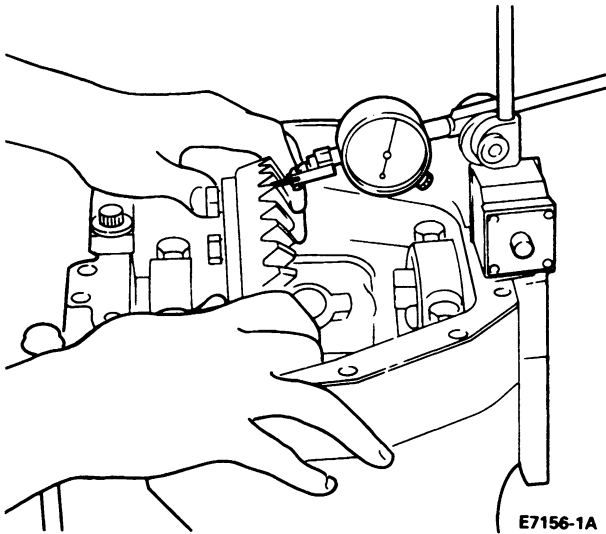
CAUTION: But do not exceed 0.25mm (0.015 inch).

DISASSEMBLY AND ASSEMBLY (Continued)

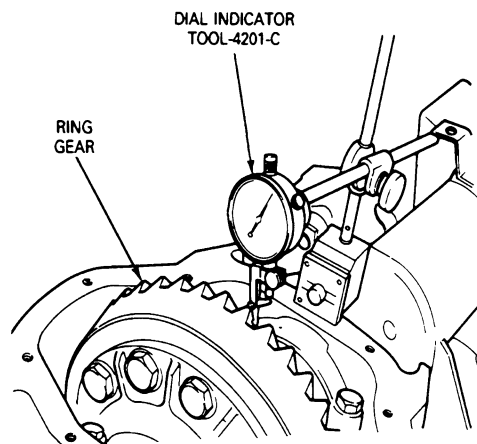
15. Install the differential case in the carrier. If necessary use a rawhide or plastic hammer to seat the differential case into the carrier housing cross bore. With partial and non-hunting / partial ring gear and pinion sets, align the marks on the ring gear and drive pinion.

NOTE: Be careful to not nick the teeth of the ring gear or pinion.

16. Remove the spreader and dial indicator from the case.
17. Install bearing caps and bolts. Make sure the letters stamped on the caps correspond in both position and direction with the letters stamped into the carrier. Tighten bolts to 122 N·m (90 ft. lb).
18. Rotate the pinion and differential assembly several revolutions to seat bearings.
19. Install Dial Indicator TOOL-4201-C on the case. Check ring gear and pinion backlash at three equally spaced points on the ring gear. Refer to Gear Tooth Contact Pattern Check in this section for backlash tolerance.



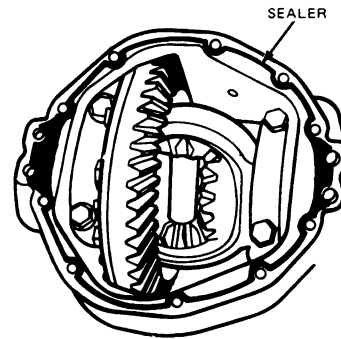
E7156-1A



E7500-1B

20. Obtain a gear tooth contact pattern check as outlined under Gear Tooth Contact Pattern Check in this section prior to complete reassembly.
21. Apply a bead 3.175-6.35mm (1/8-1/4-inch) high and 3.175-6.35mm (1/4-1/2-inch) wide of Silicone Rubber Sealant D6AZ-19562-A (clear) or -BA (black) (ESB-M4G92-A and ESE-M4G195-A) or equivalent on the mating surfaces of the carrier mounting face support arm.

NOTE: Allow one hour curing time after the axle carrier is assembled to the axle arm before installing lubricant and operating vehicle.



E4225-1A

22. Mount the differential assembly to the left hand axle arm using two guide pins, being careful not to smear gasket sealant. Install and tighten bolts to 54 N·m (40 ft·lb).
23. Use new bolts with encapsulated adhesive or wire brush the old bolts and apply thread-locking compound Threadlock and Sealer EOAZ-19554-AA (ESE-M4G204-A) or equivalent.
24. Install support arm tab bolts to side of carrier and tighten to 115-135 N·m (85-100 ft·lb).

Gear Tooth Contact Pattern Check

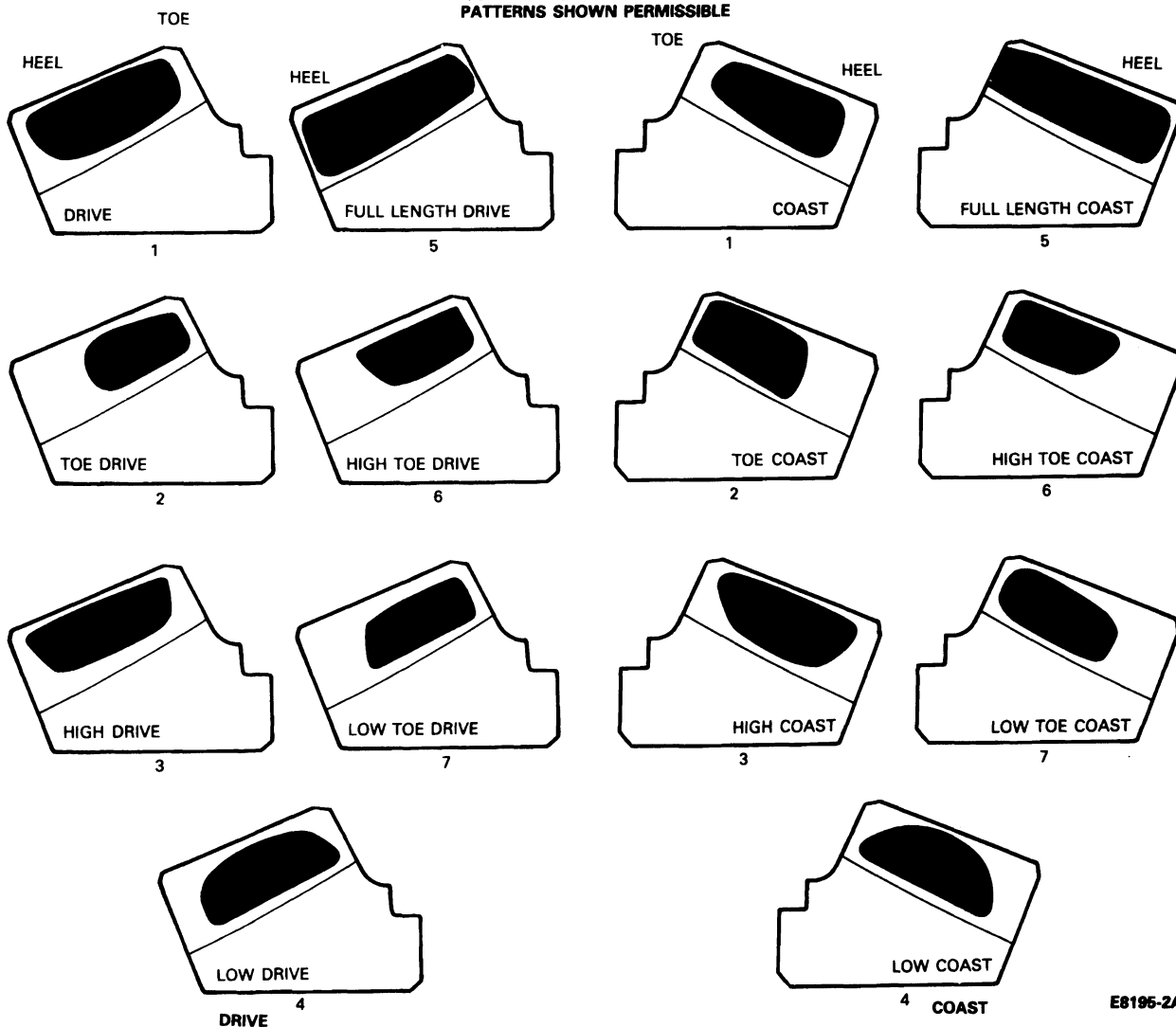
- To check the gear tooth contact, paint the gear teeth with the special marking compound.
NOTE: A mixture that is too wet will run and smear, too dry a mixture cannot be pressed out from between the teeth.
- Rotate the ring gear (use a box wrench on the ring gear attaching bolts as a lever) several complete revolutions in both directions or until a clear tooth contact pattern is obtained.
- Certain types of gear tooth contact patterns on the ring gear indicate incorrect adjustment. Incorrect adjustment can be corrected by readjusting the ring gear and / or the pinion.
- The illustration shows acceptable tooth patterns for all axles. In general, desirable tooth patterns should have the following characteristics:
 - The drive pattern should be fairly well centered on the tooth.

DISASSEMBLY AND ASSEMBLY (Continued)

- b. The coast pattern should be fairly well covered on the tooth.
- c. Some clearance between the pattern and the top of the tooth is desirable.

- d. There should be no hard lines where the pressure is high.

**ACCEPTABLE TOOTH PATTERN LIMITS
ANY COMBINATION OF DRIVE AND COAST
PATTERNS SHOWN PERMISSIBLE**

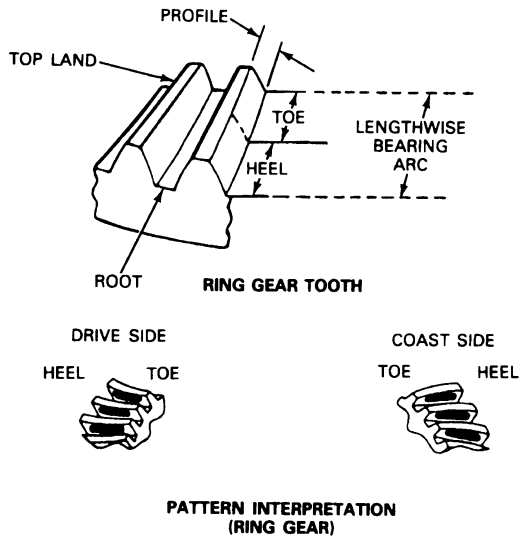


E8195-2A

5. An individual gear set need not conform exactly to the ideal pattern to be acceptable. Any combination of drive and coast patterns shown is acceptable.

DISASSEMBLY AND ASSEMBLY (Continued)

6. Since each gear set rolls a characteristic pattern, the patterns shown are considered acceptable and should be used as a guide. The drive pattern is rolled on the convex side of the tooth, and the coast pattern is rolled on the concave side.



NORMAL OR DESIRABLE PATTERN. THE DRIVE PATTERN SHOULD BE CENTERED ON THE TOOTH. THE COAST PATTERN SHOULD BE CENTERED ON THE TOOTH, BUT MAY BE SLIGHTLY TOWARD THE TOE. THERE SHOULD BE SOME CLEARANCE BETWEEN THE PATTERN AND THE TOP OF THE TOOTH.

THE TOE OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE END TOWARDS THE CENTER. THE HEEL OF THE GEAR TOOTH IS THE PORTION OF THE TOOTH SURFACE AT THE OUTER END. THE TOP LAND OF A GEAR TOOTH IS THE SURFACE OF THE TOP OF THE TOOTH.

E8196-1A

The movement of tooth contact patterns with changes in shimming can be summarized as follows:

- Thinner shim, with the backlash set to specification, moves the pinion farther from the ring gear.
- Thicker shim, with the backlash set to specification, moves the pinion closer to the ring gear.

NOTE: When making pinion position changes, shims should be changed in the range of .05mm (.002 inch) to .10mm (.004 inch) until correct pattern has been obtained.

7. If the pinion positioning shims are correct:
- Decreasing backlash moves the ring gear closer to the pinion. Drive pattern (convex side of gear) moves slightly lower and toward the toe. Coast pattern (concave side of gear) moves lower and toward the toe.

- Increasing backlash moves the ring gear away from the pinion. Drive pattern moves slightly higher and toward the heel. Coast pattern moves higher and towards the heel.

NOTE: If the patterns are not correct, make the changes as indicated. The differential case and drive pinion will have to be removed from the carrier housing to change a shim.

DRIVE SIDE		COAST SIDE		
HEEL	TOE	TOE	HEEL	
				BACKLASH CORRECT. THINNER PINION POSITION SHIM SHIM REQUIRED.
				BACKLASH CORRECT. THICKER PINION POSITION SHIM REQUIRED.

THICKER PINION POSITION SHIM WITH THE BACKLASH CONSTANT MOVES THE PINION CLOSER TO THE RING GEAR.

DRIVE PATTERN MOVES DEEPER ON THE TOOTH (FLANK CONTACT) AND SLIGHTLY TOWARD THE TOE.

COAST PATTERN MOVES DEEPER ON THE TOOTH AND TOWARD THE HEEL.

THINNER PINION POSITION SHIM WITH THE BACKLASH CONSTANT MOVES THE PINION FURTHER FROM THE RING GEAR.

DRIVE PATTERN MOVES TOWARD THE TOP OF THE TOOTH (FACE CONTACT) AND TOWARD THE HEEL.

COAST PATTERN MOVES TOWARD THE TOP OF THE TOOTH AND SLIGHTLY TOWARD THE TOE.

E8197-1A

8. Check ring gear backlash by installing a dial indicator on the carrier housing. Check ring gear and pinion backlash at three equally spaced points on the ring gear. Backlash tolerance is 0.23mm (0.005-0.009 inch) and cannot vary more than 0.08mm (0.003 inch) between the three points. If backlash is high, the ring gear must be moved closer to the pinion, by moving shims to the ring gear side to the opposite side. If backlash is low, the ring gear must be moved away from the pinion by moving shims from the ring gear side to the opposite side.

DRIVE SIDE		COAST SIDE		
HEEL	TOE	TOE	HEEL	
				PINION POSITION SHIM CORRECT. DECREASE BACKLASH.
				PINION POSITION SHIM CORRECT. INCREASE BACKLASH.

HIGH BACKLASH IS CORRECTED BY MOVING THE RING GEAR CLOSER TO THE PINION. LOW BACKLASH IS CORRECTED BY MOVING THE RING GEAR AWAY FROM THE PINION. THESE CORRECTIONS ARE MADE BY SWITCHING SHIMS FROM ONE SIDE OF THE DIFFERENTIAL CASE TO THE OTHER.

E8198-1A

DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .10mm (.004 inch), the shim pack should be changed by .15mm (.006 inch) as a starting point. The actual amount of backlash change obtained will vary depending upon the ratio and gear size.

ADJUSTMENTS

Refer to Section 04-00 for alignment procedures.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Lb-Ft
Bottom Ball Joint Nut	123-149	90-110
Top Ball Joint Nut	135 (Minimum)	100 (Minimum)
End Yoke Nut	272-298	200-220
Bearing Cap Bolts	108-122	80-90
Differential Retaining Bolts	41-54	30-40
Ring Gear Bolts (Grade 8)	81	60
Ring Gear Bolts (Grade 9)	122	90
Support Arm Tabs to Carrier Bolts	135	100
Driveshaft to Yoke Nuts and U-Bolts	11-20	8-15
Coil Spring / Insulator to Lower Spring Seat	41-94	30-70
Upper Spring Retainer and Screw	18-24	13-18
Axle Assembly to Crossmember Pivot Bolt	163-203	120-150
Shock Absorber Mounting Plate U-Bolts	116-162	85-120
Top Ball Joint Stud Nut	136 N-m	100
Bottom Ball Joint Stud Nut	123-149	90-110
Spindle to Steering Knuckle Nuts (Both Sides) (Model 50)	81	60
Spindle to Steering Knuckle Nuts (Both Sides) (Model 44)	47	35

- Requires specific tightening sequence for proper installation. Refer to ball joint installation procedure in this section.

DANA AXLE ADJUSTMENTS

Description	Specification
Drive Pinion Preload	2.25-2.43 N-m (20-40 In-Lb)
Ring Gear Backlash	0.13-0.23mm (0.005-0.009 Inch) No more than 0.08mm (0.003 Inch) variation in any three places

LUBRICANT CAPACITY

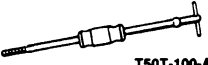

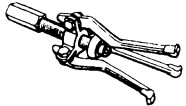


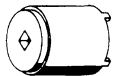
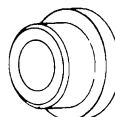
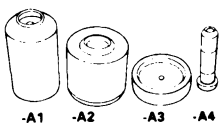

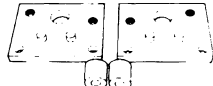
Axle Model	Approximate Capacity		
	U.S. Pints	Imperial Pints	Liters
Dana 44 — IFS	3.9	3.2	1.7
Dana 50 — IFS	4.1	3.4	1.8

NOTE: Use Axle Lubricant F 1TZ-19580-A (WSL-M2C191-A) or equivalent.

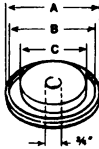

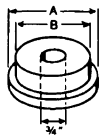
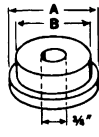
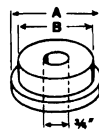
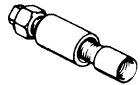
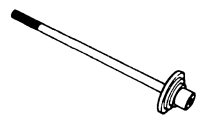


SPECIAL SERVICE TOOLS

Tool Number	Description
D79P-100-A	Slide Hammer (Needle Bearing Removal)
D80L-100-A	Blind Hole Puller Set
D80L-100-B	Forcing Screw (Needle Bearing Removal)
D80L-100-T	Collet — 1-1/4 — 1-1/2 Inch (Needle Bearing Removal)
D80L-630-5	Step Plate (Differential Side Bearing Removal)
D85T-1197-A	Spanner Locknut Wrench (Model 50 Inner Locknut Removal)
D81T-3010-A	Installing Cup (Ball Joint Installation — F-150, F-250)
D81T-3010-A	Receiving Cup (Ball Joint Removal — F-150, F-250)
D81L-4000-A	Driver Handle (Cup Removal)
D80T-4020-F44	Gauge Disc (Axle Adjustments — Model 44)
D80T-4020-F47	Gauge Tube (Axle Adjustments — Model 44)
D80T-4020-F49	Gauge Tube (Axle Adjustments)
D81T-4020-FX	Final Check Pinion Depth Gauge (Truck)
D81T-4020-F52	Final Check Gauge Block (Axle Adjustments — Model 44)
D81T-4020-F53	Final Check Gauge Block (Axle Adjustments — Model 50)
D78P-4201-B	Dial Indicator (Magnetic Base)
D81L-4220-A	Universal Bearing Remover (Bearing Removal)
D81T-4222-B	Master Differential Bearings (Axle Adjustments — Model 44)
D81T-4222-C	Master Differential Bearings (Axle Adjustments — Model 50)
D81T-4628-C	Pinion Bearing Cup Remover (Inner Bearing Cup Removal — Model 44)
D81T-4628-D	Pinion Bearing Cup Remover (Inner Bearing Cup Removal — Model 50 Outer Bearing Cup Removal — 44 and 50)

SPECIAL SERVICE TOOLS (Continued)





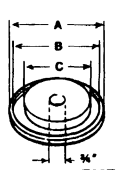
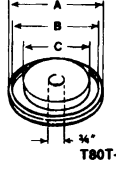
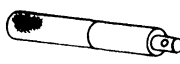
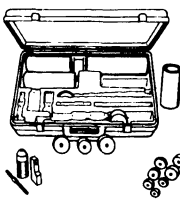
Tool Number / Description	Illustration
T50T-100-A Slide Hammer (Oil Seal Removal)	 T50T-100-A
T58L-101-B Sealer Puller	 T58L-101-B
T77F-1102-A Bearing Cup Puller (Oil Seal Removal)	 T77F-1102-A
T75L-1165-B Axle Bearing / Seal Plate (Drive Pinion Bearing Installation)	 T75L-1165-B
T75T-1176-A Forcing Screw (Bearing Cup Installation)	 T75T-1176-A
T86T-1197-A Spanner Locknut Wrench (Model 44 Adjusting Nut Removal)	 T86T-1197-A
T83T-1244-A Needle Bearing Replacer (Needle Bearing Installation)	 T83T-1244-A
T80T-3010-A 4WD Ball Joint Tool	 T80T-3010-A
T64P-3590-F Pitman Arm Puller	 T64P-3590-F
T80T-4000-B Differential Housing Spreader Adapter (Differential Case Removal and Installation)	 T80T-4000-B

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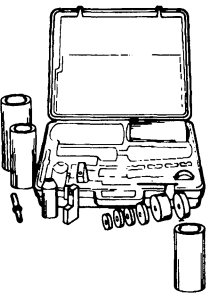


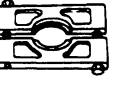


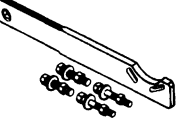

Tool Number / Description	Illustration
T80T-4000-C Pinion Seal Replacer	 T80T-4000-T
TOOL-4000-E Differential Housing Spreader (Differential Case Removal and Installation)	 TOOL-4000-E
T80T-4000-D Pinion Bearing Cup Replacer (Inner Bearing Cup Installation — Model 44)	 T80T-4000-D
T80T-4000-E Pinion Bearing Cup Replacer (Outer Bearing Cup Installation — Model 44 and 50)	 T80T-4000-E
T80T-4000-F Pinion Bearing Cup Replacer (Inner Bearing Cup Installation — Model 50)	 T80T-4000-F
T83T-4851-A Companion Flange Replacer (Yoke Installation)	 T83T-4851-A
T80T-4000-H Differential Axle Seal Replacer	 T80T-4000-H
T80T-4000-J Differential Side Bearing Replacer	 T80T-4000-J
T80T-4000-L Retainer Sleeve (Axle Bearing Removal)	 T80T-4000-L

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SPECIAL SERVICE TOOLS (Continued)

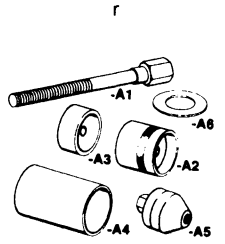

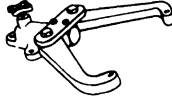

Tool Number / Description	Illustration
T80T-4000-M Axle Bearing Remover (Axle Bearing Removal)	 T80T-4000-M
T80T-4000-N Axle Bearing Replacer (Axle Bearing Installation)	 T80T-4000-N
T80T-4000-S Spindle Bearing Replacer (Needle Bearing Installation — Bronco — F-150-F-250)	 T80T-4000-S
T80T-4000-R Spindle Bearing Replacer (Spindle Bearing — F-350)	 T80T-4000-R
T80T-4000-T Seal Replacer (Seal Installation — F-150-F-250)	 T80T-4000-T
T80T-4000-U Seal Replacer (Seal Installation — F-350)	 T80T-4000-U
T80T-4000-W Driver Handle (Bearing and Seal Installation)	 T80T-4000-W
T79P-4020-A Pinion Depth Gauge	 T79P-4020-A

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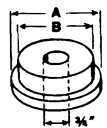
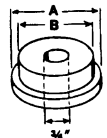

Tool Number / Description	Illustration
T80T-4020-A Truck Pinion Depth Gauge	 T80T-4020-A
TOOL-4201-C Dial Indicator (Axle Adjustments)	 TOOL-4201-C
T53T-4621-B Pinion Bearing Cone Replacer (Drive Pinion Bearing Installation — Model 44)	 T53T-4621-B
T71P-4621-B Pinion Bearing Cone Remover (Axle Bearing Installation)	 T71P-4621-B
T74P-4635-C C-Frame Assembly	 T74P-4635-C
T65L-4851-B Yoke Remover	 T65L-4851-B
T78P-4851-A Holding Tool (Yoke Removal and Installation)	 T78P-4851-A
T83T-4851-A Companion Flange Replacer	 T83T-4851-A

(Continued)

SPECIAL SERVICE TOOLS (Continued)

Tool Number / Description	Illustration
T78P-5638-A Suspension Bushing Service Set	 <p>T78P-5638-A</p>
T80T-5638-A Front Suspension Bushing Tool	 <p>T80T-5638-A</p>
T57L-500-B Bench Mounted Holding Fixture	 <p>T57L-500-B</p>
T80T-4000-K Differential Side Bearing Remover	 <p>T80T-4000-K</p>

(Continued)

Tool Number / Description	Illustration
T80T-4000-P Bearing Cup Replacer (Inner Hub-F150, Bronco)	 <p>T80T-4000-P</p>
T80T-4000-Q Bearing Cup Replacer (Inner Hub-F250)	 <p>T80T-4000-Q</p>
T63P-9171-A Keystone Clamp Pliers	 <p>T63P-9171-A</p>

SECTION 05-02L

Wheel Hubs and Bearings, Front
Wheels, 4-Wheel Drive

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION	
Front Wheel Bearing Adjustment.....	05-02L-6	Automatic Locking Hubs	05-02L-3
Bronco and F-150 with Dana 44-IFS/HD		Manual Locking Hubs	05-02L-2
Front Driving Axle with Manual Locking		SPECIAL SERVICE TOOLS	05-02L-7
Hubs	05-02L-6	SPECIFICATIONS	05-02L-7
DESCRIPTION AND OPERATION	05-02L-1	VEHICLE APPLICATION	05-02L-1
DISASSEMBLY AND ASSEMBLY			
Front Wheel Grease Seal and Bearing			
Replacement and Repacking	05-02L-5		

VEHICLE APPLICATION

Bronco and F-150-250-350 4x4 Vehicles

DESCRIPTION AND OPERATION

The hub locks on Bronco and F-150-250-350 4x4 vehicles equipped with four-wheel drive, either automatically or manually actuate the front driving axle. When actuated, the hub lock body assembly locks the hub and wheel and tire assembly to the front driving axleshaft. When released, the front driving axleshaft is disengaged from the hub assembly and the wheel assembly rotates freely on the spindle.

F-350 4x4 vehicles equipped with dual wheel rear axles have the wheel and tire assembly attached to the hub with integral two-piece swiveling lugnuts.

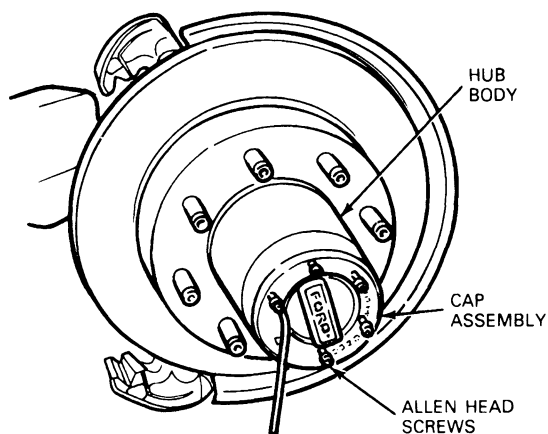
WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUGNUTS (CONE-SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUGNUTS. PAST MODEL LUGNUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE-SHAPED LUGNUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUGNUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

REMOVAL AND INSTALLATION

Manual Locking Hubs

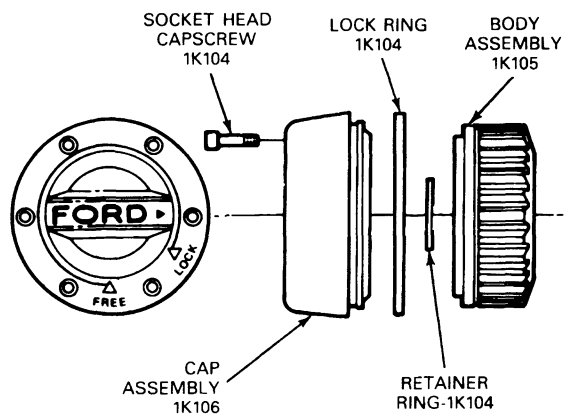
Removal and Installation

1. Separate cap assembly from hub body by removing the six Torx® head capscrews.



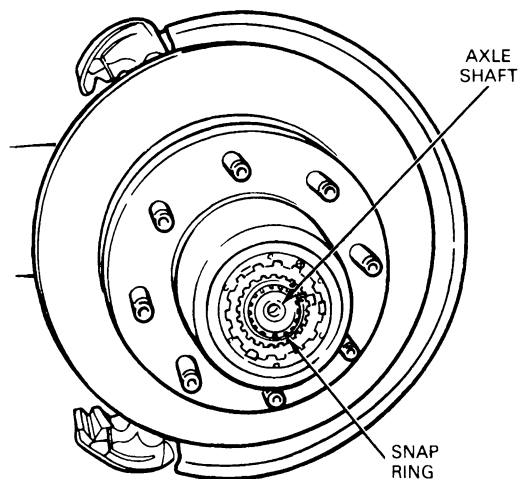
F4655-C

Bronco and F-150-250-350 4x4



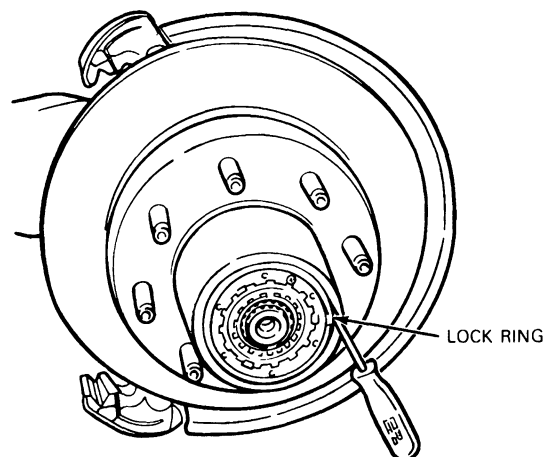
F2875-E

2. Remove the snap ring that retains the axle shaft in the hub body assembly.



F4657-C

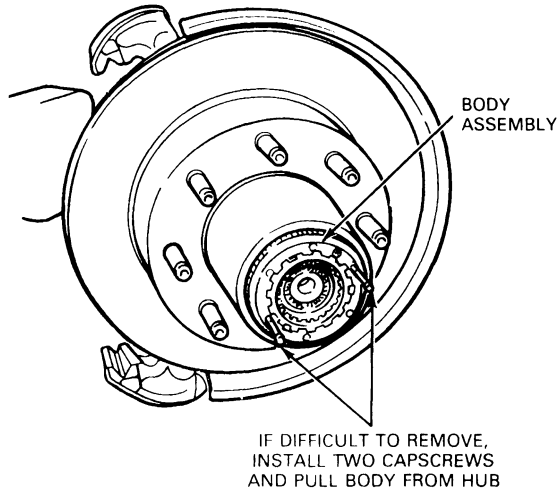
3. Remove the lock ring seated in the groove of the wheel hub.



F4658-C

REMOVAL AND INSTALLATION (Continued)

4. Remove the body assembly from the hub. If the body is difficult to remove, install two capscrews and pull the body assembly out of the hub.



F4659-C

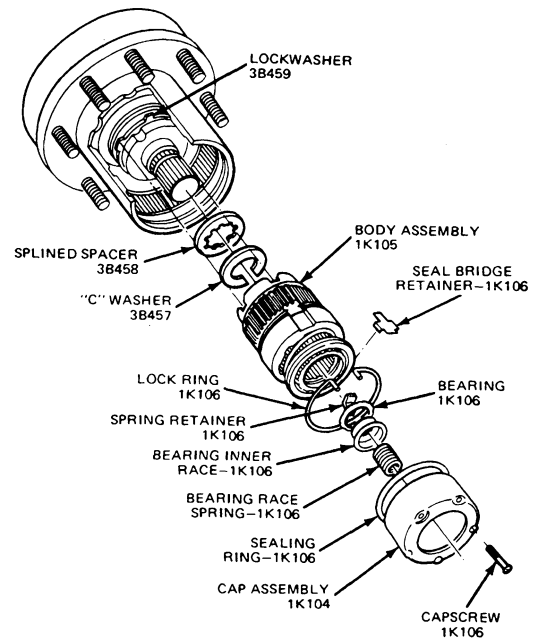
For installation, follow removal procedures in reverse order. Tighten six Torx® head capscrews to 4-6 N·m (35-50 in·lb).

NOTE: Do not pack the cap assembly with grease. Excessive grease can cause excessive dialing effort.

Automatic Locking Hubs

Removal

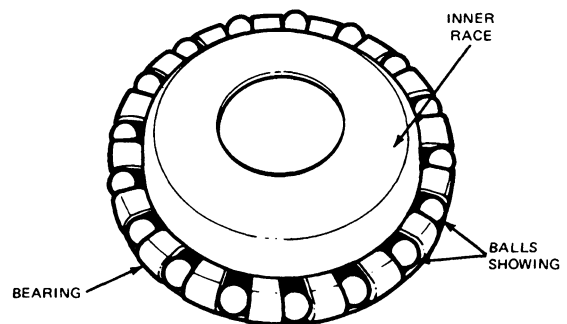
1. Separate cap assembly from body assembly by removing the five capscrews, using Torx® bit TX25 or equivalent, from the cap assembly.
2. Remove cover.
CAUTION: Do not drop spring, ball bearing, bearing race, or retainer.
3. Remove rubber seal.
4. Remove seal bridge retainer (small metal stamping) from retainer ring space.
5. Remove retainer ring by closing the ends with needlenose pliers while pulling hub lock from wheel hub.



F3304-1A

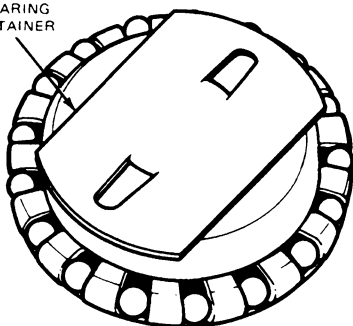
If wheel hub and spindle are to be removed:

6. Remove C-washer from stub shaft groove.
7. Remove splined spacer from shaft.
8. Remove wheel bearing locknuts and lockwasher.
9. If the hub assembly requires cleaning, refer to Steps 10-16.
10. Wash the cap bearing, race and retainer assembly in cleaner solvent and thoroughly dry the components. Repack the bearing with a lithium base grease, Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Refer to the illustrations for proper positioning of the bearing on the race.



F3581-1A

REMOVAL AND INSTALLATION (Continued)

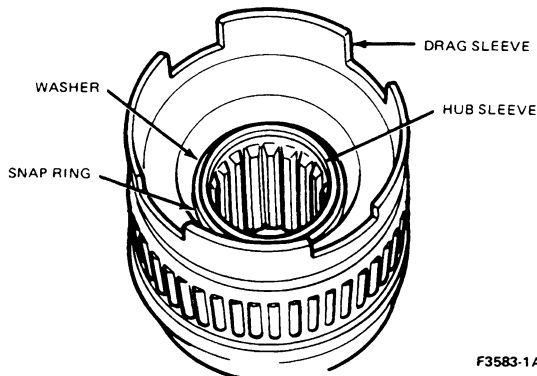
BEARING
RETAINER

F3582-1A

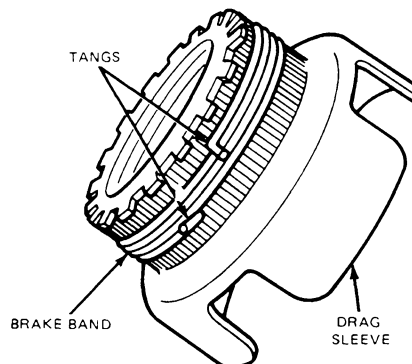
11. Remove the snap ring and flatwasher from the inner end of the hub lock assembly.
12. Pull the hub sleeve and attached parts out of the drag sleeve.
13. Cock the drag sleeve to unlock the tangs of the brake band and remove the drag sleeve assembly.

NOTE: Never remove the brake band from the drag sleeve.

14. Wash in cleaner solvent and air dry the drag sleeve and brake band. Lubricate the brake band and drag sleeve assembly with 1.5 grams (0.05 oz.) of Automatic Hublock Grease E1TZ-19590-A (ESL-M1C193-A) (Darmex Spec. DX-123-LT) or equivalent. Work the lubricant over the spring and the area of the drag sleeve under the spring.

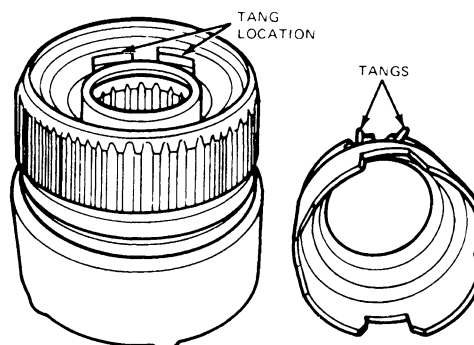


F3583-1A



F3584-1A

15. The body assembly (excludes cap assembly, and brake band and drag sleeve assembly) should be dipped in Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX (ESP-M2C166-H or ESP-M2C138-C) or equivalent and permitted to drip dry for a few minutes before proceeding with assembly.
16. Assemble one of the two tangs of the brake band on each side of the plastic outer cage located in the window of the steel inner cage. Cock parts to engage the tangs into position as the drag sleeve is positioned against the face of the cam follower. Install the washer and snap ring.



F3585-1A

Installation

1. Adjust wheel bearings. Refer to Adjustments in this section for procedure.
2. Install the splined spacer and the C-washer on the axle shaft.
NOTE: Remove excessive grease from hub lock and hub splines prior to installation.
3. Start hub lock assembly into hub, making sure the large tangs are lined up with the lockwasher and the outside diameter and inside diameter splines are in line with the hub and axle shaft splines.
4. Install retainer ring by closing the ends with needle nose pliers, at the same time, push hub lock assembly into the hub.
5. Install seal bridge retainer (small metal stamping) with narrow end first.
6. Install rubber seal over hub lock.

REMOVAL AND INSTALLATION (Continued)

7. Install cover (make sure ball bearing, spring, bearing race and retainer are in place).
8. Tighten the 5 screws to 4.5-5.6 N·m (40-50 in-lb) using Torx® Bit TX25 or equivalent in following sequence: tighten one, skip one, etc.

DISASSEMBLY AND ASSEMBLY

Front Wheel Grease Seal and Bearing Replacement and Repacking

Bronco and F-150-250-350 4x4

The recommended wheel bearing lubricant is the lithium-base grease High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A or equivalent.

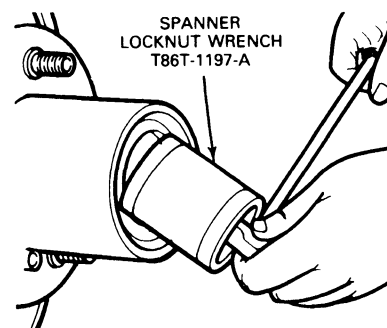
Sodium-base grease is not compatible with lithium-base grease and should not be intermixed. Therefore, before lubricating front and / or rear wheel bearing, thoroughly clean all old grease from the bearing and hub.

CAUTION: Usage of incompatible bearing lubricant could result in premature lubricant breakdown.

If bearing adjustment does not eliminate looseness or rough and noisy operation, clean, inspect and repack the hub and bearings with specified wheel grease. If bearing cups or the cone and roller assemblies are worn or damaged, replace.

Disassembly

1. Raise the vehicle and install safety stands.
2. Remove the locking hubs, refer to Manual or Automatic Locking Hub Removal and Installation in this section.
3. Remove the wheel lugnuts and the wheel and tire from the hub and rotor assembly as described in Section 04-04.
4. For Bronco and F-150 4x4 vehicles equipped with Dana Model 44 front drive axle and manual hub lock, remove the adjusting nut with Spanner Locknut Wrench T86T-1197-A. Apply inward pressure on the locknut wrench to disengage the adjusting nut locking splines and turn the nut counterclockwise to loosen and remove the nut from the spindle. For F-150 (Dana 44IFS) with automatic hub locks, F-250HD (Dana 50 IFS) with manual or automatic hub locks and F-350 (Dana 60 Monobeam) with manual or automatic hub locks, remove the outer locknut, lockwasher and inner locknut with Spanner Locknut Wrench D85T-1197-A or equivalent.

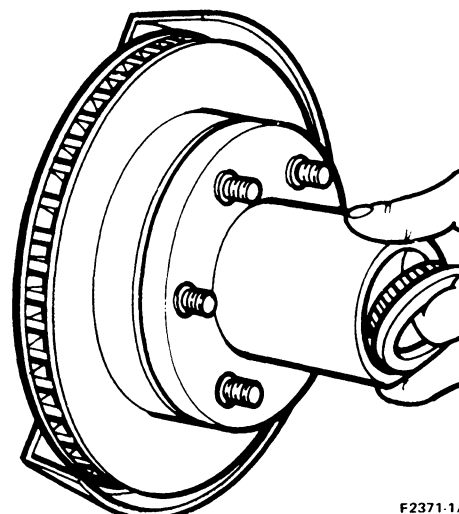


F2370-E

5. Remove the brake caliper refer to Section 06-03, securely wire the caliper to the frame.

CAUTION: Do not let the caliper hang only by the hose, or damage may occur to the hose or caliper.

6. Remove the hub and disc assembly. The outer wheel bearing cone and roller assembly will slide out as the hub is removed.



F2371-1A

7. Remove the spindle retaining nuts. Carefully remove the spindle from the knuckle studs and axle shaft.
8. Clean all old grease from the needle bearings and the spindle bore seal.
9. Clean any old grease or dirt from these parts and replace if signs of excessive wear are noted.

Assembly

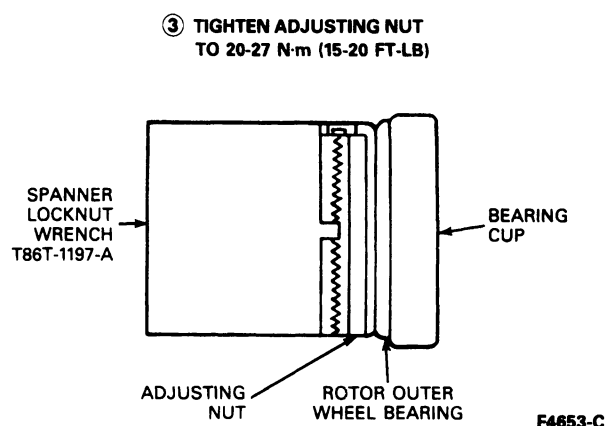
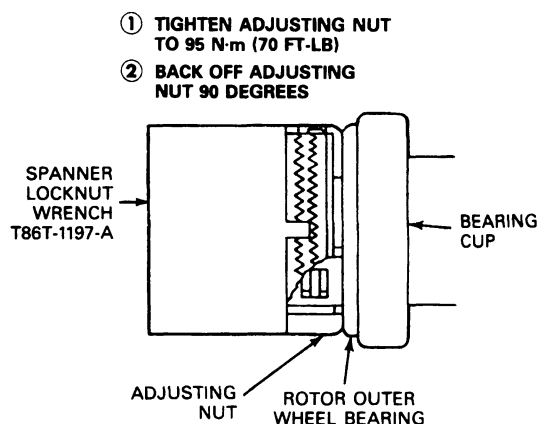
1. Using High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A or equivalent thoroughly lubricate the needle bearing and coat the spindles or face that mates with the spindle seals.
2. Assemble the spindle over the axle shaft onto the knuckle studs. Tighten the retaining nuts to 68-81 N·m (50-60 ft-lb).

DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove the inner bearing cone, grease seal and bearing cups from the hub using Bearing Cup Puller T77F-1102-A and Impact Slide Hammer T50T-100-A.
4. Inspect the bearing cups for pits or cracks. If necessary, remove with a drift. **If new cups are installed, install new cone and roller assemblies.**
5. Lubricate the bearings with High Temperature 4x4 Front Axle and Wheel Bearing Grease E8TZ-19590-A or equivalent. Clean all old grease from the hub. Pack the cones and rollers. If a bearing packer is not available, work as much lubricant as possible between the rollers and the cages.
6. Position the inner bearing cone and roller in the inner cup and install the grease seal.
7. Carefully position the hub and disc assembly on the spindle.
8. Install the outer bearing cone and roller, and adjusting nut or locknuts and lockwashers.
NOTE: On Dana Model 44 front drive axles with manual hublocks, the metal stamping on the adjusting nut must face inboard (toward the spindle). Make sure the inner diameter key on the nut enters the spindle keyway.
9. Adjust the wheel bearings as described in this section under Adjustments.
10. Install tire and wheel as described in Section 04-04.
11. Install the locking hubs as described in this section under Removal and Installation.
12. Remove the safety stands and lower the vehicle.

ADJUSTMENTS**Front Wheel Bearing Adjustment****Bronco and F-150 with Dana 44-IFS/HD Front Driving Axle with Manual Locking Hubs**

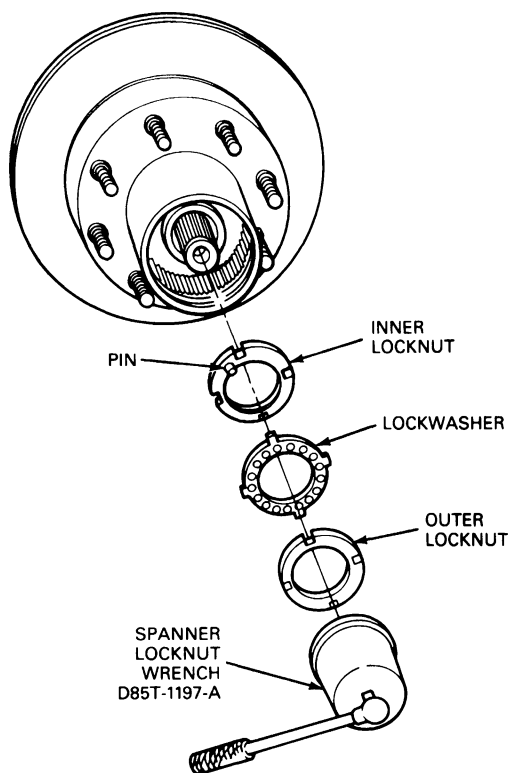
1. Raise the vehicle and install safety stands.
2. Remove the hub lock assembly. Refer to manual locking hub removal and installation procedures in this section.
3. Using a torque wrench and Spanner Locknut Wrench T86T-1197-A, apply inward pressure to unlock the adjusting nut locking splines.
4. Turn the nut clockwise to tighten to 95 N·m (70 ft-lb) while rotating the wheel back and forth to seat the bearing.
5. Apply inward pressure on the spanner locknut wrench to disengage the adjusting nut locking splines.
6. Back off the adjusting nut approximately 90 degrees.
7. Retighten the adjusting nut to 20-27 N·m (15-20 ft-lb). Remove the tool and torque wrench.
8. Check that the final end play of the hub and rotor on the spindle is 0.00 mm (0.00 inch).
9. Torque required to rotate the hub and rotor assembly is not to exceed 2.3 N·m (20 in-lb).
10. Install the hub lock assembly as described in this section.
11. Remove the safety stands. Lower the vehicle.

Front Wheel Bearing Adjustment

ADJUSTMENTS (Continued)

Bronco and F-150 with Dana 44-IFS with Automatic Locking Hubs, F-250 with Dana 50-IFS and F-350 with Dana 60 Monobeam with Manual or Automatic Locking Hubs

1. Raise the vehicle and install safety stands.
2. Remove the hub lock assembly. Refer to the automatic locking hub or manual locking hub removal and installation procedures in this section.
3. Remove the outer locknut with Spanner Locknut Wrench D85T-1197-A or equivalent. Remove the lockwasher.
4. Using spanner locknut wrench while rotating the hub back and forth, tighten the inner locknut to 68 N·m (50 ft-lb) to seat the bearing.
5. Back off the inner locknut and retighten to 41-54 N·m (30-40 ft-lb) while rotating the hub back and forth.
6. Back off the locknut 90 degrees.
7. Install the lockwasher so the key is positioned in the spindle groove. Tighten the inner locknut, aligning the pin into the nearest lockwasher hole.



F7750-A

8. Install the outer locknut and tighten to 217-278 N·m (160-205 ft-lb) using spanner locknut wrench.
9. Check the final end play of the spindle. It should be 0.00-0.11 mm (0.000-0.004 inch).
10. Torque required to rotate the hub and rotor assembly is not to exceed 2.3 N·m (20 in-lb).
11. Install the hub locks as described in this section.
12. Remove the safety stands. Lower the vehicle.

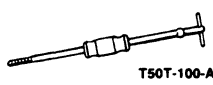
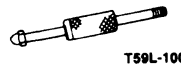

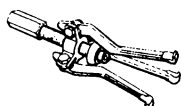
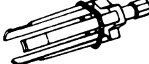
SPECIFICATIONS

WHEEL TORQUE SPECIFICATIONS

Description	N·m	Lb·Ft
E-150, F-150, Bronco (5-Lug Wheel 1/2-20)	135	100
E-250, E-350, F-250, F-350 (8-Lug Wheel 9/16-18)	190	140
F-Super Duty and F-Super Duty Stripped Chassis Vehicles (10-Lug Wheel 9/16-18)	190	140

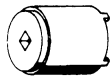
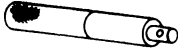
NOTE: Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts.

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer — 2-1/2 Lb.	 T50T-100-A
T59L-100-B Impact Slide Hammer — 2-1/2 Lb.	 T59L-100-B
T58L-101-B Puller Attachment (Use with Slide Hammer)	 T58L-101-B
T77F-1102-A Bearing Cup Puller (Use with Slide Hammer)	 T77F-1102-A
TOOL 1175-AC Seal Remover (Use with Slide Hammer)	 TOOL-1175-AC

(Continued)

SPECIAL SERVICE TOOLS (Continued)

Tool Number / Description	Illustration
T86T-1197-A Spanner Locknut Wrench (Dana Model 44 IFS Front Drive Axle)	 T86T-1197-A
T80T-4000-W Drive Handle (Bearing Installation)	 T80T-4000-W

Tool Number	Description
D79P-100-A	Impact Slide Hammer — 5 Lb.
D80L-927-A	Wheel Hub Cap Remover
D85T-1197-A	Spanner Locknut Wrench (Dana Model 50 IFS and Model 60 Monobeam Front Drive Axles)
D78P-1225-B	Bearing Cup Puller
D79T-4000-A	Outside Thread Chaser

GROUP

07

TRANSMISSION

SECTION TITLE	PAGE	SECTION TITLE	PAGE
SHIFT CONTROLS, AUTOMATIC		TRANSMISSION, AUTOMATIC, C6.....	07-01B-1
TRANSMISSION	07-05-1	TRANSMISSION, AUTOMATIC, E4OD	07-01A-1
TRANSFER CASE, 4X4 SYSTEM, GENERAL.....	07-07-1	TRANSMISSION, MANUAL, FOUR-SPEED.....	07-03B-1
TRANSFER CASE, ELECTRONIC SHIFT.....	07-07A-1	TRANSMISSION, MANUAL, GENERAL.....	07-00-1
TRANSFER CASE, MANUAL SHIFT	07-07B-1	TRANSMISSION, MANUAL, M5OD	07-03A-1
TRANSMISSION, AUTOMATIC, AOD	07-01C-1	TRANSMISSION, MODEL S5-42 ZF	07-03C-1
TRANSMISSION, AUTOMATIC, -4R7OW (AODE-W).....	07-01D-1		

SECTION 07-00 Transmission, Manual, General

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		CLEANING AND INSPECTION (Cont'd.)	
Bearings.....	07-00-8	Thrust Washers and Bearing Covers.....	07-00-11
Flywheel Clutch Face Runout	07-00-11	Transmission	07-00-7
Gears	07-00-9	Transmission Case	07-00-8
Gearshift Housing	07-00-8	DESCRIPTION AND OPERATION	
Input Shaft.....	07-00-11	Identification	07-00-1
Output Shaft.....	07-00-11	DIAGNOSIS AND TESTING	07-00-4
Reverse Idler Gear	07-00-10	SPECIAL SERVICE TOOLS	07-00-12
Seals and Gaskets	07-00-11	SPECIFICATIONS	07-00-12
Synchronizer Blocking Rings	07-00-11	VEHICLE APPLICATION	07-00-1

VEHICLE APPLICATION

All F-150-250-350, Bronco, F-Super Duty and F-Super Duty Stripped Chassis Vehicles Equipped with Manual Transmissions

DESCRIPTION AND OPERATION

Identification

Transmission identification codes are found on the Vehicle Safety Compliance Certification Label found on the driver's door lock pillar. For identification of the label transmission code, refer to Section 00-01, Identification Codes.

Refer to the following list for specific applications.

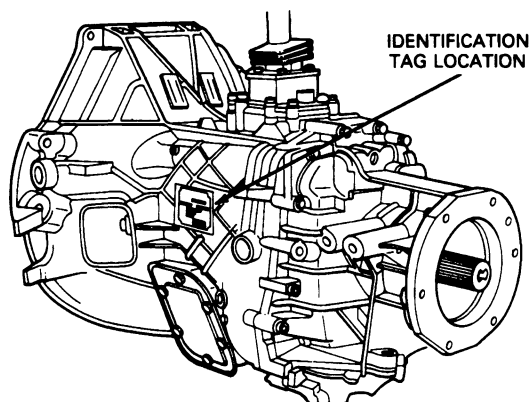
Transmission	Application
HD M5OD (ZF Wide Ratio)	F-Series over 8500 pounds GVW
HD M5OD (ZF Close Ratio)	F-Series over 8500 pounds with 7.3L Diesel
M5OD (Mazda R2)	F-Series and Bronco with either a 4.9L EFI or a 5.0L EFI and listed at under 8500 pounds GVW
M4 (Borg Warner T-18)	F-Series and Bronco with either a 4.9L EFI or a 5.0L EFI and listed at under 8500 pounds GVW

DESCRIPTION AND OPERATION (Continued)

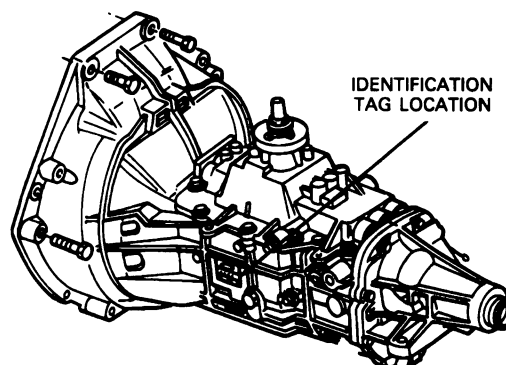
Transfer Case	Application
Borg Warner 13-56	All F-Series 4x4 and Bronco Vehicles

Manual transmissions have service identification tags to identify assemblies for service purposes. Ford truck manual transmissions have the identification tag located on the left side of the transmission case.

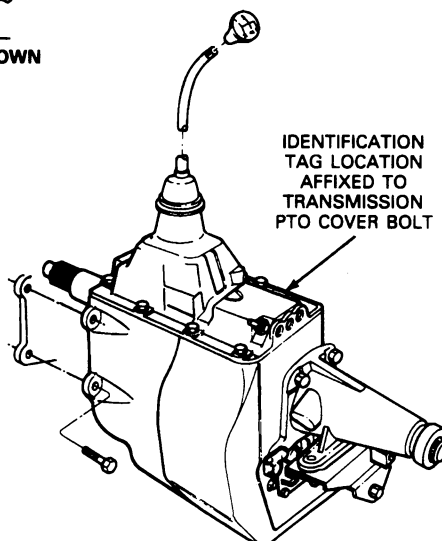
Identification Tag Locations



**ZF S5-42 TRANSMISSION —
4x4 AND F-SUPER DUTY SHOWN
(4x2 MODEL SIMILAR)**



**MAZDA
M50D R2 4x2 SHOWN
(4x4 SIMILAR)**

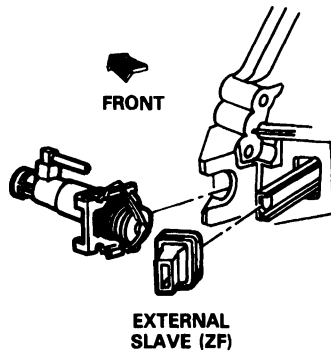
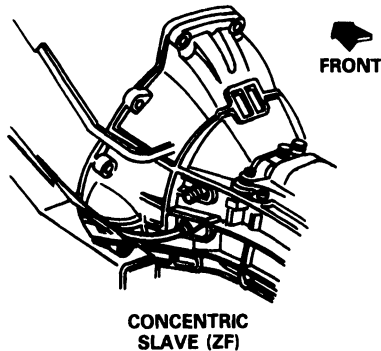


**B-W T-18
F-150 — F-250 4x2 SHOWN
(4x4 SIMILAR)**

C10822-B

DESCRIPTION AND OPERATION (Continued)

ZF transmissions are further identified by types of clutch release systems, either concentric slave or external slave. Refer to the following illustration to identify the particular clutch system.



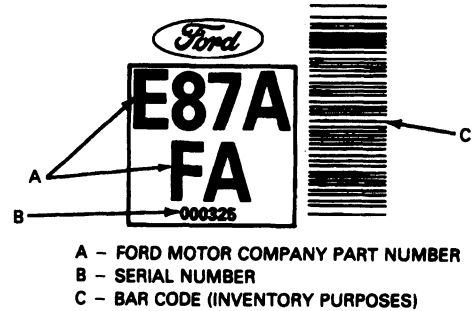
C10823-A

Transmission Identification Tag, 5-Speed Manual, ZF

SYNCHRONIZED		NUMBER OF FORWARD GEARS	TRANSMISSION SIZE (APPROXIMATE MAXIMUM FT-LB INPUT TORQUE × 10)
ZF		Ford	
MODEL	S5-42		
ZF PARTS LIST NO	TRANSMISSION SERIAL NO		
1307 050 005	1001010		
FORD PART NO	E7TA-7003-HA		
TOTAL RATIO	4.14-0.77		
BUILD DATE	OIL CAPACITY IN LTS		3.2
OIL GRADE	ESP-M2C 166-H		
MADE IN	U.S.A.		

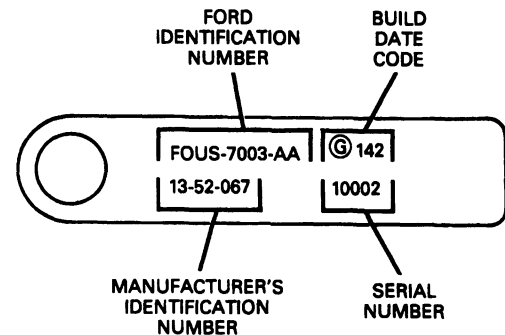
C8882-D

Transmission Identification Tag, 5-Speed Manual, Mazda



C8663-B

Transmission Identification Tag, Borg-Warner T-18 4-Speed Manual Transmission



C5847-B

Borg-Warner T-18 manual transmission has an identification tag located on the left middle bolt retaining the cover to the case.

DIAGNOSIS AND TESTING

CONDITION	POSSIBLE SOURCE	ACTION
Transmission shifts hard.	<ul style="list-style-type: none"> ● Clutch does not completely release. ● Transmission fluid low or improper type. ● Worn or damaged internal shift mechanism. ● Binding of sliding gears and / or synchronizers. ● Housings and / or shafts out of alignment. 	<ul style="list-style-type: none"> ● Check input shaft splines for lubrication. Refer to Section 08-00. ● Add lubricant or change lubricant as required. ● Remove transmission cover. Check internal shift mechanism by shifting into and out of all gears. Repair or replace as required. ● Check for free movement of gears and synchronizers. Repair or replace as required. ● Remove transmission and check for binding condition between input shaft and engine crankshaft pilot bearing or bushing. Check flywheel housing alignment. Repair or replace as required.
Noisy in forward gears. NOTE: While verifying the condition, determine whether the noise is gear roll-over noise, release bearing rub or some other transmission-related noise. Gear roll-over noise, inherent in manual transmissions, is caused by the constant mesh gears turning at engine idle speed, while the clutch is engaged and the transmission is in neutral; and release bearing rub is sometimes mistaken for mainshaft bearing noise. Gear roll-over noise will disappear when the clutch is disengaged or when the transmission is engaged in gear. Release bearing rub will disengage when the clutch is engaged. In the event that a bearing is damaged, the noise is more pronounced while engaged in gear under load or coast than in neutral.	<ul style="list-style-type: none"> ● Lubricant level low or improper type. ● Components grinding on transmission. ● Component housing bolts loose. ● Flywheel housing to engine crankshaft alignment. ● Noisy bearings or gears. 	<ul style="list-style-type: none"> ● Add lubricant, or refill with specified lubricant. ● Check for screws, bolts, etc., of cab or other components grounding out. Correct as required. ● Check torque on transmission to flywheel housing bolts, output shaft flange nut and flywheel housing to engine block bolts. Tighten bolts to specification. ● Check and align flywheel housing to engine crankshaft. ● Remove and disassemble transmission. Inspect input, output and countershaft bearings. Inspect speedometer gear and gear teeth for wear or damage. Replace as required.
Gears clash when shifting from one forward gear to another.	<ul style="list-style-type: none"> ● Engine idle speed too high. ● Pilot bearing binding. ● Damaged gear teeth and / or synchronizer. ● Clutch not releasing completely. 	<ul style="list-style-type: none"> ● Refer to the Powertrain Control / Emissions Diagnosis Manual ● Remove transmission and check for a binding condition between input shaft and engine crankshaft pilot bearing. Replace as required. ● Disassemble transmission, repair or replace as required. ● Check clutch system. Refer to Group 08.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
Transmission jumps out of gear.	<ul style="list-style-type: none"> ● Stiff shift boot. Improper fit of inner boot. ● Loose transmission to engine mounting bolts, or loose levers. ● Flywheel housing to engine crankshaft out of line. ● Crankshaft pilot bearing worn. ● Interior components damage. ● Worn gear teeth due to partial engagement. 	<ul style="list-style-type: none"> ● Replace shift boot assembly if exceptionally stiff. ● Tighten transmission to engine block bolts to specifications. Loosen all bolts and reseal flywheel housing. Tighten all bolts. Tighten levers if necessary. ● Shim or replace housing as required. ● Replace bearing. ● Disassemble transmission. Inspect the synchronizer sleeves for free movement on their hubs. Inspect the synchronizer blocking rings for widened index slots, rounded clutch teeth and smooth internal surface. Check countershaft cluster gear for excessive end play. Check shift forks for worn or loose mounting on shift rails. Check fork pads for excessive wear. Inspect synchronizer sliding sleeve and gear clutch teeth for wear or damage. Repair or replace as required. ● Replace worn or damaged gears.
Transmission will not shift into one gear — all others OK.	<ul style="list-style-type: none"> ● Manual-shift linkage damaged or worn. ● Back-up switch ball frozen. ● Internal components. 	<ul style="list-style-type: none"> ● Repair or replace parts as required. ● If reverse is problem, check backup switch for ball frozen in extended position (if so equipped). ● Remove transmission. Inspect shift rail and fork system synchronizer system and gear clutch teeth for restricted travel. Repair or replace as required.
Transmission is locked in one gear. It cannot be shifted out of that gear.	<ul style="list-style-type: none"> ● Internal components. ● Loose fork on rail. 	<ul style="list-style-type: none"> ● Remove transmission. Inspect problem gears, shift rails and forks and synchronizer for wear or damage. Repair as required. ● Check shift rail interlock system.
Transfer case makes noise.	<ul style="list-style-type: none"> ● Incorrect tire inflation pressures and/or incorrect size tires and wheels. ● Excessive tire tread wear. ● Internal components. 	<ul style="list-style-type: none"> ● Make sure that all tires and wheels are the same size, and that inflation pressures are correct. ● Check tire tread wear to see if there is more than .06 inch difference in tread wear between front and rear. Interchange one front and one rear wheel. Re-inflate tires to specifications. ● Operate vehicle in all transmission gears with transfer case in 2HI, or HI range. ● If there is noise in transmission in neutral gear, or in some gears and not in others, remove and repair transmission. ● If there is noise in all gears, operate vehicle in all transfer case ranges. If noisy in all ranges or HI range only, disassemble transfer case. Check input gear, intermediate and front output shaft gear for damage. Replace as required. If noisy in LO range only, inspect intermediate gear and sliding gears for damage. Replace as required.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
4-wheel drive transfer case jumps out of gear.	<ul style="list-style-type: none"> ● Incomplete shift linkage travel. ● Loose mounting bolts. ● Front and rear driveshaft slip yokes dry or loose. ● Internal components. 	<ul style="list-style-type: none"> ● Adjust linkage to provide complete gear engagement. ● Tighten mounting bolts. ● Lubricate and repair slip yokes as required. Tighten flange yoke attaching nut to specifications. ● Disassemble transfer case. Inspect sliding clutch hub and gear clutch teeth for damage. Replace as required.
Transmission leaks.	<ul style="list-style-type: none"> ● Improper amount of lubricant — wrong type. ● Other component leaking. ● False report. ● Internal components. ● Improper installation torque on fill and drain plugs. 	<ul style="list-style-type: none"> ● Check level and type. Fill to bottom of filler plug hole. ● Identify leaking fluid as engine, power steering or transmission. Repair as required. ● Remove all traces of lube on exposed transmission surfaces. Check vent for free breathing. Operate transmission and inspect for new leakage. Repair as required. ● Remove transmission. Inspect for leaks at the input shaft bearing retainer seal and shift rail expansion plug. Inspect for leaks at the top cover gasket. Inspect case for sand holes or cracks. Repair or replace as required. ● Check fill, drain plug and bore threads. Repair as necessary. Tighten to specified torque value.

TC5152E

DIAGNOSIS AND TESTING (Continued)

DIAGNOSIS GUIDE — BEARING FAILURE CONCERNS

CONDITION	POSSIBLE SOURCE	ACTION
<p>The service life of most transmissions is governed by the life of the bearings. The majority of bearing failures can be related to vibration or contamination of the fluid. Some of the biggest reasons for bearing failures are:</p>	<ul style="list-style-type: none"> Worn out due to other part failure. 	<ul style="list-style-type: none"> Remove, disassemble and clean the transmission, then replace damaged parts. (Necessary to reset bearing preload if any tapered bearings are replaced.) Same as above. Provide correct towing procedures to tow operator.
	<ul style="list-style-type: none"> Damage due to towing vehicle further than 50 miles with driveshaft installed. Mainshaft tapered bearing and needle caged bearings are especially susceptible to damage. Fatigue of raceways or rollers. Wrong type or grade of lubricant. Lack of lubricant. Vibrations break-up of retainer and brinelling of races-fretting corrosion. Bearings tied up due to chips in bearings. Bearing set up too tight or too loose. Improper fit of shafts or bore. Acid etch of bearing due to water in lube. Overloading of vehicle. Incorrect preload causes faster wearing of the bearings, due to incomplete contact area. Pocket bearing not lubricated due to missing, damaged or misinstalled input shaft oil dam. Pocket bearing not lubricated due to damaged tin oil baffle in the input bearing shim pack. 	<ul style="list-style-type: none"> Same as above. Same as above. Same as above. Determine cause of vibration and correct. Otherwise proceed as above. Same as above. Replace damaged parts. Same as above. Same as above. Replace any shafts or housing section with improper fit. Same as above. Identify and correct source of water entry. Same as above. Compare gross combined weight of vehicle and trailer to rated capacity. Same as above. Be sure to follow preload setting procedure in Shop Manual. Replace damaged components and make sure of proper oil dam installation. Refer to the appropriate transmission section in this group. Check for proper installation of the snap ring on the mainshaft next to the oil dam. Replace damaged components making sure the tin oil baffle is not damaged during reassembly.

TC10325C

CLEANING AND INSPECTION

Transmission

Cleaning

After the transmission has been disassembled, soak the parts except the bearings, in a cleaning solvent until all the old lubricant is dissolved or loosened. Brush or scrape all foreign matter from the parts. Be careful not to damage any of the parts with the scraper.

An excessive amount of foreign material usually results from a bearing failure, gear seizure, tooth breakage, extreme synchronizer wear, or clashing gears. **In such cases, the input and output shaft bearings should be carefully inspected and replaced if necessary. Since countershaft bearings, output shaft pilot bearings, and reverse idler bearings are not so susceptible to damage from foreign material in the lubricant, they need not be replaced if they seem satisfactory.**

Wipe the parts or blow compressed air on them until they are thoroughly dry.

To clean the bearings, rotate them in clean solvent until all lubricant is removed. Hold the bearing assembly to prevent it from rotating and dry it with compressed air.

CLEANING AND INSPECTION (Continued)

When the bearings are dry, lubricate them thoroughly with transmission lubricant and cover them with a clean, lint-free cloth until ready for use.

Inspection

Inspect all transmission parts before reassembly to determine if they should be replaced.

Gearshift Housing

Check the operation and condition of the shift levers, forks, and shift rails. If binding occurs when the levers are operated, disassemble the housing assembly, and replace the worn or damaged parts.

Transmission Case

Inspect the case for cracks, worn or damaged bearing bores, damaged threads, or similar damage. If such damage is found, replace the case.

Holes larger than 6.35mm (1/4 inch) can be repaired by drilling, tapping and plugging.

Holes smaller than 6.35mm (1/4 inch) diameter, such as sand holes or casting porosity can be repaired using Metallic Plastic Repair Kit, Part No. C6AZ-19554-A (M3D35-A) or equivalent as directed.

CAUTION: Do not use this method to repair casting cracks.

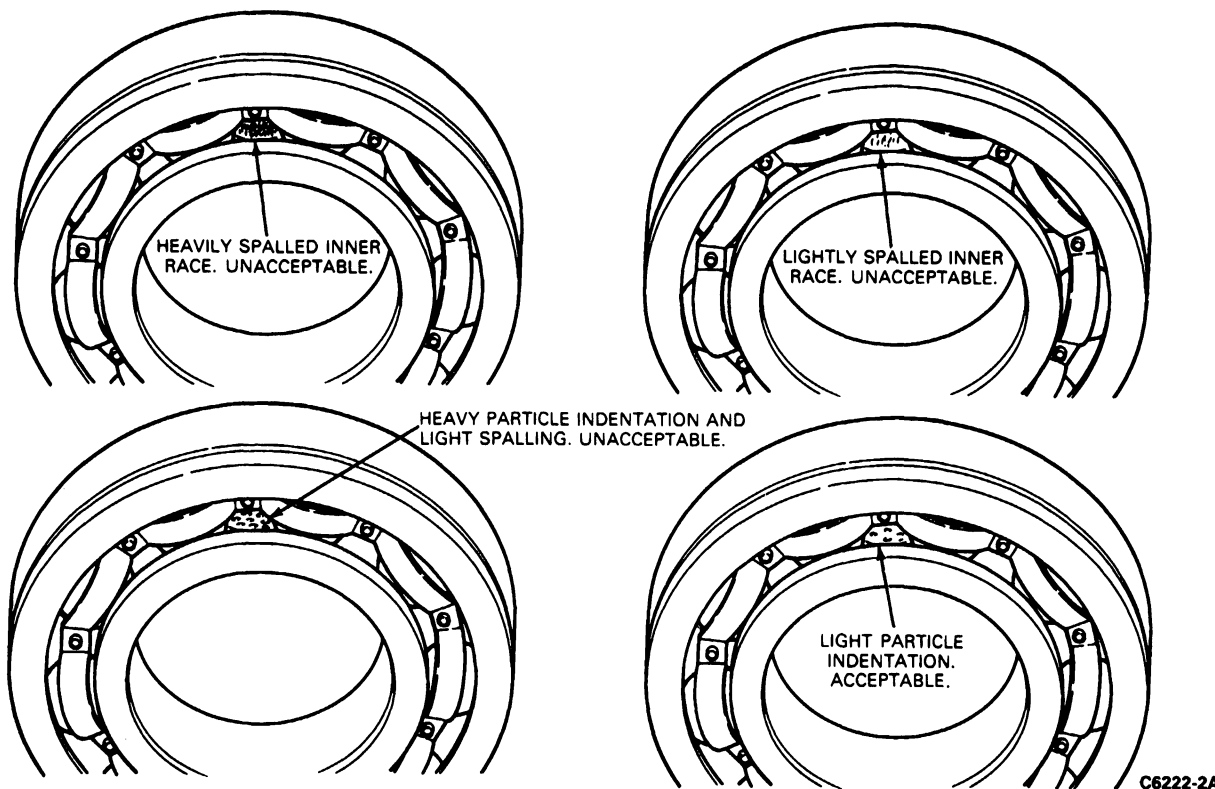
The recommended procedure for using the Metallic Plastic Repair Kit is as follows:

Steam clean the transmission or transfer unit case to remove grease, oil, or road dirt. Clean the repair area thoroughly. Metallic plastic will not stick to a dirty or oily surface.

1. Prepare the surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut the hole or porous area to a greater depth than the rest of the cleaned surface. Solid metal must surround the hole.
2. Mix the metallic plastic base and hardener as directed on the container. Stir thoroughly until uniform.
3. Apply the repair mixture with a suitable clean tool (putty knife, wood spoon, etc.), forcing the mixture into the hole or porosity.
4. Allow the repair mixture to harden by either of two methods: heat cure with a 250-watt lamp placed 254mm (10 inches) from the repaired surface, or air dry for 10 to 12 hours at temperatures above 10°C (50°F).
5. Sand or grind the repaired area, blending it with the general contour of the surrounding surface.

Bearings

Examine the bearing assemblies for cracked cups or races. Check the races for roughness. Inspect the balls and rollers for looseness, wear, chipping, flaking or other damage. Check the bearings for binding on the shafts or looseness in the bores. If any of these conditions are present, replace the bearings.


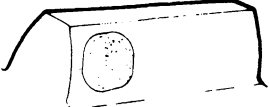

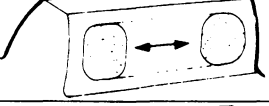
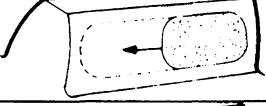

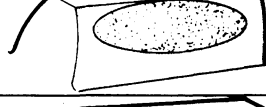
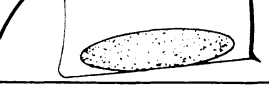
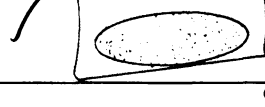
CLEANING AND INSPECTION (Continued)**Bearing Inspection****Gears**

Some forms of grind marks and tooth wear contact patterns are acceptable and should not be considered as a source of gear noise. Grind marks are distinctive from wear or damage which are local swells (polished raised projections), nicks and chips. All gears have possible factory repair grind marks. Phosphate coated gears are especially easy to recognize since the grind operation removes a patch of phosphate and base metal exposing the lighter metallic color. The following illustrations show normal and abnormal gear tooth contact patterns, normal tooling marks, and approved and unapproved chip / nick removal procedures.

When unacceptable gear tooth wear patterns are present, transmission components such as shafts, bearings or washers must be checked for wear or damage. Gears must also be checked thoroughly for any abnormality which may cause poor contact patterns.

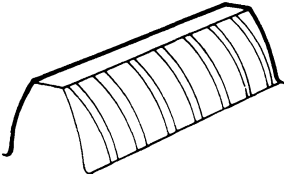
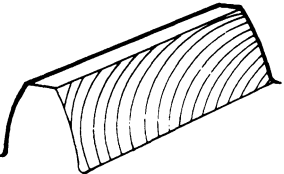
CLEANING AND INSPECTION (Continued)

Typical Transmission Gear Tooth Contact Patterns

CONTACT PATTERN	UNACCEPTABLE	ACCEPTABLE
1. DESIRED PATTERN (CONTACT)		
2. END CONTACT PATTERN		
3. TRAVELING CONTACT (PATTERN MOVES FROM SIDE TO SIDE ON FACE OF GEAR)		
4. HIGH CONTACT PATTERN		
5. LOW CONTACT PATTERN		

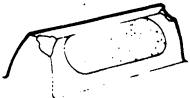
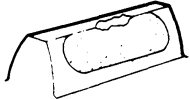
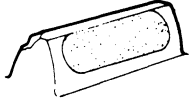
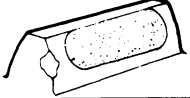
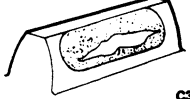
C3187-2A

Normal Tool Marks, Typical

	NORMAL GEAR "SHAVING" TOOL MARKS
NOTE: NO ROUGHNESS OR RIDGES EVIDENCED ON GEAR TOOTH FACE.	
	NORMAL GEAR "SHAVING" TOOL MARKS. MARKS HAVE A "WIRE BRUSHED" APPEARANCE.
NOTE: NO ROUGHNESS OR RIDGES EVIDENCED ON GEAR TOOTH FACE.	

C3188-1A

Approved Transmission Gear Tooth Chip/Nick Removal Procedure

1. GRIND CHIP/NICK FROM CORNER FACE OF GEAR-DRIVE SIDE. (APPROVED)	
2. GRIND CHIP/NICK FROM EDGE OF GEAR O.D.-MAY EXTEND SLIGHTLY INTO GEAR PATTERN ON TOOTH FACE. (APPROVED)	
3. GRIND CHIP/NICK FROM CORNER FACE OF GEAR-COAST SIDE. (APPROVED)	
4. GRIND CHIP/NICK FROM GEAR EDGE MAY EXTEND SLIGHTLY INTO GEAR FACE. (APPROVED)	
5. GRIND CHIP/NICK FROM GEAR FACE-IN GEAR PATTERN AREA. (NOT APPROVED)	

C3189-1A

Reverse Idler Gear

Replace the reverse idler gear if the gear, bushing or roller bearings are badly worn or if the teeth are chipped or burred. Replace the reverse idler gear shaft if it is excessively worn or scored.

CLEANING AND INSPECTION (Continued)**Input Shaft**

Replace the input shaft if it is worn, bent, or twisted, if the gear has chipped, nicked, worn, or missing teeth, or if the cone surface is damaged. If the pilot bearing bore is scored, replace the gear and gear rollers.

Output Shaft

Replace all output shaft gears that are chipped, nicked, burred, or badly worn. Replace the output shaft if it is out of round or worn, or if the pilot bearing surface is scored.

Thrust Washers and Bearing Covers

Check the surfaces of all thrust washers. Replace washers that are scored and / or reduced in thickness.

Replace bearing covers that are grooved or showing wear from the thrust or adjacent bearings. Check the oil return threads in the bearing covers. If the sealing action of the threads has been destroyed by contact from the input or output shafts, replace the covers.

Synchronizer Blocking Rings

Inspect the synchronizer blocking rings for widened index slots, rounded clutch teeth and smooth internal surfaces (must have machined grooves). With the blocker ring on the cone, measure the distance between the face of the gear clutching teeth and the face of the blocking ring. Refer to the following chart for allowable dimensions:

Transmission-Synchronizer	Dimension
ZF- 1, 2, 3, 4, 5	Not less than 0.6mm (0.024 Inch)
ZF- Reverse	Not less than 0.4mm (0.016 Inch)
Mazda - All	Not less than 1.5mm (0.059 Inch)

Check the synchronizer sleeves for free movement on the hubs. Make sure the alignment marks (etched or paint marks) are properly indexed.

Replace the seal in the input shaft bearing retainer.

Replace the seals on the cam and shafts.

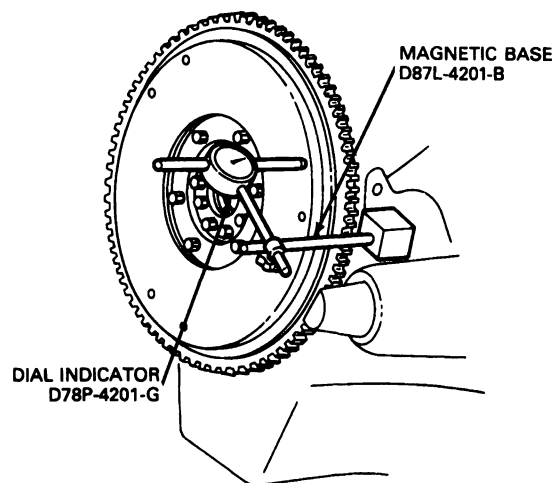
Seals and Gaskets

Examine and, if necessary, replace input and output shaft bearing retainer seals and gaskets.

Flywheel Clutch Face Runout

Install Dial Indicator D78P-4201-G and Magnetic Base D87L-4201-B or equivalent so that the indicator point bears against the flywheel face. Turn the flywheel making sure that it is full forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

If the flywheel clutch face runout exceeds specifications (refer to the appropriate engine section), remove the flywheel and check for burrs between the flywheel and the face of the crankshaft mounting flange. If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or machine the crankshaft-flywheel mounting face if the mounting face flange runout is excessive. If the ring gear runout exceeds 0.25mm (0.010 inch), check installation of the gear to the flywheel flange. If it is not properly seated, re-install it to the flywheel. If it is properly seated, replace it. Refer to Ring Gear Replacement in Section 03-00, Engine Service, Gasoline, in the Light Truck Engine manual for the proper procedure. For flywheel runout specifications, refer to the appropriate engine section under Specifications.



A10724-C

SPECIFICATIONS

MANUAL TRANSMISSION LUBRICANT CAPACITIES

Transmission	Approximate Refill Capacity	
	U.S. Pints	Liters
Mazda R2 M50D Five Speed Transmission. Fill with ESP-MC2138-CJ (DEXRON II®) or equivalent.	7.6	3.6
ZF M50D-HD Five Speed Transmission. Fill with ESP-M2C166-H (Motorcraft Mercon) or equivalent. Synthetic MERCON (E6AZ-19582-B) may be used in extreme operating conditions to improve bearing life. ● Extensive idling at less than -25°F. ● Severe duty at greater than 100°F if transmission lubricant is suspected of overheating.	6.8	3.2
Warner Four-Speed Transmission Without Extension — (4x4). Fill with ESP-MC2138-CJ (DEXRON II®) or equivalent.	6.5	3.0

NOTE: Fill transmissions to bottom of filler hole.

TC8883A

SPECIAL SERVICE TOOLS

Tool Number	Description
D78P-4201-G	Dial Indicator
D87L-4201-B	Magnetic Base

SECTION 07-01A Transmission, Automatic, E4OD

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION		DIAGNOSIS AND TESTING (Cont'd.)	
Case Assembly.....	07-01A-194	Transmission Fluid Cooler Flow Test.....	07-01A-19
Converter and Transmission Cooler.....	07-01A-194	Transmission Solenoids and Sensors	
Electrical Connectors and Solenoid		Resistance Tests.....	07-01A-71
Body.....	07-01A-193	Transmission Tester 007-00085	
Forward, Direct, Intermediate, Overdrive,		Instructions.....	07-01A-70
Coast and Reverse Clutches.....	07-01A-193	Verification of Condition.....	07-01A-15
Oil Cooler Line Leakage.....	07-01A-194	DISASSEMBLY AND ASSEMBLY	
One-Way Clutches.....	07-01A-193	Center Support.....	07-01A-170
Output Shaft.....	07-01A-193	Extension Housing.....	07-01A-189
Planet Assemblies.....	07-01A-194	Forward Hub and Ring Gear.....	07-01A-170
Thrust Bearings.....	07-01A-194	Intermediate Brake Drum.....	07-01A-172
Transmission.....	07-01A-193	Forward Planet Assembly.....	07-01A-184
Transmission Fluid Drain and Refill.....	07-01A-194	Input Shell.....	07-01A-185
Valve Bodies.....	07-01A-193	Pump.....	07-01A-149
DESCRIPTION		Coast Clutch Cylinder Assembly.....	07-01A-156
E4OD Automatic Transmission.....	07-01A-1	Overdrive Ring Gear And Center Shaft	
E4OD Sensors and Actuators.....	07-01A-7	Assembly.....	07-01A-160
Shift Solenoid Failure Modes.....	07-01A-14	Reverse Clutch Piston.....	07-01A-188
Solenoid Operation.....	07-01A-14	Reverse Planet Assembly.....	07-01A-186
DIAGNOSIS AND TESTING		Low Reverse One-Way Clutch.....	07-01A-187
After On-Board Diagnostics.....	07-01A-65	Subassemblies.....	07-01A-189
Air Pressure Checks.....	07-01A-21	Intermediate Brake Drum and Forward	
Automatic Transmission.....	07-01A-17	Clutch Assemblies.....	07-01A-189
Checking The Automatic Transmission Fluid		Overdrive Ring Gear / Center Shaft / Coast	
Level.....	07-01A-16	Clutch Assembly.....	07-01A-192
Converter and Fluid Cooler.....	07-01A-19	Transmission.....	07-01A-114
Converter Leakage Check.....	07-01A-18	IN-VEHICLE SERVICE	
Drive Cycle Test.....	07-01A-65	Extension Housing Gasket.....	07-01A-101
Electrical / Hydraulic / Mechanical / Diagnosis		Extension Housing Seal and Bushing.....	07-01A-99
Charts.....	07-01A-27	Manual Lever Seal.....	07-01A-110
Electrical / Hydraulic / Mechanical Diagnosis		Parking Mechanism.....	07-01A-102
Charts.....	07-01A-28	Transmission Cooler Line Routing.....	07-01A-91
Fluid Condition Check.....	07-01A-17	Valve Bodies and Intermediate Band	
Line Pressure Test.....	07-01A-19	Servo.....	07-01A-103
Pinpoint Tests.....	07-01A-66	REMOVAL AND INSTALLATION	
Preliminary Inspection.....	07-01A-15	Transmission.....	07-01A-83
Quick Tests.....	07-01A-63	SPECIAL SERVICE TOOLS / EQUIPMENT	07-01A-197
Stall Speed Test.....	07-01A-20	SPECIFICATIONS	
Throttle Position (FIPL) Sensor.....	07-01A-23	Transmission.....	07-01A-195
Torque Converter Clutch Test.....	07-01A-24	VEHICLE APPLICATION	07-01A-1


VEHICLE APPLICATION

All E-Series, F-Series and Bronco with E4OD Automatic Transmission

DESCRIPTION

E4OD Automatic Transmission

The E4OD transmission is a fully automatic, electronically controlled, four-speed unit with a locking torque converter. The main operating components of the E4OD transmission include a torque converter clutch, six multiple-disc friction clutches, one band, two sprag one-way clutches and a roller one-way clutch which provide for the desired function of three planetary gear sets.

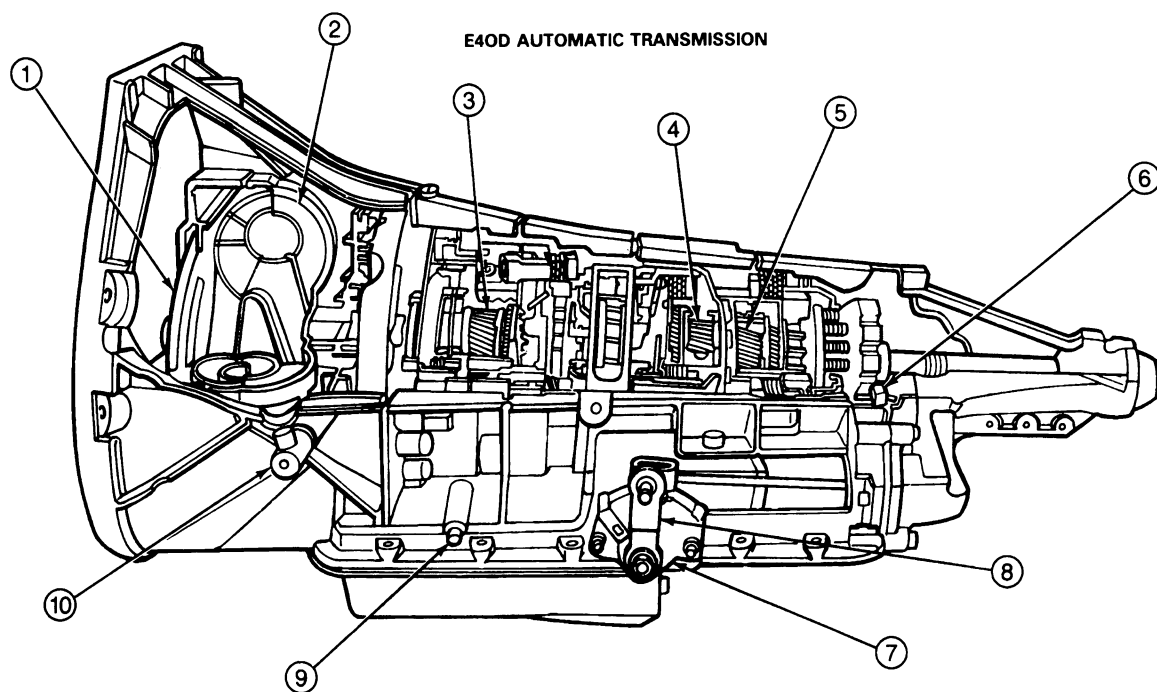
Transmission gear selection in the  range and converter clutch operation is controlled by the EEC-IV control system. Operating conditions are relayed to Powertrain Control Module by various sensors throughout the vehicle. The PCM compares these conditions with electronically stored parameters and logically determines the state that the transmission should operate at.

DESCRIPTION (Continued)

In the **D** range, automatic operation of all four gears is possible. The Transmission Control Switch (TCS) lockout switch, located on the vehicle's shift lever disables overdrive operation and enables automatic operation through the first three gears. Whenever the ignition key is turned on, the vehicle will automatically provide overdrive operation regardless of the switch position the last time the vehicle was running.

Manual gear selection is available in the 1 and 2 range. Second gear is commanded when the gear selector is in the 2 range and when downshifted into the 1 range at speeds above approximately 56 km/h (35 mph) (for diesel 48 km/h [30 mph]). First gear is commanded in the 1 range at start-ups and when downshifted into 1 range below approximately 56 km/h (35 mph) (for diesel 48 km/h [30 mph]).

NOTE: Any reference to Intermediate Brake Drum or Direct Clutch Cylinder are one and the same.

E4OD Automatic Transmission

D9279-C

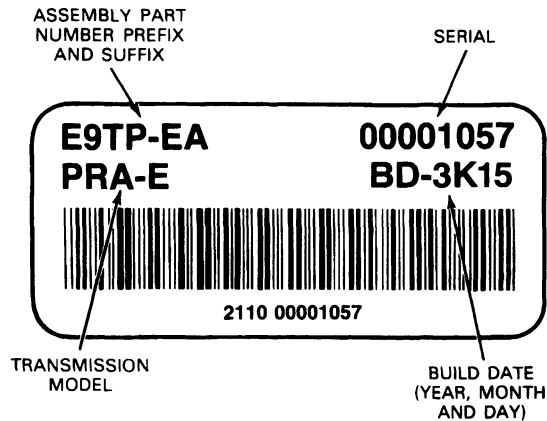
Item	Description
1	Torque Converter Clutch
2	Torque Converter
3	Overdrive Planet
4	Forward Planet

(Continued)

Item	Description
5	Reverse Planet
6	Parking Assembly
7	Manual Lever Position Sensor
8	Manual Lever
9	Line Pressure Tap
10	Shift Linkage Boss

DESCRIPTION (Continued)**Transmission Identification Tag**

The identification tag is located on the left side of the transmission case, rearward of the manual lever position sensor (MLP).

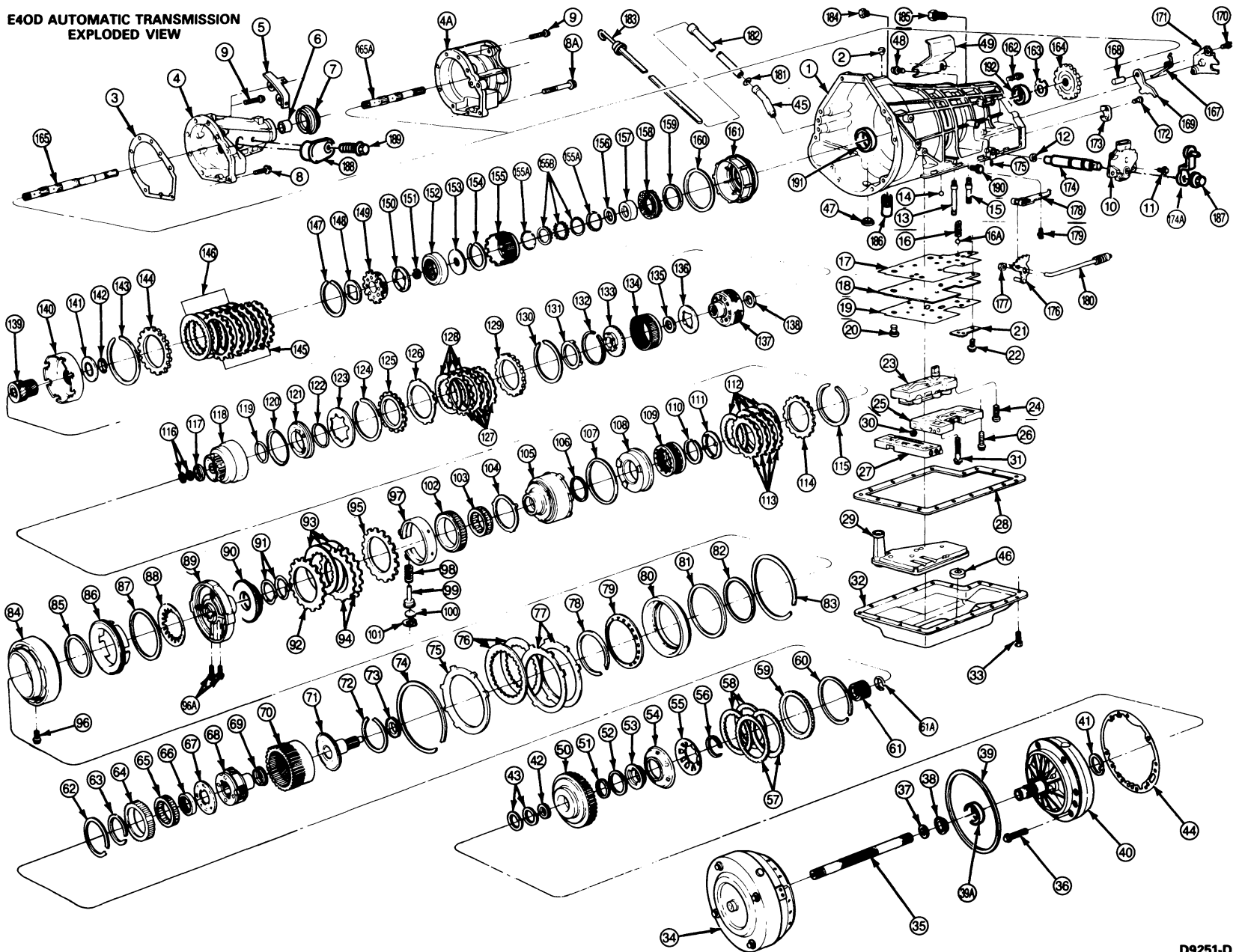
**BUILD DATE CODES**

<u>YEAR CODE</u>	<u>MONTH CODE</u>
1988 — 8	JAN. — A
1989 — 9	FEB. — B
1990 — 0	MAR. — C
1991 — 1	APR. — D
1992 — 2	MAY. — E
1993 — 3	JUN. — F
1994 — 4	JUL. — G
1995 — 5	AUG. — H
1996 — 6	SEP. — J
1997 — 7	OCT. — K
	NOV. — L
	DEC. — M

D9250-C

DESCRIPTION (Continued)

E4OD Automatic Transmission, Exploded View



D9251-D

DESCRIPTION (Continued)

E4OD AUTOMATIC TRANSMISSION, EXPLODED VIEW (LEGEND)

Item No.	Part Number	Description
1	7005	Case Assembly
2	7034	Vent Assembly
3	7086	Gasket — Extension Housing
4	7A039	Extension Assembly (4x2)
#	7A041	— Extension & Bushing Assy
#	7A040	— Extension
4A	7A039-DA	Extension Assembly (4x4)
	7A039-EA	Extension Assembly (Superduty)
5	7H102	Bracket — Wiring
6	7A034	Bushing — Extension Housing (4x2)
7	7052	Seal — Extension Housing (4x2)
8	N605802-S36	Bolt — Extension (4x2 Bottom) (2 Pcs.) M10X1.5X35MM
8A	N606569-S36	Bolt — Extension (Superduty & 4x4 Bottom) (2 Pcs.) M10X1.5X90MM
9	N605803-S36	Bolt — Extension (Top) (7 Pcs.) M10X1.5X40MM
10	7F293	Sensor — Manual Lever Position
11	N805312-S100	Bolt Assembly (2 Pcs.) M6X1.0X30MM
12	7B498	Seal — Manual Lever
13	N805331-S	Stud — Case to Solenoid Body (1 Pc.) M6X1.0X79MM
14	7E195	Ball — Rubber Check (9 Pcs.) (2 in Main Control)
	379581-S	Ball — Steel Check (1 Pc.)
15	N805330-S	Stud — Case to Control Assembly (4 Pcs.) M6X1.0X61.25MM
16	7D017	EPC Blow-off Spring
16A	353078-S	EPC Blow-off Ball
17	7D100	Gasket — Case to Separator Plate
18	7A008	Plate — Separator
19	7C155	Gasket — Separator Plate to Control
20	7G308	Screen — Solenoid
#21	7F282	Plate — Separator Plate Reinforcing
22	N605772-S	Bolt (3 Pcs.) M6X1.0X16MM
23	7G391	Solenoid Body Assembly
24	N805329-S	Bolt — Torx Head (9 Pcs.) M6X1.0X40MM
25	7A100	Main Control Body Assembly
26	N805326-S	Bolt (18 Pcs.) M6X1.0X42.5MM
27	7G422	Accumulator Body Assembly
28	7A191	Gasket — Oil Pan
*29	7G186-AA	Filter and Seal Assembly (4x2)
*	7G186-BA	Filter and Seal Assembly (4x4)
30	N805328-S	Nut (5 Pcs.) M6X1.0
31	N805327-S	Bolt (7 Pcs.) M6X1.0X66MM
32	7A264-FA	Pan — Oil (4x2)
	7A264-GA	Pan — Oil (4x4)
33	N806078-S36	Bolt — Oil Pan (20 Pcs.) M8X1.25X12MM
34	7902	Torque Converter Assembly
34A	87650-S2	— Plug — Converter Drain 1/8 in-27
35	7017	Shaft — Input
36	N805260-S	Bolt & Washer Assembly — Pump (9 Pcs.) M8X1.25X65MM
	7G379	— Washer — Replacement (9 Pcs.)
37	7L323	Seal Ring — Teflon
38	7A248	Seal — Converter Hub
39	7D441	Seal — Square Cut O.D. Pump
40	7A103	Pump Assembly
41	7D014	Washer — Pump Thrust
42	7E486	Needle Bearing Assembly
43	7G402	Seal Ring — Teflon (2 Pcs.)
44	7A136	Gasket — Pump
45	7N463	Stub Tube
46	7L027	Magnet — Pan
47	7N171	Plug — Converter Access
48	N605770-S36	Bolt — Heat Shield (2 Pcs.)
49	7A434	Heat Shield — Solenoid Body Connector
50	7G387	Coast Clutch Cylinder Assembly
51	7A548-JA	Seal — Inner

Not Serviced

* Serviced in Kits Only

Item No.	Part Number	Description
52	7A548-EA	Seal — Outer
53	7G419	Piston Coast Clutch
54	7N519	Ring — Piston Apply
55	7B070-EA	Spring — Piston Return
56	N804949-S	Ring — Retaining
57	7B442-CA	Plate — Coast Clutch External Spline (2 Pcs.)
58	7B164-CA	Plate — Coast Clutch Internal Spline (2 Pcs.)
59	7B437-CA	Plate — Coast Clutch Pressure
60	N804950-S	Ring — Retaining (Selective Fit)
	N804951-S	Ring — Retaining
	N804952-S	Ring — Retaining
61	7670	Gear Assembly — Overdrive Sun
61A	377300-S	Ring — Retaining
62	377155-S	Ring — Retaining (Outer Race to Overdrive Ring Gear)
63	N806284-S	Ring — Retaining (Overdrive OWC to Outer Race)
*64	7G389	Race — Overdrive One Way Clutch Outer
*65	7G381	Clutch Assembly — Overdrive One Way
*66	7G388	Race — Overdrive One Way Clutch Inner
67	7L339	Washer — Thrust
68	7E031	Planet Assembly — Overdrive
#	7L676	— Carrier
#	7D008-CA	— Planet Gears (3 or 4 Pcs.)
#	7A238-CA	— Planet Shafts (3 or 4 Pcs.)
#	7A242-CA	— Thrust Washers (6 or 8 Pcs.)
#	7D037-BA	— Needle Bearings (60 or 80 Pcs.)
#	380225-S	— Retaining Pins (3 or 4 Pcs.)
#	7E486	— Needle Bearing Assembly
69	7F240	Needle Bearing Assembly
70	7653	Gear — Overdrive Ring
71	7G382	Center Shaft
72	7G375	Ring — Retaining (Center Shaft to Overdrive Ring Gear)
73	7C178	Needle Bearing Assembly
74	7B421	Ring — Overdrive Retaining (Selective Fit)
75	7B066-BB	Plate — Overdrive Clutch Pressure
76	7B164-EA	Plate — Overdrive Clutch Internal Spline (2 Pcs.)
77	7B442-DA	Plate — Overdrive Clutch External Spline (2 Pcs.)
78	N806645-S	Ring — Return Spring Retaining
79	7B070-CA	Spring — Overdrive Return
80	7G418	Piston — Overdrive
81	7A548	Seal — Overdrive Outer
82	7F225	Seal — Overdrive Inner (Same as Intermediate Inner)
83	7B421	Ring — Int./O.D. Cylinder Retaining
84	7G384	Cylinder — Intermediate/Overdrive
85	7F225	Seal — Intermediate Inner
86	7E005	Piston — Intermediate
87	7F224	Seal — Intermediate Outer
88	7B070-DB	Spring — Intermediate Return
89	7G033	Support Assembly — Center
90	7L326	Washer — Thrust
91	7D429-A	Seal — Direct Clutch Cast Iron (2 Pcs.)
92	7B066-CA	Plate — Intermediate Clutch Apply
93	7F219	Plate — Intermediate Clutch Internal Spline (2 or 3 Pcs.)
94	7B442	Plate — Intermediate Clutch External Spline (1 or 2 Pcs.)
95	7B437	Plate — Intermediate Clutch Pressure
96	N805310-S101	Bolt — Cylinder Hydraulic Feed (1 Pc.) M10X1.5X24MM
96A	N805311-S101	Bolt — Center Support Hydraulic Feed (2 Pcs.) M12X1.75X31MM
97	7D034	Band Assembly
98	7D028	Spring — Servo Return
99	7E221	Piston Assembly — Servo

CD9252-D

DESCRIPTION (Continued)

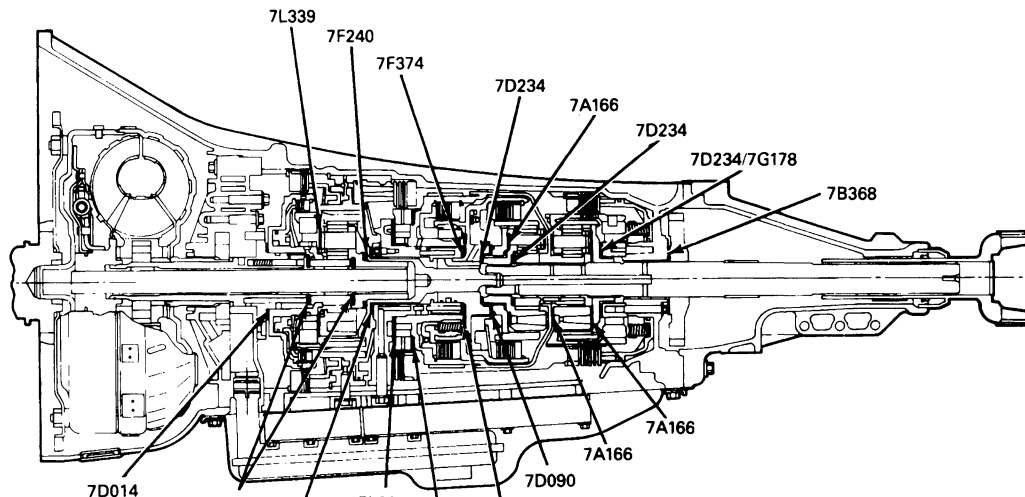
E4OD AUTOMATIC TRANSMISSION, EXPLODED VIEW (LEGEND) (CONTINUED)

Item No.	Part Number	Description
100	7D027	Plate — Servo Cover
101	N660246-S	Ring — Servo Retaining
*102	7G380	Race — Intermediate One Way Clutch Outer
*103	7F271	Clutch Assembly — Intermediate One Way
104	7G401	Washer — Thrust (LG. Dia.)
105	7D044	Drum Assy. — Intermediate Brake
106	7A548-GA	Seal — Inner
107	7A548-FA	Seal — Outer
108	7A262	Piston Assembly
#	7A258	— Piston
#	375393-S	— Check Ball (7/32 Inch Dia.)
#	7E220	— Ball Retainer
109	7G298	Spring — Piston Return
110	N804817-S	Ring — Spring Retaining
111	7C096	Washer — Thrust (Small Dia.)
112	7B164-GA	Plate — Direct Clutch Internal Spline (3 or 4 pcs.)
113	7B442-FA	Plate — Direct Clutch External Spline (3 or 4 pcs.)
114	7B066-BA	Plate — Direct Clutch Pressure
115	377126-S	Ring — Retaining (Selective Fit)
	377127-S	Ring — Retaining
	377128-S	Ring — Retaining
	377437-S	Ring — Retaining
	377444-S	Ring — Retaining
116	7D019	Seal Ring — Teflon® (2 pcs.)
117	7F374	Needle Bearing Assembly
118	7D424	Cylinder — Forward Clutch Assembly (3 or 4 plate)
119	7E244	Seal — Inner
120	7A548	Seal — Outer
121	7A262	Piston Assembly
#	7A258	— Piston
#	375393-S	— Check Ball
#	7E220	— Ball Retainer
122	7D256	Ring — Piston Apply
123	7B070-AA	Spring — Piston Return
124	377127-S	Ring — Retaining (For Return Spring)
125	7B066-AA	Plate — Forward Clutch Pressure
126	7E457	Spring — Cushion
127	7B442-FA	Plate — Forward Clutch External Spline (3 or 4 pcs.)
128	7E311-AA	Plate — Forward Clutch Internal Spline (3 or 4 pcs.)
129	7B066-BA	Plate — Rear Clutch Pressure
130	377127-S	Ring — Retaining (Selective Fit)
	377437-S	Ring — Retaining
	377444-S	Ring — Retaining
	386841-S	Ring — Retaining
	386842-S	Ring — Retaining
131	7D090	Washer — Plastic Thrust
132	377132-S	Ring — Retaining
133	7D393	Hub — Forward
134	7D392	Gear — Forward Ring
135	7F078	Needle Bearing Assembly
136	7A166	Washer — Thrust
137	7A398	Planet Assembly — Forward
#	7D055	— Carrier
#	7D008-AB	— Planet Gears (3 or 4 pcs.)
#	7A238-AA	— Planet Gear Shafts (3 or 4 pcs.)
#	7A242-AA	— Thrust Washers (6 or 8 pcs.)
#	7D037-CA	— Needle Bearings (51 or 68 pcs.)
#	380225-S	— Retaining Pins (3 or 4 pcs.)
138	7D234	Needle Bearing Assembly
139	7D063	Gear Assembly — Forward/Reverse Sun
140	7D064	Input Shell
141	7D066	Washer — Thrust
142	377300-S	Ring — Retaining
143	N806207-S	Ring — Retaining

Item No.	Part Number	Description
144	7D408	Plate — Reverse Clutch Pressure
145	7B442-EA	Plate — Reverse Clutch External Spline (5 or 6 pcs.)
146	7E312	Plate — Reverse Clutch Internal Spline (5 or 6 pcs.)
147	377155-S	Ring — Retaining
148	7A166	Washer — Thrust
149	7D006	Planet Assembly — Reverse
#	7D007	— Carrier
#	7D008-BB	— Planet Gears (3 or 4 pcs.)
#	7A238-BA	— Planet Gear Shafts (3 or 4 pcs.)
#	7A242-BA	— Thrust Washers (6 or 8 pcs.)
#	7D037-CA	— Needle Bearings (63 or 84 pcs.)
#	380225-S	— Retaining Pins (3 or 4 pcs.)
150	7A166	Washer — Thrust
151	387031-S	Ring — Retaining (for Output Shaft) (1-1/2 in dia.)
152	7A153	Gear — Reverse Ring
*153	7D164	Hub — Output Shaft
154	377132-S	Ring — Retaining
155	7D390	Hub Assembly — Reverse Clutch
155A	377135-S	Ring — 3-31/32 Retaining (2 — Att 7E194 IN 7E193 Assy.)
*155B	7E392	Spring Assy. — Overrunning Clutch
*155C	7190	Roller — Overrunning Clutch (16 Req'd)
*155D	7E194	Bushing — Overrunning Clutch
156	7E413	Needle Bearing Assembly
*157	7D171	Race — Low/Reverse One Way Clutch Inner
158	7F153	Spring Assembly — Piston Return
159	7D404	Seal — Inner
160	7D403	Seal — Outer
161	7D402	Piston
162	7D167	Bolts (5 pcs.) 5/16 in-24 (One Way Clutch to Case)
163	7B368	Washer — Thrust
164	7A233	Parking Gear
165	7060-AA	Output Shaft Assembly (4x2)
165A	7060-CA	Output Shaft Assembly (4x4)
167	7D070	Spring — Parking Pawl Return
168	387640-S	Pin — Parking Pawl
169	7A441	Parking Pawl
170	N805232-S	Bolt and Washer Assembly (2 pcs.)
171	7D419	Plate — Parking Rod Guide
172	N805261-S190	Bolt (1 pc.)
173	7G101	Abutment — Parking Pawl Actuating
174	7C493	Shaft Manual Control Lever
174A	7A256	Lever Assy. — Man. Cont.
175	7B210	Pin — Manual Lever Retaining
176	7A115	Lever — Inner Detent
177	N800287-S36	Nut — Inner Detent Lever M14x1.5 Hex
178	7E332	Spring Assembly — Manual Valve Detent
179	N805503-S	Bolt — Hex Flange Head M6x1.0x16.5mm
180	7D410	Rod Assembly — Parking Pawl Actuating
181	87034-94	O-Ring Filler Tube
182	7A228	Tube Assy. — Oil Filler
183	7A020	Indicator Assy. — Oil Level
184	7D273	Connector Assembly — Oil Tube — Inlet (Front)
185	7D174	Valve Assembly — Oil Cooler Check — Outlet (Rear)
186	7H194	Filter Assembly, Accum. Regulator
187	N620482-S2	Nut, M10x1.5 Hex
188	7H183	Plug Assembly, Ext. Hsg.
189	57621-S2	Screw and Washer Assy., 1/4-20x.62
190	390685-S	Plug, Test Port, 1/8-27 Hex
191	7025	Bushing, Case Front
192	7025	Bushing, Case Rear

Not Serviced*
 * Serviced in Kits Only

CD7886-D

DESCRIPTION (Continued)**Thrust Washer and Needle Bearing Locations****BASE NUMBERS****DESCRIPTION**

7D014	THRUST WASHER - PUMP SUPPORT
7E486	NEEDLE BEARING - SUN GEAR
7L339	THRUST WASHER - OVERDRIVE PLANETARY CARRIER
7G128	NEEDLE BEARING - CENTER SHAFT
7G178	NEEDLE BEARING - CENTER SUPPORT
7L326	THRUST WASHER - CENTER SUPPORT
7G401	THRUST WASHER - INTERMEDIATE ONE-WAY CLUTCH
7D428	THRUST WASHER - INTERMEDIATE BRAKE DRUM
7F374	NEEDLE BEARING - FORWARD CLUTCH (PLASTIC) CYLINDER
7F078	NEEDLE BEARING - SUN GEAR
7D090	THRUST WASHER - FORWARD CLUTCH HUB
7D423	THRUST WASHER - PLANETARY CARRIER
7E413	NEEDLE BEARING - OUTPUT SHAFT HUB
7B368	THRUST WASHER - OUTPUT SHAFT

D9253-B

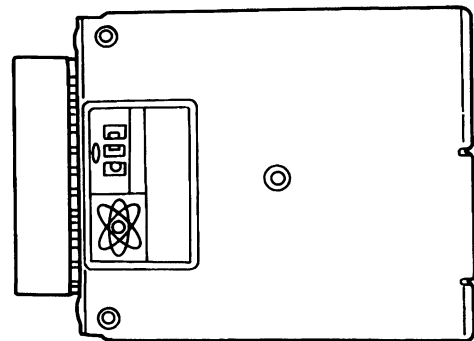
E4OD Sensors and Actuators

The following pages provide a brief description of each of the sensors and actuators used with the E4OD transmission. The function of each of these components and the associated symptoms and Diagnostic Trouble Codes (DTCs) are also given.

Powertrain Control Module (PCM)

On vehicles equipped with gasoline engines, the operation of the E4OD automatic transmission is controlled by the PCM. Many input sensors provide information to the PCM, which then controls the actuators which affect transmission operation.

On vehicles equipped with diesel engines, the operation of the E4OD transmission is also controlled by the PCM. However, some of the input sensors are different.



D11825-A

DESCRIPTION (Continued)

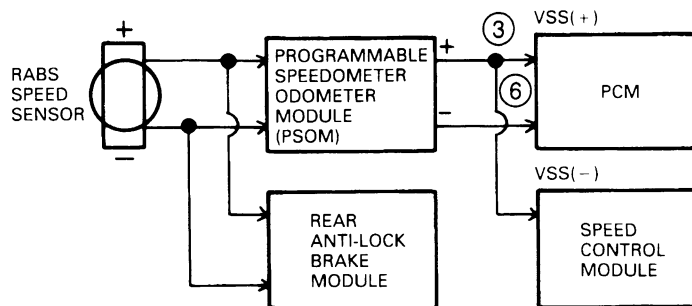
Programmable Speedometer / Odometer Module (PSOM)

Description: The Programmable Speedometer / Odometer Module (PSOM) receives input from the Rear Anti-Lock Brake System (RABS) Speed Sensor, which is mounted on the rear axle differential housing. The PSOM processes this input signal information and relays it to the Speed Control module PCM. This signal tells the PCM the vehicle speed in MPH.

Transmission function: Used as an input in determining shift scheduling and Electronic Pressure Control (EPC).

Symptoms: Harsh engagements, firm shift feel, abnormal shift schedule, unexpected downshifts may occur at closed throttle, abnormal torque converter clutch operation or engages only at Wide-Open Throttle (WOT). May flash TCIL.

Diagnostic Trouble Codes: 29 (two digit), 452 (three digit).



D11826-A

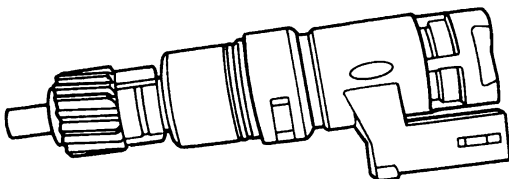
Vehicle Speed Sensor (VSS)

Description: The Vehicle Speed Sensor (VSS) is a variable reluctance sensor that sends a signal to the PCM. This VSS signal tells the PCM the vehicle speed in MPH.

Transmission function: Used as an input in determining shift scheduling and Electronic Pressure Control (EPC).

Symptoms: Harsh engagements, firm shift feel, abnormal shift schedule; unexpected downshifts may occur at closed throttle, abnormal torque converter clutch operation or torque converter clutch engages only at Wide-Open Throttle (WOT). May flash TCIL.

Diagnostic Trouble Codes: 29 (two digit), 452 (three digit).



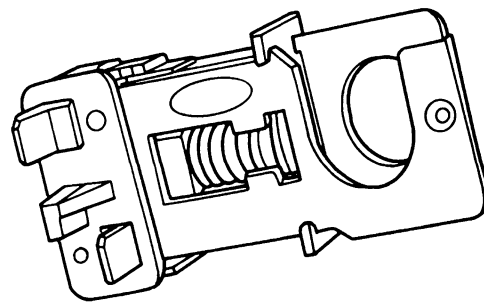
D11827-A

Description: The Brake On / Off (BOO) switch tells the PCM when the brakes are applied. The switch is closed when the brakes are applied and open when they are released.

Transmission function: Disengages torque converter clutch when brake is applied.

Symptoms: Failed on or not connected — Torque converter clutch will not engage at less than 1 / 3 throttle. Failed off — Torque converter clutch will not disengage when brake is applied.

Diagnostic Trouble Codes: 74 (two digit), 536 (three digit).



D11828-A

Profile Ignition Pickup (PIP) Sensor — Gasoline Engines
Revolutions Per Minute Sensor (RPM) sensor — Diesel Engines

Description: On gasoline engines, the Profile Ignition Pickup (PIP) signal is produced by a Hall-Effect device in the distributor. It tells the PCM the engine rpm and the crankshaft position.

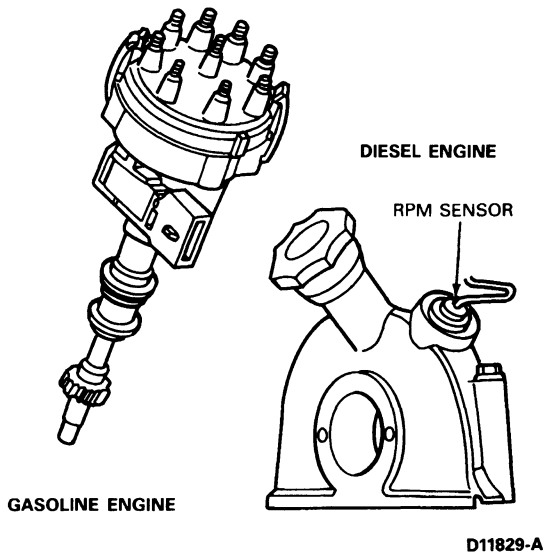
On diesel engines, the RPM provides engine rpm to the PCM.

DESCRIPTION (Continued)

Transmission function: Used as an input in determining shift scheduling and (EPC).

Symptoms: Diesel engines — Harsh engagements and shifts, late WOT upshifts, abnormal or no torque converter clutch operation. Gasoline engines — PIP sensor failure, engine will not run. May flash TCIL.

Diagnostic Trouble Codes: 14 (two digit), 211 (three digit).

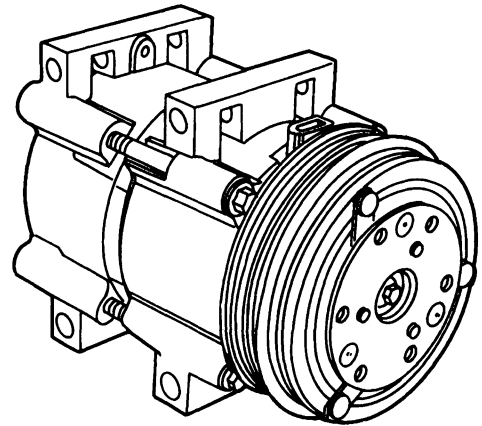
**Air Conditioning Clutch (ACC)**

Description: The Air Conditioning Clutch (ACC) is an electromagnetic clutch that is energized when the clutch cycling pressure switch closes. The switch is located on the suction accumulator-drier. The closing of the switch completes the circuit to the clutch and draws it into engagement with the compressor driveshaft.

Transmission function: Used as an input to determine EPC when the ACC is engaged to compensate for the additional load on the engine.

Symptoms: Failed on — EPC slightly low with A/C off. Failed off — EPC slightly high with A/C on.

Diagnostic Trouble Codes: 67 (two digit), 539 (three digit).



Manifold Absolute Pressure (MAP) Sensor — Gasoline Engines
Barometric Pressure (BARO) Sensor — Diesel Engines

Description: On gasoline engines, the Manifold Absolute Pressure (MAP) sensor senses atmospheric pressure to produce an electrical signal. The frequency of this signal varies with intake manifold pressure. The MAP sensor sends this signal to the PCM. The PCM uses this signal to determine altitude. The PCM then adjusts the E4OD shift schedule for the altitude.

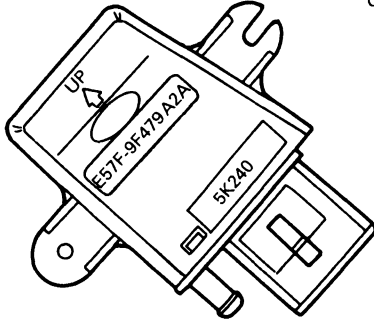
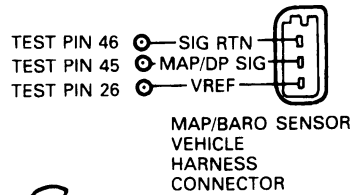
On diesel engines, the Barometric Pressure (BARO) sensor operates similar to the MAP sensor. It measures barometric pressure instead of intake manifold pressure. The PCM uses the signal from the BARO sensor to determine the altitude at which the vehicle is operating. The PCM then adjusts the E4OD shift schedule for the altitude.

Transmission function: Used as an input to determine shift schedule and EPC for altitude operation.

Symptoms: Firm shift feel, late shifts at altitude.

DESCRIPTION (Continued)

Diagnostic Trouble Codes: 22, 72 (two digit), 126, 128, 129 (three digit).



D11831-A

Low Range Switch 4x4

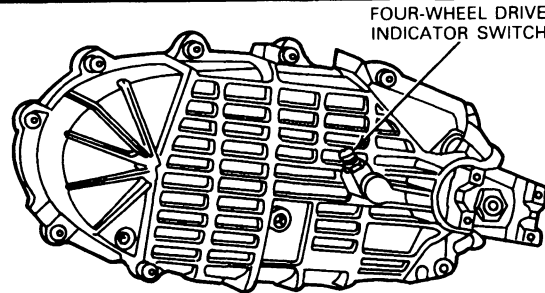
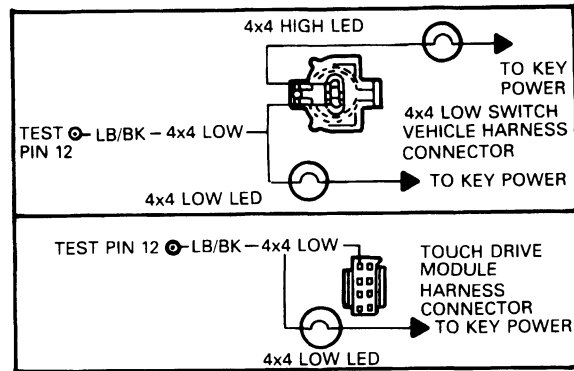
Description: The low range switch is located on the transfer case assembly. It provides an indication of when the 4x4 transfer case gear system is in the LOW range.

Transmission function: Modifies shift schedule for 4x4L transfer case gear ratio.

Symptoms: Failed on — Early shift schedule in 4x2 and 4x4H. Failed off — Shifts delayed in 4x4L.

NOTE: If the 4x4 low indicator light fuse is blown, the transmission will shift according to 4x4 low shift schedule regardless of transfer case position.

Diagnostic Trouble Codes: 47 (two digit), 633 (three digit).



D11832-A

Throttle Position (TP) Sensor (Formerly Called TPS / FIPL)

Description: The Throttle Position (TP) Sensor is a potentiometer that is mounted on the throttle body on gas applications and on the fuel injection pump lever on diesel applications. The TP sensor detects the position of the throttle plate or lever and sends this information as a voltage signal to the PCM.

The TP sensor on diesel applications is preset to a gauge block specification. To check or readjust, refer to the service manual for procedures.

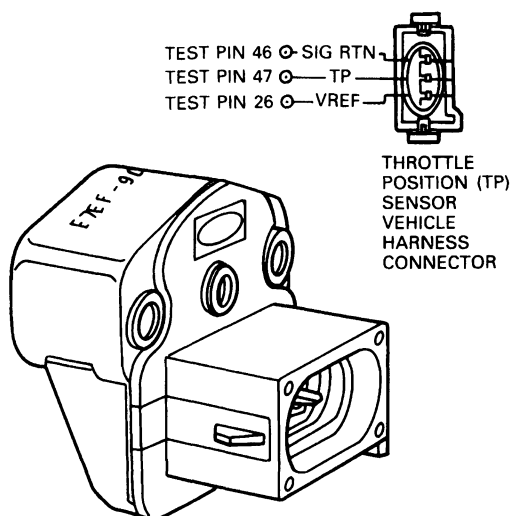
If a malfunction occurs in the TP circuit, the PCM will recognize that the TP sensor signal is out of specification. The PCM will then operate the E4OD transmission in a High capacity mode to prevent transmission damage. This High capacity mode causes harsh upshift and engagements.

Transmission function: Used as an input to determine shift scheduling and EPC.

Symptoms: Harsh engagements, firm shift feel, abnormal shift schedule, abnormal or no torque converter clutch operation. May flash TCIL.

DESCRIPTION (Continued)

Diagnostic Trouble Codes: 23, 33, 43, 53, 63, 73, 121, 122, 123, 167.



D11833-A

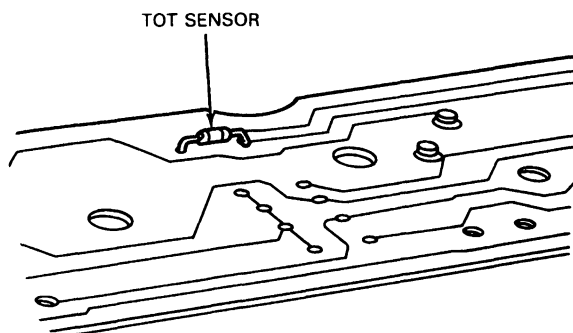
Transmission Operating Temperature (TOT) Sensor

Description: The Transmission Operating Temperature (TOT) sensor is located on the solenoid body in the transmission sump. It is a temperature-sensitive device called a thermistor. It sends a voltage signal to the PCM. The voltage signal varies with the transmission oil temperature. The PCM uses this signal to determine whether a cold start shift schedule is necessary. The cold start shift schedule lowers shift speeds to allow for the reduced performance of cold engine operation.

Transmission function: Used as an input to determine shift schedule and EPC for temperature effects.

Symptoms: Torque converter clutch and stabilized shift schedule happens too soon after a cold start. Codes 68 or 657 indicate transmission oil temperature exceeds 270 degrees Fahrenheit, results in increased EPC pressure and torque converter clutch engagement. May flash TCIL.

Diagnostic Trouble Codes: 26, 56, 66, 68, (two digit) 636, 637, 638, 657 (three digit).



D11834-A

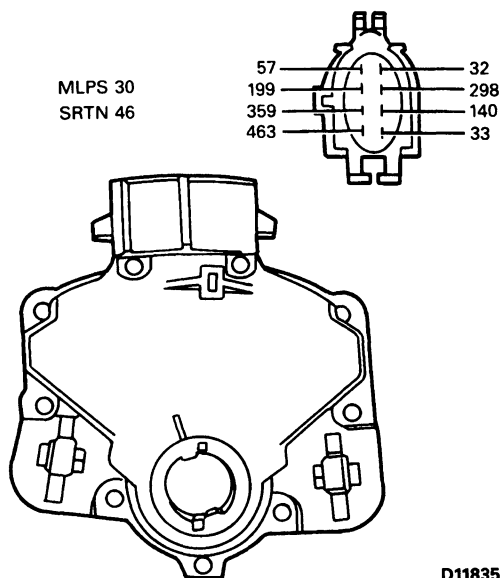
Manual Lever Position Sensor (MLP)

Description: The Manual Lever Position Sensor (MLP) sends a signal to the PCM. This indicates the position of the shift lever (P, R, N, D, 2 or 1). The MLP is located on the outside of the transmission at the manual lever.

Transmission function: Used as an input to determine desired gear and EPC.

Symptoms: Harsh engagements, firm shift feel.

Fault Codes: 67 (two digit), 634, 654 (three digit) (this code also displays if A/C is on during On-Board Diagnostic or On-Board Diagnostic run in neutral).



D11835-A

DESCRIPTION (Continued)

Transmission Control Switch (TCS)/Transmission Control Indicator Lamp (TCIL)

Description: The Transmission Control Switch (TCS) is a momentary contact switch. When the switch is pressed, a signal is sent to the PCM. The PCM then energizes the Transmission Control Indicator Lamp and the Coast Clutch Solenoid (CCS), applying the coast clutch to provide engine braking and cancels fourth gear operation.

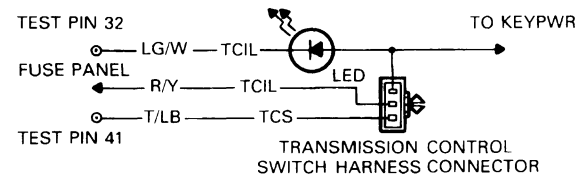
NOTE: TCIL will also flash if the EPC circuit is shorted.

Sensor: Transmission Control Switch (TCS)

Transmission function: Disable fourth gear operation.

Symptoms: No overdrive cancel when switch is cycled.

Diagnostic Trouble Codes: 65 (two digit), 632 (three digit), tested during Key On Engine Off (KOEO) On-Board Diagnostic only.



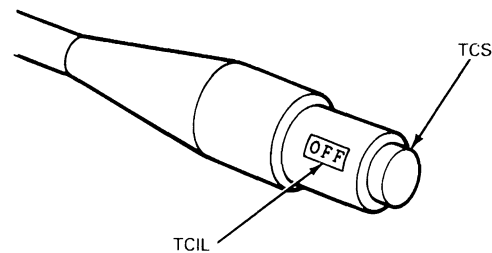
*TEST PINS LOCATED ON BREAKOUT BOX. ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.
D11836-A

Actuator: Transmission Control Indicator Lamp (TCIL).

Transmission function: Indicates overdrive cancel mode activated (lamp on) and EPC circuit shorted (lamp flashing).

Symptoms: Failed on — overdrive cancel mode always indicated, no flashing for EPC circuit shorted. Failed off — overdrive cancel mode never indicated, no flashing for EPC circuit shorted.

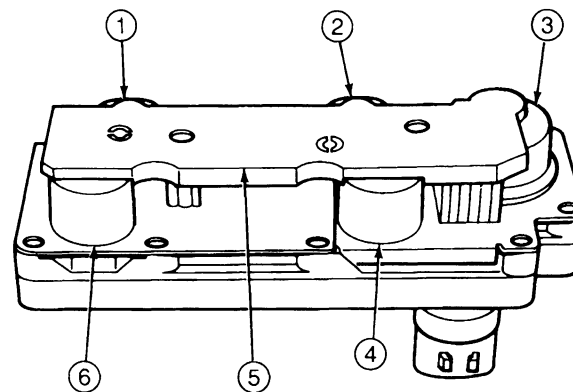
Diagnostic Trouble Codes: 97 (two digit), 631 (three digit).



D11837-A

Transmission Solenoid Body

Description: The PCM controls the E4OD transmission operation through four on / off solenoids and one Variable Force Solenoid (VFS). These solenoids and TOT sensor are housed in the transmission solenoid body assembly. Refer to the following information for the functions of these solenoids.



D5992-B

Item	Description
1	Shift Solenoid 1 (SS1)
2	Shift Solenoid 2 (SS2)
3	EPC Solenoid
4	Coast Clutch Solenoid (CCS)
5	TOT Sensor Location
6	Torque Converter Clutch (TCC) Solenoid

TD5992A

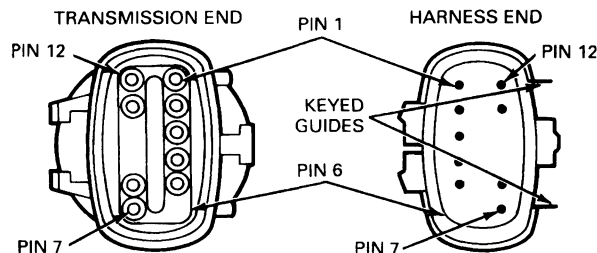
DESCRIPTION (Continued)

TRANSMISSION CONNECTOR PIN ASSIGNMENTS

12-WAY CONNECTOR PIN	DESCRIPTION	EEC-IV 60-WAY CONNECTOR PIN	
		GAS	DIESEL
1	VPWR	37, 57	37, 57
2	SS2	19	19
3	SS1	52	52
4	TCC	53	53
5	CCS	55	55
6	—	—	—
7	TOT	42	7
8	SGRTN	46	46
9	—	—	—
10	—	—	—
11	EPC	38	38
12	EPCPWR	37, 57	35*

*This is a unique EPC power feed for DIESEL application only.

12-WAY CONNECTOR



NOTE: BOTH VIEWS ARE "LOOKING INTO" THE CONNECTORS MATING ENDS.

D11838-A

Electronic Pressure Control (EPC) Solenoid

Description: The Electronic Pressure Control (EPC) Solenoid is a Variable Force Solenoid. The VFS-type solenoid is an electro-hydraulic actuator combining a solenoid and a regulating valve. It supplies Electronic Pressure Control (EPC) which regulates transmission line pressure and line modulator pressure. This is done by producing resisting forces to the main regulator and the line modulator circuits. These two pressures control the clutch application pressures.

Transmission function: Regulates EPC pressure.

Symptoms: Failed on — Gasoline engine: minimum EPC pressure (minimum transmission torque capacity). Limit engine torque (partial fuel shut-off, heavy misfire). Flashing TCIL.

Failed on — Diesel engine: cut power on pin 35 (EPC power) to attain maximum EPC pressure, harsh engagement and shifts, flashing TCIL.

Failed off — Gasoline and diesel engines: Maximum EPC pressure, harsh engagements and shifts. May flash TCIL.

Diagnostic Trouble Codes: 98, 99 (two digit) 998, 624 (three digit) (output circuit check, generated only by electrical condition).

CAUTION: Do not attempt to adjust the EPC Solenoid. This will change the operation of the transmission and may affect the warranty.

*Output circuit check, generated only by electrical condition.

**May also be generated by other non-electronic related transmission hardware condition.

Shift Solenoids 1 and 2

Shift solenoids 1 and 2 provide gear selection of first through fourth gears by controlling the pressure to the three shift valves.

Shift Solenoid 1 (SS1)

Transmission function: Gear selection.

Symptoms: Improper gear selection depending on failure mode and manual lever position; refer to the Shift Solenoid Application Chart. May flash TCIL.

Diagnostic Trouble Codes: 91*, 49**, 59**, 69** (two digit), 621*, 617**, 618**, 619** (three digit) (*Output circuit check, generated only by electrical condition.

**May also be generated by other non-electronic related transmission hardware condition).

Shift Solenoid 2 (SS2)

Transmission function: Gear selection.

Symptoms: Improper gear selection depending on failure mode and manual lever position; refer to the Shift Solenoid Application Chart. May flash TCIL.

Diagnostic Trouble Codes: 92*, 49**, 69** (two digit), 622*, 617**, 619** (three digit) (*Output circuit check, generated only by electrical condition. **May also be generated by other non-electronic related transmission hardware condition).

Solenoid 3 (TCC)

Solenoid 3 provides torque converter clutch control by shifting the converter clutch control valve to apply or release the torque converter clutch.

Transmission function: Engages torque converter clutch.

Symptoms: Failed on — Engine stalls in drive at idle low speeds with brake applied or manual 2. Failed off — Converter clutch never engages. May flash TCIL.

Diagnostic Trouble Codes: 94*, 62** (two digit) 627*, 628** (three digit) (*Output circuit check, generated only by electrical condition. **May also be generated by other non-electronic related transmission hardware condition).

Solenoid 4 (CCS)

Solenoid 4 provides coast clutch control by shifting the coast clutch shift valve. Solenoid 4 is activated by pressing the Transmission Control Switch or by selecting the 1 or 2 range with the transmission selector lever. In manual 1 and 2, the coast clutch is controlled by solenoid 4 and also hydraulically as a fail-safe to ensure engine braking. In reverse, the coast clutch is controlled hydraulically and solenoid 4 is not on.

Transmission function: Engages coast clutch to provide engine braking in third gear when overdrive cancel is on.

Symptoms: Failed on — Third gear engine braking with O/D range selected. Failed off — No third gear engine braking in overdrive cancel.

DESCRIPTION (Continued)

Diagnostic Trouble Codes: 93* (two digit), 626* (three digit).

*Output circuit check, generated only by electrical condition.

**May also be generated by other non-electronic related transmission hardware condition.

Solenoid Operation

The following solenoid application chart shows normal solenoid operation for given operating modes.

SOLENOID APPLICATION CHART

GEAR SELECTOR POSITION	ECA COMMANDED GEAR	SHIFT CONTROL			
		SOLENOID 1	SOLENOID 2	TORQUE CONVERTER CLUTCH SOLENOID 3	COAST CLUTCH SOLENOID 4
PARK	FIRST	ON	OFF	OFF	OFF
REVERSE	FIRST	ON	OFF	OFF	OFF
NEUTRAL	FIRST	ON	OFF	OFF	OFF
OD	FIRST	ON	OFF	*	OFF
OD	SECOND	ON	ON	*	OFF
OD	THIRD	OFF	ON	*	OFF
OD	FOURTH	OFF	OFF	*	OFF
OD CANCEL	FIRST THROUGH THIRD GEAR ONLY, S1, S2 AND TCC SAME AS OD, CCS ALWAYS ON.				
MANUAL 2	SECOND	OFF	OFF	*	ON
MANUAL 1	SECOND	OFF	OFF	OFF	ON
MANUAL 1	FIRST	ON	OFF	OFF	ON

*PCM CONTROLLED

CD11853-A

Shift Solenoid Failure Modes**Shift Solenoid Failure "Always ON"**

Failed ON due to PCM and/or vehicle wiring concerns; solenoid electrically or hydraulically stuck ON.

SS1 ALWAYS ON			
ECA GEAR COMMANDED	GEAR SELECTOR POSITION		
	OD	2	1
ACTUAL GEAR OBTAINED			
1	1	2	1
2	2	2	1
3	2	2	1
4	1	2	1

SS2 ALWAYS ON			
ECA GEAR COMMANDED	GEAR SELECTOR POSITION		
	OD	2	1
ACTUAL GEAR OBTAINED			
1	2	1	1
2	2	2	1
3	3	2	2
4	3	2	2

CD11854-A

DESCRIPTION (Continued)**Shift Solenoid Failure "Always OFF"**

Failed OFF due to PCM and / or vehicle wiring concerns; solenoid electrically or hydraulically stuck OFF.

SS1 ALWAYS OFF			
ECA GEAR COMMANDED	GEAR SELECTOR POSITION		
	OD	2	1
	ACTUAL GEAR OBTAINED		
1	4	2	1
2	3	2	2
3	3	2	2
4	4	2	2

SS2 ALWAYS OFF			
ECA GEAR COMMANDED	GEAR SELECTOR POSITION		
	OD	2	1
	ACTUAL GEAR OBTAINED		
1	1	2	1
2	1	2	1
3	4	2	2
4	4	2	2

CD11855-A

- Validate Customer Concern (When does condition exist?)

- Upshift
- Downshift
- Coasting
- Engagement
- Noise / Vibration
- Determine if noise / vibration is related to the following:
 - RPM Dependent
 - Vehicle Speed Dependent
 - Shift Dependent
 - Gear Dependent

Verification of Condition

This section provides information which must be used in both determining the actual cause of customer concerns and performing the appropriate service procedures.

The following procedures must be used when verifying customer concerns for E4OD transmission:

1. Required equipment:
 - E4OD Transmission Tester 007-00085 or equivalent
 - SUPER STAR II Tester 007-0041-A or equivalent

NOTE: The SUPER STAR II Tester 007-0041-A or equivalent must be used on fast mode to properly display the On-Board Diagnostic codes.

 - Digital Volt Ohmmeter 007-00001 or equivalent
 - Manual Lever Position Sensor Tester D89T-70010-A or equivalent
 - Gear Position Sensor Adjuster T91P-70010-A
 - 60-Pin Breakout Box 007-00033 or equivalent
 - (TP) VRV Gauge Block T92T-7B200-AH
2. Determine customer concerns relative to vehicle usage:
 - Hot or cold vehicle operating temperature
 - Hot or cold ambient temperatures
 - Type of terrain
 - Vehicle loaded / unloaded
 - City / highway driving

NOTE: Some E4OD transmission conditions may cause engine concerns. An EPC short circuit may cause alternate firing. The torque converter clutch not disengaging will stall the engine.
3. Fluid level and condition.
4. Road test vehicle to verify customer concern.

NOTE: Inspect vehicle for non-Ford approved add-on devices such as:

DIAGNOSIS AND TESTING

Troubleshooting the automatic transmission is simplified by using the proven method of diagnosis. One of the most important things to remember is that there is a definite procedure to follow. Do not take short cuts or assume that critical checks or adjustments have already been made.

The following procedures are recommended for checking and / or verifying that the various components are adjusted and operating properly. Use Rotunda Automatic Transmission Tester 014-00737 or equivalent. Follow the manufacturer's instructions.

Preliminary Inspection

The following items must be checked before proceeding:

- Check Fluid Level / Condition
- Vehicle at Normal Operating Temperature
- Visual Inspection of Harness Connections / Wiring
- **Were On-Board Diagnostics Run?**
- Check for Leaks
- Check for Electronic Add-On Items
- Check for Vehicle Modifications
- Check Shift Linkage for Proper Adjustment

DIAGNOSIS AND TESTING (Continued)

- Air conditioning
- Generators (alternators)
- Engine turbos
- Cellular telephones
- Cruise controls
- CB radios
- Linear boosters
- Backup alarm signals
- Computers
- These items, if not installed properly, will affect PCM or transmission function. Pay particular attention to add-on wiring splices in the PCM or transmission wiring harness, abnormal tire size or axle ratio changes.
- After a road test, with the vehicle warm and before disturbing any connectors, perform the Quick Test using SUPER STAR II Tester 007-004 1-A or equivalent. Refer to the Powertrain Control/Emissions Diagnosis Manual¹.

Checking The Automatic Transmission Fluid Level

NOTE: Vehicles equipped with 4x4 applications must have the 4x4 shift selector in any position other than neutral.

With the vehicle on a level surface, start the engine and move the transmission shift selector through all of the gear ranges allowing sufficient time for each position to engage. Securely latch the transmission shift selector in the park position, fully set the parking brake and leave the engine running.

Wipe off the dipstick cap, pull the dipstick out and wipe the indicator end clean. Put the dipstick back into the filler tube and make sure it is fully seated. Pull the dipstick out and read the fluid level.

CAUTION: Your vehicle should not be driven if the fluid level is below the bottom hole on the dipstick and outside temperatures are above 10°C (50°F).

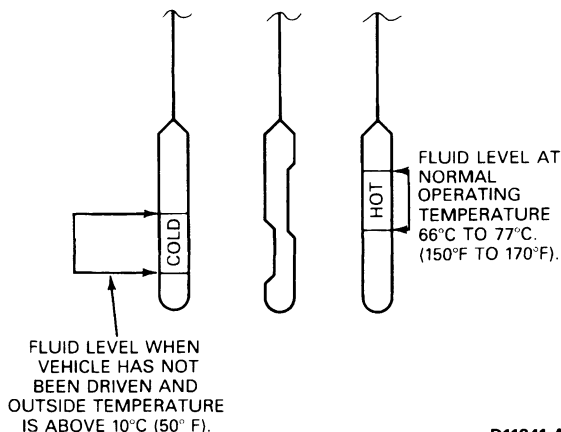
When checking fluid at normal operating temperature, the fluid level should be within the crosshatched area or "HOT" marked area on the dipstick. When the vehicle has not been driven, and outside temperature is above 10°C (50°F), the fluid level should be between the holes or "COLD" marked area on the dipstick.

Adding Fluid

Only Motorcraft MERCON® Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent is used in all Ford automatic transmissions. Before adding any fluid, be sure that the correct type will be used.

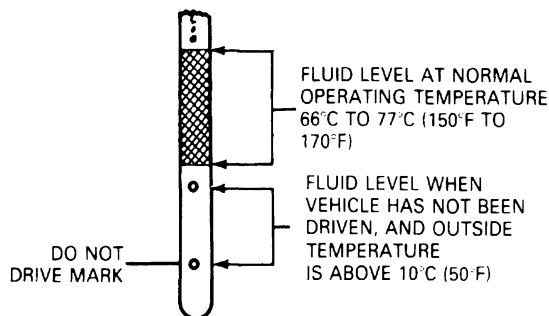
Add fluid in 1/2-pint (.24L) increments through the filler tube to bring the level to the correct area on the dipstick. If an overfill occurs, excess fluid must be removed.

Econoline Only



D11841-A

F-Series and Bronco Only



D7423-1B

High or Low Fluid Level

A fluid level that is too high may cause the fluid to become aerated due to the churning action of the rotating parts of the transmission. Aerated fluid will cause erratic control pressure, and the aerated fluid may be forced from the vent.

A fluid level that is too low will affect transmission operation. Low level may indicate fluid leaks that may cause transmission damage.

¹ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Automatic Transmission

Fluid Checking and Adding Procedure

Under normal circumstances, you do not need to check the fluid level of the transmission, since the vehicle does not use up transmission fluid. However, if the transmission is not working properly, for instance, the transmission may slip or shift slowly, or you may notice some sign of fluid leakage, the fluid level should be checked.

It is preferable to check the transmission fluid level at normal operating temperature after approximately 20 miles (32 km) of driving. However, if necessary, you can check the fluid level without having to drive 20 miles to obtain a normal operating temperature if outside temperatures are above 10°C (50°F).

NOTE: If the vehicle has been operating for an extended period at high speeds or in city traffic during hot weather, or pulling a trailer, the vehicle should be turned off for about 30 minutes to allow the fluid to cool before checking.

Fluid Condition Check

1. Make the normal fluid level check as outlined previously under Checking the Automatic Transmission Fluid.
2. Observe color and odor of the fluid. It should be red, not brown or black. Odor may indicate overheating condition, clutch disc or band failure.
3. Use an absorbent white facial tissue and wipe the dipstick. Examine the stain for evidence of solid particles and for antifreeze signs (gum or varnish on dipstick).

If particles are present in the fluid or there is evidence of antifreeze or water, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive particles in the transmission oil pan, the transmission **must** be disassembled and completely cleaned and serviced. This includes cleaning and flushing the torque converter and transmission cooling system. During disassembly and assembly, all overhaul checks and adjustments of clearances and end play must be made. After the transmission has been serviced, all diagnostic tests and adjustments listed in the Diagnostic Charts must be completed to make sure that the problem has been corrected.

Fluid Leakage Checks

Leakage at the transmission oil pan gasket often can be stopped by tightening the attaching bolts to 14-16 N-m (10-12 ft-lb). If necessary, replace the gasket.

If leakage is found by the solenoid body connector, refer to Valve Body and Intermediate Band Servo under In-Vehicle Service in this section. Replace O-ring on the connector snout of the solenoid body assembly as outlined in this section.

Check the fluid filler tube connection at the transmission case. If leakage is found here, install a new stub tube.

Check the fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear, or damage. If leakage cannot be stopped by tightening a fluid line tube nut, replace the damaged parts. When fluid is found to be leaking between the case and the cooler line fitting, tighten the fitting to maximum specification. **Do not try to stop the fluid leak by increasing the torque beyond specification. This may cause damage to the case threads.** If the leak continues, replace the cooler line fitting and tighten to specification. The same procedure should be followed for fluid leaks between the radiator cooler and cooler line fittings.

Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the cooler in the radiator is probably leaking.

The cooler can be further checked for leaks by disconnecting the lines from the cooler fittings and applying no more than 345 kPa (50 psi) air pressure to the fittings. Remove the radiator cap to relieve the pressure buildup at the exterior of the oil cooler tank. If the cooler is leaking and / or will not hold pressure, replace the cooler.

If leakage is found at the manual lever shaft, replace the seal.

When a converter drain plug leaks, remove the drain plug. Coat the threads with Pipe Sealant Teflon® D8AZ-19554-A or equivalent and install drain plug. Tighten to 24-27 N-m (18-20 ft-lb).

Check for fluid leaking from the end of extension housing. Leakage may result from damaged seal, missing garter spring or worn extension bushing. Replace seal assembly and / or bushing as necessary.

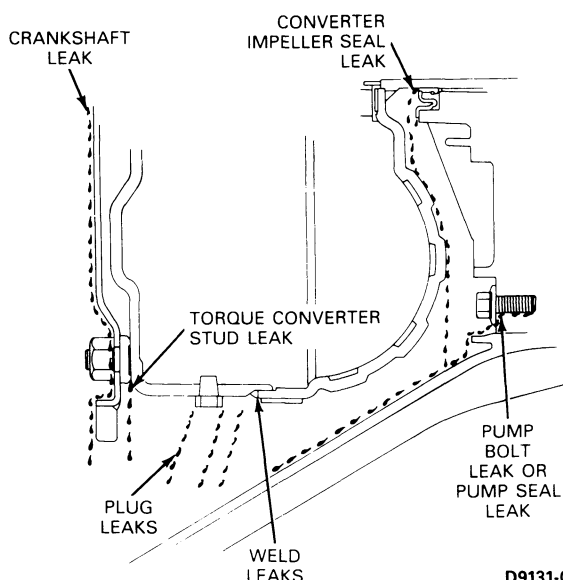
Oil soluble aniline or fluorescent dyes premixed at the rate of 2.5ml (1/2 teaspoon) of dye powder to 0.24L (1/2 pint) of transmission fluid have proven helpful in locating the source of fluid leakage. Such dyes may be used to determine whether an engine oil or transmission fluid leak is present, or if the fluid in the oil cooler leaks into the engine coolant system. A black light must be used with the fluorescent dye solution.

Fluid Leakage in Converter Area

In diagnosing and correcting fluid leaks in the converter area, use the following procedures to locate the exact cause of the leakage. Leakage at the front of the transmission as evidenced by fluid around the converter housing, may have several sources. By careful observation it is possible, in many instances, to pinpoint the source of the leak before removing the transmission from the vehicle. The paths which the fluid can take to reach the bottom of the converter housing are as follows.

DIAGNOSIS AND TESTING (Continued)

Possible Converter Area Leak Points



D9131-C

1. Fluid leaking by the converter impeller hub seal lip will tend to move along the converter impeller hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the housing.
2. Fluid leakage by the outside diameter of the converter hub seal and the case will follow the same path which the leaks by the inside diameter of the seal follow.
3. Fluid leakage from the converter to the flywheel stud weld will appear at the outer diameter of the converter on the back face of the flywheel, and in the converter housing only near the flywheel. If a converter-to-flywheel stud leak is suspected, remove converter and pressure check as outlined.
4. Fluid leakage from the pump will flow down the back of the converter housing. Leakage may be from loose or missing pump bolts, torn or damaged pump-to-case gasket and / or a worn pump bushing.
5. Engine oil leaks are sometimes improperly diagnosed as transmission pump seal leaks. The following areas of possible leakage should also be checked to determine if engine oil leakage is causing the problem.
 - a. Leakage at the rocker arm cover may allow oil to flow over the converter housing or seep down between the converter housing and cylinder block causing oil to be present in or at the bottom of the converter housing.
 - b. Oil gallery plug leaks will allow oil to flow down the rear face of the block to the converter housing.

- c. Leakage at the crankshaft seal will work back to the flywheel, and then into the converter housing.
6. The following procedures should be used to determine the cause of the leakage before service is made.
 - a. Remove the transmission dipstick and note the color of the fluid. Original factory fill fluid is dyed red to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the red color should assist in pinpointing the leak.
 - b. Remove the converter housing cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case, and rear face of the engine and oil pan. Clean the converter area by washing with suitable nonflammable solvent, and blow dry with compressed air.
 - c. Wash out converter housing and the front of the flywheel. The converter housing may be washed out using clean solvent and a squirt-type oil can. Blow all washed areas dry with compressed air.
 - d. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist and position suitable safety stands under vehicle. Run the engine at fast idle, then at engine idle, occasionally shifting to the drive and reverse ranges to increase pressure within the transmission. Observe the front of the flywheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

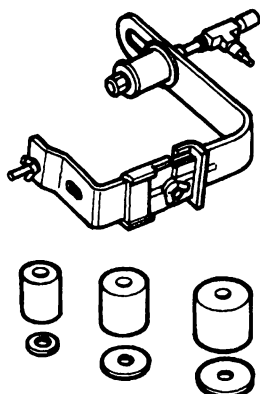
Converter Leakage Check

If welds on the torque converter indicate leakage, remove the converter and make the following check.

Assemble Rotunda Torque Converter Leak Test Kit 021-00054 or equivalent to the converter. Test the converter for leaks, following the directions supplied with the kit.

DIAGNOSIS AND TESTING (Continued)

Rotunda Torque Converter Leak Test Kit 021-00054



D9269-1A

Converter and Fluid Cooler

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and **MUST** be removed from the system before the transmission is put back into service.

CAUTION: Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the converter and oil cooler MUST be cleaned by using the Rotunda Torque Converter / Oil Cooler Cleaner 014-00028 or equivalent. Under NO circumstances should an attempt be made to clean converters by hand agitation with solvent.

Transmission Fluid Cooler Flow Test

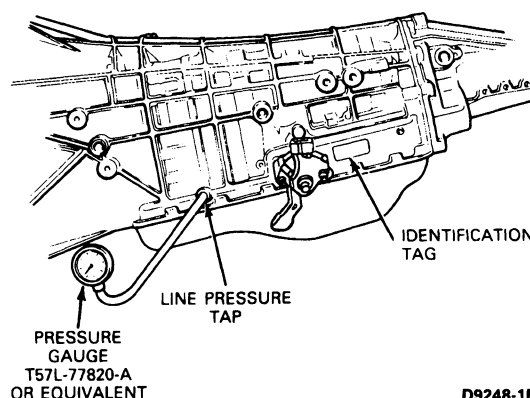
NOTE: The transmission linkage / cable adjustment, fluid level, and line pressure must be within specification before performing this test. Refer to service procedures as outlined.

1. Remove dipstick from filler tube.
2. Place funnel in filler tube.
3. Raise vehicle on hoist and position suitable safety stands under vehicle.
4. Remove cooler return line (rear fitting) from fitting on transmission case. Refer to In-Vehicle service in this section for transmission cooler line routing.
5. Connect one end of a hose to the cooler return line and route the other end of the hose up to a point where it can be inserted into the funnel at the filler tube.
6. Remove safety stands and lower vehicle. Insert end of hose into funnel.

7. Start engine and run at idle with transmission in neutral range.
8. When fluid flowing from hose is solid, a liberal amount of fluid should be observed. "Liberal" is described as about 1/2 quart delivered in 30 seconds. If liberal flow is observed, test is completed.
9. If the flow is not liberal, stop engine. Disconnect hose from cooler return line and connect it to converter-out line fitting (front fitting) on transmission case.
10. Repeat Steps 7 and 8. If flow is now liberal, refer to appropriate section for diagnosis of transmission fluid cooler. If flow is not liberal, flush the system. If liberal flow is not yet obtained, replace cooler lines.

Line Pressure Test

1. Connect pressure gauge to line pressure tap.



D9248-1B

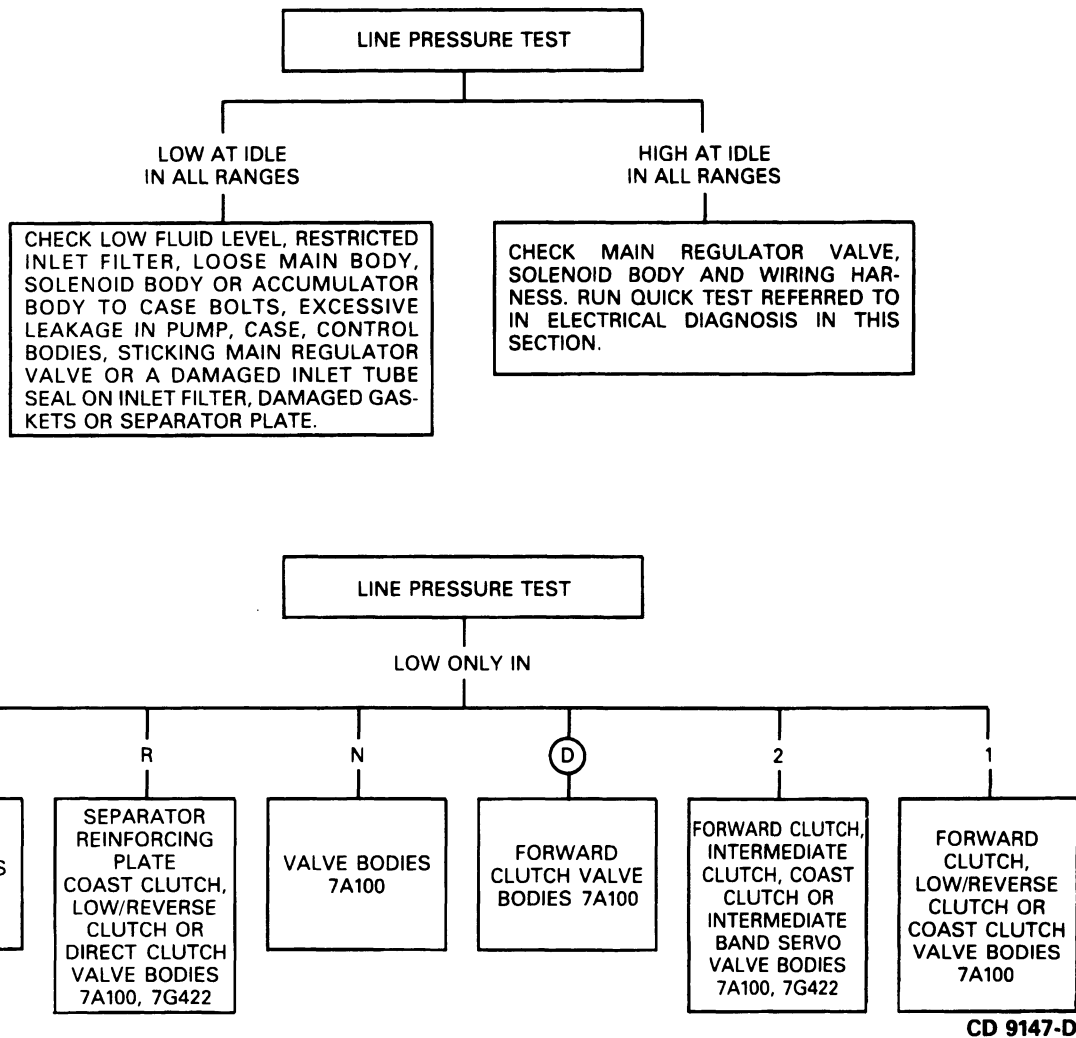
2. Start engine and check line pressures. Refer to the following chart to determine if line pressure is within specification.
CAUTION: Perform line pressure test prior to performing stall speed test. If line pressure is low at stall, do not perform stall speed test or further transmission damage will occur. DO NOT MAINTAIN WOT in any gear range FOR MORE THAN FIVE (5) SECONDS.
3. If line pressure is not within specifications, perform On-Board Diagnostics and Pinpoint Test, air pressure check and service main control system or pump as required.
CAUTION: Transmission Tester MUST BE REMOVED from the transmission and the vehicle harness reinstalled to verify these pressures.

DIAGNOSIS AND TESTING (Continued)

LINE PRESSURE SPECIFICATIONS

Gear	Line Pressure — Idle		Line Pressure — Stall	
	KPA	PSI	KPA	PSI
P, N	379-448	55-65	—	—
R	517-683	75-99	1655-1827	240-265
\odot , 2	379-448	55-65	1076-1200	156-174
1	517-683	75-99	1082-1282	161-186

Line Pressure Test Chart



CD 9147-D

Stall Speed Test

The stall test checks the operation of the following items:

- Converter one-way clutch
- Forward clutch
- Low / reverse one-way clutch
- Reverse clutch

- Overdrive one-way clutch
- Direct clutch
- Engine performance

NOTE: The stall test should only be performed with the engine and transmission at normal operating temperatures.

DIAGNOSIS AND TESTING (Continued)

WARNING: APPLY THE SERVICE AND PARKING BRAKES FIRMLY WHILE PERFORMING EACH STALL TEST.

CAUTION: Perform line pressure test prior to performing stall test. If line pressure is low at stall, do not perform stall test or further transmission damage will occur.

1. Connect tachometer to engine.
2. After testing each of the following ranges, \odot , 2, 1 and R, move selector lever to N (neutral) and run engine for about 15 seconds to allow converter to cool before testing next range.

CAUTION: Do not maintain WOT in any gear range for more than five seconds.

Press accelerator pedal to floor (WOT) in each range. Record rpm reached in each range. Stall speeds should be in appropriate range.

CAUTION: If engine rpm recorded by the tachometer exceeds maximum specified rpm, release accelerator pedal immediately. Clutch or band slippage is indicated.

Engine	Stall Speed (rpm)
4.9L	1485-1860
5.0L	1955-2435
5.8L	2100-2600
7.3L-D	1680-2100
7.5L	1840-2300

If the stall speeds were too high, refer to the following Stall Speed Diagnosis Chart. If the stall speeds were too low, first check engine tune-up. If engine is OK, remove torque converter and check torque converter reactor one-way clutch for slippage.

Range	Possible Source
\odot	<ul style="list-style-type: none"> • Forward Clutch • Overdrive One-Way Clutch • Low / Reaction One-Way Clutch
R	<ul style="list-style-type: none"> • Direct Clutch • Overdrive One-Way Clutch and Coast Clutch • Reverse Clutch

(Continued)

Range	Possible Source
2	<ul style="list-style-type: none"> • Forward Clutch • Overdrive On-Way Clutch and Coast Clutch
1	<ul style="list-style-type: none"> • Forward Clutch • Reverse Clutch and Low / Reaction One-Way Clutch • Coast Clutch and Overdrive One-Way Clutch

Air Pressure Checks

A no-drive condition can exist, even with correct transmission fluid pressure, because of inoperative clutches or bands. Refer to the Clutch / Band application chart to determine the appropriate elements. A clutch concern may be located through a series of checks by substituting air pressure for fluid pressure to determine the location of the malfunction.

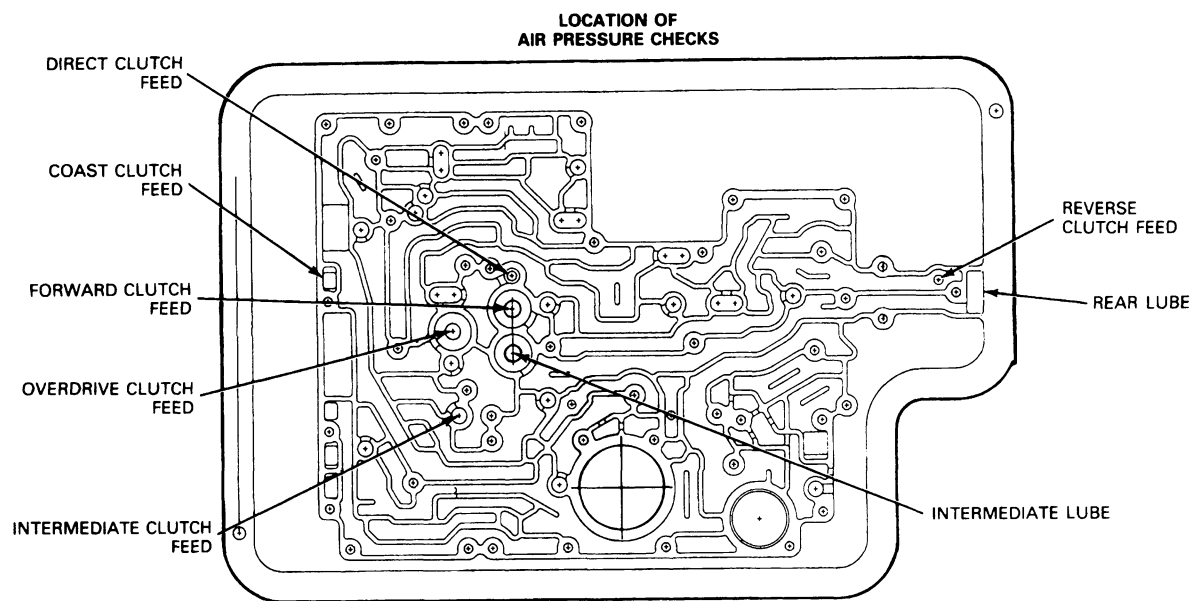
Example: When the selector lever is in a forward gear range (\odot , 2, 1) a no-drive condition may be caused by an inoperative forward clutch.

Perform the following procedures:

1. Drain the transmission fluid. Remove oil pan.
2. Remove pump inlet filter and seal assembly, solenoid body and the control assemblies.
3. The inoperative clutches may be located by applying air pressure into the appropriate clutch port. See diagram for clutch port locations.
4. Apply air pressure to the appropriate clutch port (see diagram). A dull thud may be heard, or movement felt when clutch piston is applied. If clutch seals or check ball are leaking a hissing may be heard.

DIAGNOSIS AND TESTING (Continued)

Air Pressure Test Part Locations



D9149-B

CLUTCH/BAND APPLICATION CHART

Gear	Friction Elements							One-Way Clutch (Drive)			One-Way Clutch (Coast)		
	Coast	Inter- medi- ate	Direct	For- ward	Low/ Re- verse	Over- Drive	Inter- medi- ate Band	O/D OWC	Inter- medi- ate OWC	Low Re- action OWC	O/D OWC	Inter- medi- ate OWC	Low Re- action OWC
Ⓔ first	^a	—	—	apply	—	—	—	HOLD	—	HOLD	O/R ^a	—	O/R
Ⓕ second	^a	apply	—	apply	—	—	—	HOLD	HOLD	O/R	O/R ^a	O/R	O/R
Ⓖ third	^a	apply	apply	apply	—	—	—	HOLD	O/R	O/R	O/R ^a	O/R	O/R
Ⓖ fourth	—	apply	apply	apply	—	apply	—	O/R	O/R	O/R	O/R	O/R	O/R
1	apply	—	—	apply	apply	—	—	HOLD	—	HOLD	CC	—	—
2	apply	apply	—	apply	—	—	apply	HOLD	HOLD	O/R	CC	BA	O/R
reverse	apply	—	apply	—	apply	—	—	HOLD	O/R	—	CC	O/R	—

^a In D Range with the Transmission Control Switch pressed, the coast clutch is applied and the O/D one-way clutch is bypassed.

O/D — Overdrive

OWC — One-Way Clutch

O/R — Overrunning

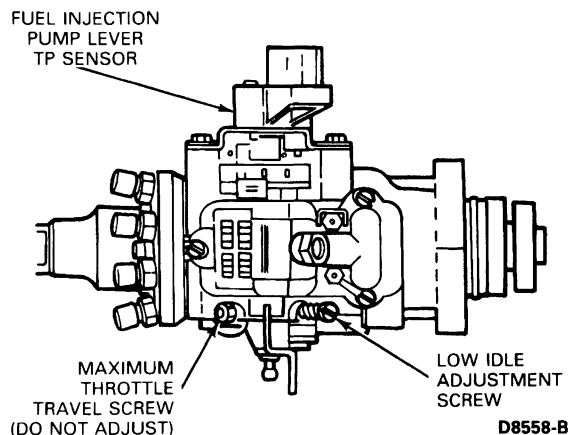
CC — Coast Friction Clutch Applied

BA — Band Applied

DIAGNOSIS AND TESTING (Continued)

Throttle Position (FIPL) Sensor

The Throttle Position (FIPL) sensor is used on E-250-350, F-250-350, and F-Super Duty vehicles equipped with a 7.3L diesel engine and an E4OD automatic transmission. The TP (FIPL) sensor is a potentiometer attached to the fuel injection pump and is operated by the throttle lever.



The TP (FIPL) sensor is incorporated to provide an electrical signal, which is proportional to the amount of fuel being delivered, as an input to the Transmission Electronic Control Assembly (TECA). Based on this information, the TP (FIPL) provides the proper shift scheduling and torque capacity.

Should a malfunction occur in the TP (FIPL) sensor circuit, the electrical signal sent to the TECA will be recognized as erroneous. When this out-of-specification signal is detected, the TECA will provide a high-capacity operating mode that protects the transmission from potential damage. This operating mode includes maximum TV pressure, resulting in harsh upshifts and engagements and a singular shift schedule regardless of accelerator pedal position, resulting in the 1-2, 2-3 and 3-4 shifts occurring at a speed commensurate with a heavy (but not wide open) throttle setting.

Should harsh or poorly scheduled shifts be encountered, perform Key-On, Engine-Off On-Board Diagnostics to determine the appropriate repair to be performed and correct as necessary before proceeding. Should it be necessary to service the TP (FIPL) sensor, refer to the following procedure.

To check the TP (FIPL) sensor for proper operation and to make any adjustments the engine **MUST** be turned off.

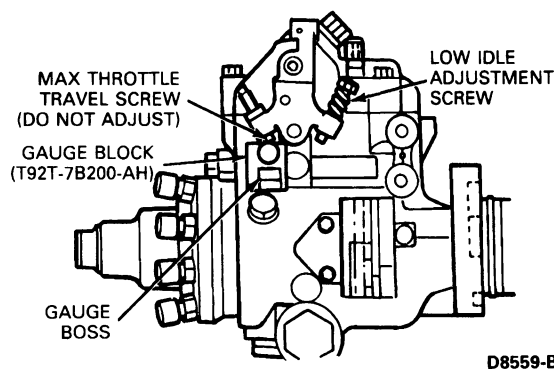
1. Perform Key-On, Engine-Off On-Board Diagnostics and wait for all the DTCs to be issued.

NOTE: The throttle must be held to the floor, during Key-On, Engine-Off On-Board Diagnostics until the codes have begun to issue from the STAR Tester Transmission Control.

2. After the last DTC has been issued, press the Transmission Control Switch (TCS), this will initiate the TP (FIPL) sensor adjustment mode and allow the STAR Tester to be used as an "audible guide" in setting the TP (FIPL) sensor.

NOTE: The STAR Tester remains in the adjustment mode for only ten minutes. Steps 3-5 must be completed within this time period. If the ten minute time limit is exceeded this procedure must be repeated from Step 1.

3. Remove the throttle cable from the throttle lever on the right side of the fuel injection pump.
4. Insert the VRV Gauge Block T92T-7B200-AH (0.515 inch) between the gauge boss and the maximum throttle travel screw. Hold the throttle lever open against the gauge block. A steady tone indicates the TP (FIPL) sensor is properly adjusted. If the setting is too low the STAR Tester will issue a slow beep (1 per second), if the setting is too high the STAR Tester will issue a fast beep (4 per second).

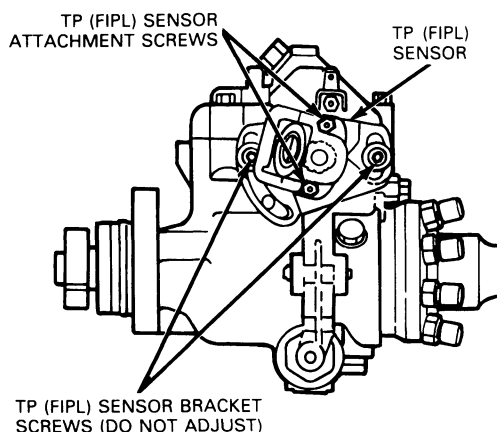


NOTE: The TP (FIPL) sensor bracket is permanently attached to the pump with tamper-proof screws. Movement of the bracket is not intended as a means for adjustment. If required, adjustment of the TP (FIPL) sensor may be accomplished by utilizing the clearance between the sensor to bracket screws and the sensor.

NOTE: If the TP (FIPL) sensor bracket is loose, remove the epoxy from the bracket to pump mounting screws, adjust the TP (FIPL) sensor / bracket assembly to obtain a steady tone, retighten the screws, and reapply epoxy to the screw heads.

DIAGNOSIS AND TESTING (Continued)

- To adjust, loosen the two screws that attach the TP (FIPL) sensor to the mounting bracket. Rotate the TP (FIPL) sensor until a steady tone is heard from the STAR Tester. If the setting is too low the STAR Tester will issue a slow beep (1 per second), if the setting is too high the STAR Tester will issue a fast beep (4 per second). Once a steady tone is heard, tighten the attaching screws to 8-10.5 N·m (75-90 in·lb). If the TP (FIPL) sensor cannot be adjusted to obtain a steady tone, replace the TP (FIPL) sensor and repeat this procedure from Step 1.



D8560-C

- Remove the gauge block. Cycle the throttle lever from idle to wide open throttle (WOT) five times. Reinsert the gauge block to verify the setting. If the tone is not steady then readjustment is necessary. Repeat this procedure from Step 5.
- Remove the gauge block. Reattach the throttle cable.
- Start the engine. Check throttle operation and transmission shift scheduling and quality.

WARNING: DO NOT TURN THE MAXIMUM THROTTLE TRAVEL SCREW. THIS SCREW HAS BEEN PRESET AND SHOULD NOT BE ADJUSTED.

CAUTION: If replacing the (TP) Fuel Injection Pump Lever sensor, refer to the TSB's, OASIS master parts catalog for the latest release of the (TP) FIPL.

Torque Converter Clutch Test

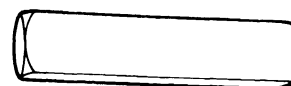
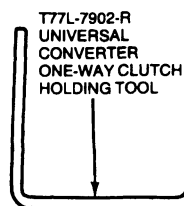
- Perform Quick Test as stated in the Powertrain Control/Emissions Diagnosis Manual.² Check for a code 94, 62, 627, 628 or 629. Refer to the pinpoint test for diagnosis.

² Can be purchased as a separate item.

- Connect a tachometer to the engine.
- Bring engine to normal operating temperature by driving the vehicle at highway speeds for approximately 15 minutes in \odot range.
- After normal operating temperatures are reached, maintain a constant vehicle speed of about 80 km/h (50 mph), and tap the brake pedal with the left foot.
- Engine rpm should increase when the brake pedal is tapped, and decrease about five seconds after the pedal is released. If this does not occur, refer to Torque Converter Operation Concerns in the Electrical/Hydraulic/Mechanical Diagnosis Charts.
- If the vehicle stalls in \odot at idle with the vehicle at a stop, move the manual lever to the Manual 1 position. If the vehicle stalls, the cause may be the converter control valve in the pump. Service as required. If the vehicle doesn't stall in Manual 1, refer to the Electrical Diagnosis for PCM and Vehicle Harness Diagnosis.

Converter One-Way Clutch Check

- Insert the One-Way Clutch Holding Tool T77L-7902-R in one of the grooves in the stator thrust washer.

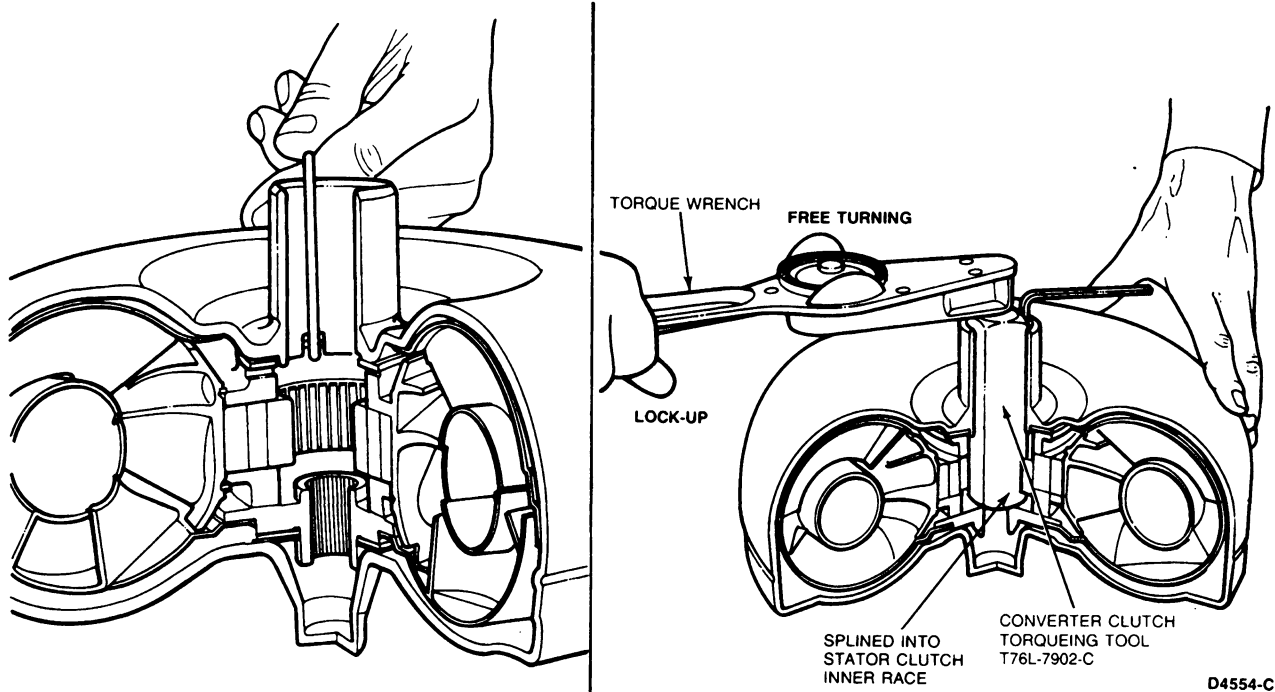


D2877-H

- Insert Converter Clutch Torquing Tool T76L-7902-C in converter pump drive hub to engage one-way clutch inner race.
- Attach a torque wrench to the one-way clutch tightening tool. With the one-way clutch holding tool held stationary, turn the torque wrench counterclockwise. The converter one-way clutch should lock up and hold a 13 N·m (10 ft·lb) force. The converter one-way clutch should rotate freely in a clockwise direction until torquing tool contacts the holding tool. Try the clutch for lock up and hold in at least five different locations around the converter.

DIAGNOSIS AND TESTING (Continued)

4. If the clutch fails to lock up and hold a 13 N·m (10 ft-lb) torque, replace the converter unit.

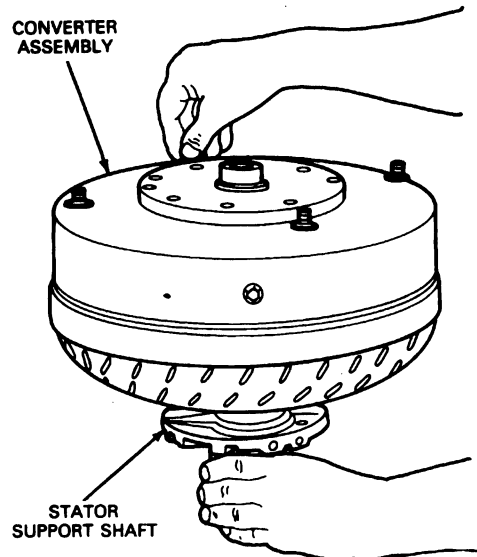
**Stator to Impeller Interference Check**

1. Position the stator support on a bench with the spline end of the shaft pointing up.
2. Mount a converter on the stator support with the splines on the one-way clutch inner race engaging the mating splines of the stator support.

NOTE: Converter must be positioned on top of stator as shown in the illustration to properly perform this check.

3. Hold the stator support stationary and try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.
4. If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the converter.

NOTE: Stator support may remain in pump assembly during this test.



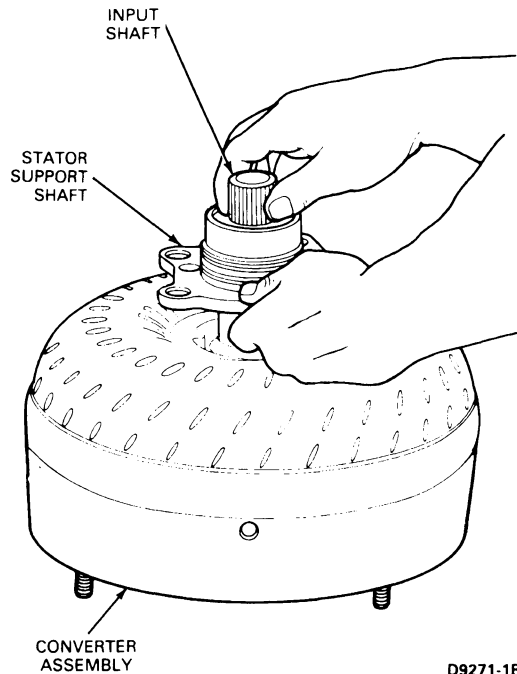
D9270-1A

Stator to Turbine Interference Check

1. Position the converter on the bench stud side down.
2. Install a stator support to engage the mating splines of the stator support shaft.

DIAGNOSIS AND TESTING (Continued)

3. Install the input shaft, engaging the splines with the turbine hub.



D9271-1B

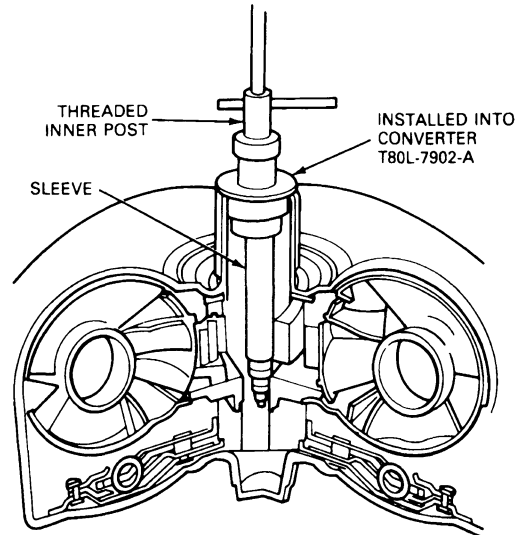
4. Hold the stator shaft stationary and attempt to rotate the turbine with the input shaft. The turbine and lock-up clutch assemblies should rotate in both directions, not exceeding maximum torque of 9.5 N·m (7 ft-lb), without any signs of metallic interference or scraping noise.
5. If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. In such cases, the converter must be replaced.

Check the converter crankshaft pilot for nicks or damaged surfaces that could cause interference when installing the transmission to the engine. Check the converter impeller hub for nicks or sharp edges that would damage the pump seal.

NOTE: Stator support may remain in pump assembly during this test.

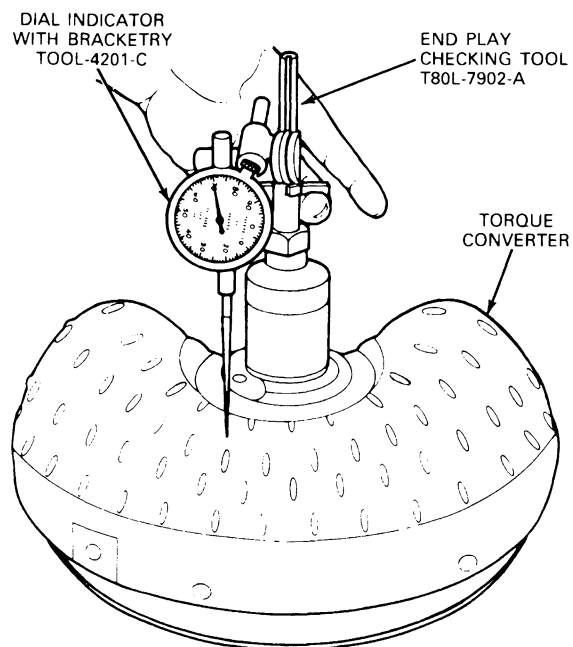
Converter End Play Check

1. Insert End Play Checking Tool T80L-7902-A into the converter pump drive hub until it bottoms.
2. Expand the sleeve in the turbine spline by tightening the threaded inner post until the tool is securely locked into the spline.



D9273-1B

3. Attach a Dial Indicator with Bracketry TOOL-4201-C to the tool. Position the indicator button on the converter housing as shown in the illustration and set the dial face at 0 (zero). Refer to the following chart for specification.
- NOTE: Dial Indicator must be between ridges.



D5723-B

DIAGNOSIS AND TESTING (Continued)**TORQUE CONVERTER END-PLAY (E4OD)**

New or Rebuild Converter		Used Converter	
mm	Inch	mm	Inch
.35-.96	.014 — .038	1.8 Max.	.071 Max

Electrical/Hydraulic/Mechanical/Diagnosis Charts

The E4OD diagnosis charts follow a new format. The enhanced format is used to separate electrical from mechanical causes or concerns.

The benefit of the new format is the adoption of major headings and a logical sequence to the diagnostic routine. To best use the chart:

1. Define the major concern.

2. Eliminate the possible causes in the Electrical Cause / Concern column 200 numbers.
3. Eliminate the possible causes in the Hydraulic-Mechanical Cause / Concern column 300 numbers.

The items listed under the main headings are arranged in order of teardown.

DIAGNOSIS AND TESTING (Continued)**Electrical/Hydraulic/Mechanical Diagnosis Charts****INDEX**

E4OD	ROUTINES	
	ELECTRICAL **	MECHANICAL HYDRAULIC
ENGAGEMENT CONCERNS:		
No Forward and No Reverse	None	307
No Forward Only	None	301
No Reverse Only	None	302
Harsh Forward and Harsh Reverse	208	308
Harsh Reverse Only	203	303
Harsh Forward Only	204	304
Delayed Forward and Delayed Reverse	None	309
Delayed/Soft Reverse Only	None	305
Delayed/Soft Forward Only	None	306
SHIFT CONCERNS:		
Timing Concerns		
— Early/Late (Some/All)	211	311
— Erratic/Hunting (Some/All)	212	312
Feel		
— Soft/Slipping (Some/All)	213	313
— Harsh (Some/All)	214	314
Some/All Shifts Missing	210	310
No First Gear in Drive, Engages in a Higher Gear	215	315
No First Gear in Manual 1st.	216	316
No Manual Second Gear	217	317
TORQUE CONVERTER OPERATION CONCERNS:		
Does NOT Apply	240	340
Always Applied/Stall Vehicle	241	341
Cycling/Shudder/Chatter	242	342
OTHER:		
Shift Lever Efforts High	None	351
External Leaks	252	352
Poor Vehicle Performance	253	353
Noise/Vibration — Forward or Reverse	None	354
Engine will not Crank	255	355
No Park Range	None	356
Overheating	257	357
No Engine Braking in Manual 2	None	358
No Engine Braking in Manual 1	259	359
No Engine Braking with O.D. Cancelled	260	360
Fluid Venting or Foaming	None	361
REFERENCE:		
Pressure Chart		401
Check Ball Locations		501

**Perform electrical routines first

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DIAGNOSIS AND TESTING (Continued)

NO FORWARD ENGAGEMENTS

Possible Component	Reference/Action
201 — ELECTRICAL ROUTINE	
No Electrical Concerns	
301 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid	
— Improper level.	— Adjust fluid to proper level.
— Condition.	— Inspect per instructions under Fluid Condition Check.
Shift Linkage (Internal/External) or Cable	
— Damaged, misadjusted, disconnected.	— Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify MLPS sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures	
— Low line pressure.	— Check pressure at line tap. Refer to Pressure Chart #401 for specification. If pressures are low, check the following possible components: Pump inlet filter and seal assembly, main controls, pump assembly, forward clutch assembly.
Pump Inlet Filter and Seal Assembly	
— Plugged, damaged.	— Inspect filter and seal assembly for damage.
— Filter seal damaged, cut.	— Replace as required.
Main Controls	
— Manual valve stuck, damaged.	— Inspect for damage and service as required.
— Control body housing leakage.	
— Bolts not tightened to specification.	— Retighten bolts to specification.
— Gaskets damaged.	— Inspect gasket for damage and replace as required.
Forward Clutch Assembly	
— Assembly	— Air check clutch assembly as outlined in the service manual.
— Piston, seal; check ball damaged, missing, not seating.	— Inspect seals for damage, check ball seating, location. Service piston assembly as required.
— Center support damaged, holes blocked/feedbolts loose/missing.	— Inspect for damage. Service as required.
— Forward clutch sealing rings damaged.	— Inspect for damage. Service as required.
— Forward clutch ring gear damaged.	— Inspect for damage. Service as required.
— Friction elements damaged, worn; spline teeth damaged, missing.	— Check for abnormal wear, damage. Service as required.
Forward/Reverse sun gear damaged.	— Inspect for damage. Service as required.
Forward planet assembly damaged.	— Inspect for damage. Service as required.
Output Shaft	
— Splines damaged.	— Inspect for damage. Service as required.
Low One-Way Clutch Assembly (Planetary)	
— Worn, damaged or misassembled.	— Inspect for damage. Service as required.

CD11857-A

DIAGNOSIS AND TESTING (Continued)

NO REVERSE ENGAGEMENTS

Possible Component	Reference/Action
202 — ELECTRICAL ROUTINE	
No Electrical Concerns	
302 — HYDRAULIC/MECHANICAL ROUTINE	
Fluid <ul style="list-style-type: none"> — Improper level. — Condition. 	<ul style="list-style-type: none"> — Adjust fluid to proper level. — Inspect per instructions under Fluid Condition Check.
Shift Linkage (Internal/External) or Cable <ul style="list-style-type: none"> — Damaged or misadjusted. 	<ul style="list-style-type: none"> — Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLPS sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures <ul style="list-style-type: none"> — Low line pressure. 	<ul style="list-style-type: none"> — Check pressure at line pressure tap. Refer to Hydraulic Pressure Chart #410 for specifications. If pressures are low, check the following possible components: Pump inlet filter and seal assembly, main control, pump assembly, reverse clutch assembly.
Oil Filter and seal assembly <ul style="list-style-type: none"> — Plugged, damaged or seal missing. 	<ul style="list-style-type: none"> — Replace filter and seal assembly for damage. Service as required.
Main Controls <ul style="list-style-type: none"> — Bolts not torqued to specification. — Gaskets damaged. — Valve springs, valve body, direct clutch accumulator valve damaged, stuck, missing, or misassembled. — Reinforcing plate improperly installed; bolts not torqued to specification. 	<ul style="list-style-type: none"> — Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Inspect for proper installation. Retorque bolts to specification.
Coast Clutch Assembly <ul style="list-style-type: none"> — Assembly — Seals or piston damaged. 	<ul style="list-style-type: none"> — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required.
Direct Clutch Assembly <p>NOTE: Only if 3rd gear also is inoperative.</p> <ul style="list-style-type: none"> — Assembly — Seals or piston damaged. — Clutch plates burnt, missing. — Check ball damaged, missing. — Center support damaged or holes blocked. — Center support hub damaged. 	<ul style="list-style-type: none"> — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.
Forward Planetary Assembly <ul style="list-style-type: none"> — Assembly damaged. 	<ul style="list-style-type: none"> — Determine source of damage. Service as required.
Reverse Clutch Assembly <ul style="list-style-type: none"> — Assembly — Seals or piston damaged. — Piston bore damaged. — Friction elements damaged, worn; missing plates. — Feed hole damaged, plugged, missing. 	<ul style="list-style-type: none"> — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.
Reverse Planetary Assembly <ul style="list-style-type: none"> — Assembly damaged. 	<ul style="list-style-type: none"> — Determine source of damage. Service as required.
Reverse Ring Gear <ul style="list-style-type: none"> — Gears/lugs to reverse carrier damaged. 	<ul style="list-style-type: none"> — Determine source of damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)**HARSH REVERSE ENGAGEMENT — ONLY**

#203	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (TP, VSS, RPM, EPC)		— Run On-Board Diagnostics. Refer to PC/ED manual for diagnosis. Perform Engagement Test, EPC Test and Pinpoint Test "E" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test, rerun On-Board Diagnostics.
#303	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Improper Pressures — high line pressure. Main Controls — bolts not torqued to specification. — gasket damaged. — EPC solenoid stuck or damaged. — direct clutch accumulator valve and plunger, engagement control valve, direct clutch accumulator regulator valve, springs - stuck, misassembled, contaminated, damaged. Direct Clutch Assembly — assembly. — seals damaged, missing. — center support hub/seal ring damaged. — holes blocked/missing. — check ball damaged. — friction elements damaged or missing.		— Check pressure at Line pressure tap. Refer to Pressure Chart #401 for specification. If high, check the following possible components: main controls, pump inlet filter and seal assembly. — Retorque bolts to specification. — Inspect for damage and replace. — Perform EPC Tests Outlined in routine #203. Service as required. — Inspect for damage, contamination. Service as required. — Air check clutch assembly as outlined in the service manual. — Inspect for direct clutch assembly for damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)**HARSH FORWARD ENGAGEMENT — ONLY**

#204	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (TP, RPM, VSS, EPC)	— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Engagement Test, EPC Test and Pinpoint Tests "D and E" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test, rerun Self-Test.
#304	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Improper Pressures — high line pressure. Main Controls — bolts not torqued to specification. — gaskets damaged. — EPC solenoid stuck or damaged. — CB13 check ball missing, plate seat damaged. — engagement control valve, springs — damaged, stuck, misassembled, contaminated. Pump Assembly — bolts not torqued to specification. — gaskets damaged. — main regulator/booster valve stuck, damaged, misassembled. Forward Clutch Assembly — assembly. — plates burnt, missing; check ball missing, damaged; hub damaged.	— Check pressure at Line pressure tap. Refer to Pressure Chart #401 for specification. If pressures are high, check main controls. — Retorque bolts to specification. — Inspect for damage and replace. — Perform EPC Tests outlined in routine #204. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Air check clutch assembly as outlined in the Service Manual. — Inspect for damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)

DELAYED/SOFT REVERSE ENGAGEMENT — ONLY

#205	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	No Electrical Concerns	
#305	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged. — direct clutch accumulator regulator valve, low reverse modulator valve, springs — stuck, damaged, missing, misassembled. — reinforcing plate improperly installed, bolts not torqued to specification. Coast Clutch Assembly Damaged — assembly. — seals damaged, missing. Direct Clutch Assembly — assembly. — seals damaged, missing. — center support hub/seal ring damaged. — holes blocked/missing. — check ball damaged. — friction elements damaged or missing. Reverse Clutch Assembly — assembly. — seals, piston damaged. — check ball missing, damaged. — friction elements — damaged, worn. — assembly leakage.	— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Inspect for proper installation. Retorque bolts to specification. — Inspect for damage. Service as required. — Air check clutch assembly as outlined in the Service Manual. — Inspect for damage. Service as required. — Air check clutch assembly as outlined in the Service Manual. — Inspect direct clutch assembly for damage. Service as required. — Inspect for damage. Service as required. — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Identify source of leakage. Service as required.

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DIAGNOSIS AND TESTING (Continued)**DELAYED/SOFT FORWARD ENGAGEMENT — ONLY**

#206	ELECTRICAL ROUTINE	
ELECTRICAL COMPONENT		REFERENCE/ACTION
No Electrical Concerns		
#306	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Fluid — improper level. — condition.		— Adjust fluid to proper level. — Inspect according to Service Manual instructions under Fluid Condition Check.
Shift Linkage or Cable — damaged, misadjusted.		— Inspect and service as required. Adjust linkage as outlined in service manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual.
Improper Pressures — low line pressure.		— Check pressure at Line tap. Refer to Pressure Chart #401 for specification. If pressures are low, check the following possible components: pump inlet filter and seal assembly, main controls, pump assembly.
Pump Inlet Filter and Seal Assembly — plugged, damaged. — filter seal damaged.		— Inspect filter and seal assembly for damage. Service as required.
Main Controls — bolt not torqued to specification. — gaskets damaged.		— Retorque bolts to specification. — Inspect for damage and replace.
Center Support Assembly — feedbolts missing, improperly torqued. — hub damaged, holes blocked or missing.		— Install feedbolts and torque to specification. — Inspect for damage. Service as required.
Forward Clutch Assembly — assembly. — seals or piston damaged. — check balls damaged, missing.		— Air check clutch assembly as outlined in the Service Manual. — Inspect seals for damage. Service as required.
— clutch hub damaged. — friction elements damaged, missing.		— Inspect for mislocation, poor seating, damage. Replace cylinder as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)**NO FORWARD AND NO REVERSE ENGAGEMENTS**

#207	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
No Electrical Concerns		
#307	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
OD ENGAGED		
Fluid		
— improper level.		
— Adjust fluid to proper level. Inspect according to Service Manual instructions under Fluid Condition Check.		
Shift Linkage (internal/external) or Cable		
— damaged, misadjusted or disconnected.		
— Inspect for damage. Service as required. Adjust linkage as outlined in Service Manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual.		
Improper Pressures		
— low line pressures.		
— Check pressure at Line tap. Refer to Pressure Chart #401 for specification. If pressures are low, check the following possible components: pump inlet filter and seal assembly, main controls, pump assembly, forward clutch assembly.		
Pump Inlet Filter and Seal Assembly		
— plugged, damaged.		
— filter seal damaged or cut.		
— Inspect filter and seal assembly for damage. Service as required.		
Main Controls		
— manual valve — stuck, damaged.		
— control body housing leakage.		
— bolts not torqued to specification.		
— gaskets damaged.		
— Inspect for damage. Service as required.		
— Retorque bolts to specification.		
— Inspect for damage and replace.		
Pump Assembly		
— bolts not torqued to specification.		
— gaskets damaged.		
— main regulator/booster valve damaged, missing, misassembled.		
— excessive pump gear end clearance.		
— Retorque bolts to specification.		
— Inspect for damage and replace.		
— Inspect for damage. Service as required.		
— Perform pump gear end clearance check as outlined in the Service Manual.		
Center Support Assembly		
— damaged, holes blocked or feedbolts missing or improperly torqued.		
— Inspect for damage. Service as required.		
— Retorque bolts to specification.		
Forward/Reverse Sun Gear		
— damaged.		
— Inspect for damage. Service as required.		
Forward Planet Assembly		
— damaged.		
— Inspect for damage. Service as required.		
Input Shaft/Center Shaft/Output Shaft		
— splines damaged.		
— Inspect for damage. Service as required.		
Overdrive Carrier		
— damaged.		
— Inspect for damage. Service as required.		
Drive in OD with OD cancelled.		
Note: For Diagnostic purposes only.		
Not for extended driving.		
Overdrive OWC		
— misassembled, damaged.		
— Inspect for damage. Service as required.		
— sprags or races damaged.		
— Inspect for damage. Service as required.		

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DIAGNOSIS AND TESTING (Continued)**HARSH FORWARD AND REVERSE ENGAGEMENTS**

#208	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (EPC, TP)		— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Engagement Test, EPC Test and Pinpoint Test "E" using the Transmission Tester (007-00085). Service as required. Clear codes, road test and rerun Self-Test.
#308	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Improper Pressures — high line pressure. Main Controls — bolts not torqued to specification. — gasket damaged. — EPC solenoid stuck or damaged. — engagement control valve stuck, damaged, contaminated, misassembled. Pump Assembly — bolts not torqued to specification. — gaskets damaged. — main regulator/booster valve stuck, damaged, misassembled.		— Check pressure at Line pressure taps. Refer to Pressure Chart #401 for specification. If high, check main controls. — Retorque bolts to specification. — Inspect for damage and replace. — Perform EPC Tests in routine #208. Service as required. — Inspect for damage, contamination. Service as required. — Retorqued bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required.

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DELAYED/SOFT FORWARD AND REVERSE ENGAGEMENTS

#209	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
No Electrical Concerns		
#309	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Fluid — improper level. Improper pressures — low line pressure. Pump Inlet Filter and Seal Assembly — plugged, damaged. — seal damaged, cut. Main Controls — bolts not torqued to specification. — gaskets damaged. — springs - stuck, damaged, missing, misassembled. ***Initial Engagement *** Torque Converter Drain Back		— Adjust to proper level. Inspect per Service Manual instructions under Fluid Condition. — Check pressure at Line tap. Refer to Pressure Chart #401 for specification. If low check the following components: pump inlet filter/seal assembly, main control, pump assembly. — Inspect filter and seal assembly for damage. Service as required. — Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Refer to Converter Diagnosis Section in this manual for diagnosis.

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: SOME OR ALL SHIFTS MISSING

#210	ELECTRICAL ROUTINE															
POSSIBLE COMPONENT		REFERENCE/ACTION														
Powertrain Control System — electrical inputs/outputs, vehicle wiring harness, Powertrain Control Module (PCM). (TP, RPM, MLP, VSS, SS1/SS2)		— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests "A and D" using the Transmission Tester (007-00085) and the MLP Tester (D89T-70010-A) as outlined in the manual. Service as required. Clear code, road test, rerun Self-Test.														
#310	HYDRAULIC/MECHANICAL ROUTINE															
POSSIBLE COMPONENT		REFERENCE/ACTION														
Fluid — improper level. Shift Linkage (internal/external) or Cable. — damaged, misadjusted, disconnected. Pump Inlet Filter/Seal Assembly — plugged, damaged. — filter seal damaged. Main Controls — valves stuck, damaged, misassembled. For diagnosis related to a specific shift see Reference/Action.		— Adjust fluid to proper level. Inspect according to Service Manual instructions under Fluid Condition Check. — Inspect and service as required. Adjust linkage as outlined in Service Manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual. — Inspect filter and seal assembly for damage. Service as required. — Inspect for damage. Service as required. — To diagnose specific No shift refer to the Appropriate Shift Routine: <table><tr><th>No Shift</th><th>Routine</th></tr><tr><td>1-2</td><td>220/320</td></tr><tr><td>2-3</td><td>221/321</td></tr><tr><td>3-4</td><td>222/322</td></tr><tr><td>4-3</td><td>223/323</td></tr><tr><td>3-2</td><td>224/324</td></tr><tr><td>2-1</td><td>225/325</td></tr></table>	No Shift	Routine	1-2	220/320	2-3	221/321	3-4	222/322	4-3	223/323	3-2	224/324	2-1	225/325
No Shift	Routine															
1-2	220/320															
2-3	221/321															
3-4	222/322															
4-3	223/323															
3-2	224/324															
2-1	225/325															

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: TIMING — EARLY/LATE (SOME/ALL)

#211	ELECTRICAL ROUTINE											
POSSIBLE COMPONENT		REFERENCE/ACTION										
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM) (TP, TOT, EPC, VSS, SS1/SS2, RPM) Other Electrical Concerns — no power to PCM, Keep Alive Memory erased from PCM. — Programmable Speedometer/Odometer Module (PSOM) improperly programmed or damaged.		— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests "A, B and E" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun Self-Test. — Restore memory by performing Drive Cycle Test. — Refer to Service Manual for PSOM diagnostic and programming procedures.										
#311	HYDRAULIC/MECHANICAL ROUTINE											
POSSIBLE COMPONENT		REFERENCE/ACTION										
Other — tire size change. — axle ratio change. Power Engine Performance Main Controls — EPC solenoid stuck or damaged hydraulically or mechanically. — valves, accumulators, seals — stuck or damaged. — gaskets damaged. — bolts not torqued to specification. For diagnosis related to a specific shift or if all above are OK see Reference/Action.		— Refer to the specification decal on door panel and verify that vehicle has original equipment. Changes in tire size or axle ratio may affect shift timing. — Refer to Routine #253/353. — Inspect for damage, contamination. Refer to Electrical Routine #211. Service as required. — Inspect for damage, contamination. Service as required. — Inspect for damage and replace. — Retorque bolts to specification. — To diagnose specific shift — timing concern refer to Soft/Slipping routines: <table><tr><td>Soft/Slipping Shift</td><td>Routine</td></tr><tr><td>1-2</td><td>226/326</td></tr><tr><td>2-3</td><td>227/327</td></tr><tr><td>3-4</td><td>228/328</td></tr><tr><td>Downshifts</td><td>229/329</td></tr></table>	Soft/Slipping Shift	Routine	1-2	226/326	2-3	227/327	3-4	228/328	Downshifts	229/329
Soft/Slipping Shift	Routine											
1-2	226/326											
2-3	227/327											
3-4	228/328											
Downshifts	229/329											

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: TIMING — ERRATIC/HUNTING (SOME/ALL)

#212	ELECTRICAL ROUTINE																														
POSSIBLE COMPONENT		REFERENCE/ACTION																													
<p>Powertrain Control System</p> <ul style="list-style-type: none">— vehicle wiring harnesses, Powertrain Control Module (PCM), electrical inputs/outputs <p>(TP, RPM, EPC, TOT, SS1/SS2, MLP, TCC)</p> <p>With Speed Control "ON"</p> <ul style="list-style-type: none">— torque converter cycling— shift cycling (3-4/4-3 shifts)		<ul style="list-style-type: none">— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests "A, B, C, D, E" using the Transmission Tester (007-00085) and the MLP tester (D89T-70010-A) as outlined in this manual. Service as required. Clear codes, road test and rerun Self-Test.— Re-evaluate with Speed Control "OFF" or depress Transmission Control Switch (overdrive cancelled). If condition still exists proceed with diagnosis.																													
#312	HYDRAULIC/MECHANICAL ROUTINE																														
POSSIBLE COMPONENT		REFERENCE/ACTION																													
<p>Fluid</p> <ul style="list-style-type: none">— improper level. <p>Pump Inlet Filter and Seal Assembly</p> <ul style="list-style-type: none">— plugged, damaged.— filter seal damaged. <p>Main Control</p> <ul style="list-style-type: none">— valves, accumulators, seals, damaged, stuck.— bolts not torqued to specification.— gaskets damaged.— wrong parts used in rebuild. <p>Torque Converter Clutch</p> <p>For further diagnosis for timing issues refer to Reference/Action.</p>		<ul style="list-style-type: none">— Adjust fluid to proper level.— Inspect according to Service Manual instructions under Fluid Condition Check.— Inspect filter and seal assembly for damage. Service as required.— Inspect for damage. Service as required.— Retorque bolts to specification.— Inspect for damage and replace.— Verify that proper parts were used.— Refer to converter cycling (#342).— For specific shift diagnosis refer to the following chart: <table><tr><th>Shifts</th><th>No</th><th>Soft/Slip</th><th>Harsh</th></tr><tr><td>1-2</td><td>220/320</td><td>226/326</td><td>232/332</td></tr><tr><td>2-3</td><td>221/321</td><td>227/327</td><td>233/333</td></tr><tr><td>3-4</td><td>222/322</td><td>228/328</td><td>234/334</td></tr><tr><td>4-3</td><td>223/323</td><td>229/329</td><td>235/335</td></tr><tr><td>3-2</td><td>224/324</td><td>229/329</td><td>236/336</td></tr><tr><td>2-1</td><td>225/325</td><td>223/329</td><td>237/337</td></tr></table>		Shifts	No	Soft/Slip	Harsh	1-2	220/320	226/326	232/332	2-3	221/321	227/327	233/333	3-4	222/322	228/328	234/334	4-3	223/323	229/329	235/335	3-2	224/324	229/329	236/336	2-1	225/325	223/329	237/337
Shifts	No	Soft/Slip	Harsh																												
1-2	220/320	226/326	232/332																												
2-3	221/321	227/327	233/333																												
3-4	222/322	228/328	234/334																												
4-3	223/323	229/329	235/335																												
3-2	224/324	229/329	236/336																												
2-1	225/325	223/329	237/337																												

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: FEEL — SOFT/SIPPING (SOME/ALL)

#213	ELECTRICAL ROUTINE											
POSSIBLE COMPONENT		REFERENCE/ACTION										
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM) (TP, RPM, EPC, TOT)		— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests "E and B" using the Transmission Tester (007-00085) as outlined in the manual. Service as required. Clear codes, road test, rerun Self-Test.										
#313	HYDRAULIC/MECHANICAL ROUTINE											
POSSIBLE COMPONENT		REFERENCE/ACTION										
Fluid — improper level — condition Improper Pressures — low line pressure Main Controls — bolts not torqued to specification. — gaskets damaged. — line modulator valve springs damaged, stuck, misassembled. — EPC solenoid malfunction. — accumulator assembly damaged or wrong assembly. Pump Assembly — bolts not torqued to specification. — gaskets damaged. — main regulator/booster valve damaged, misassembled. — EPC air bleed check valve damaged or missing. For diagnostics related to specific shifts see Reference/Action.		— Adjust fluid to proper level. — Inspect according to Service Manual instructions under Fluid Condition Check. — Check pressures at Line pressure tap. Refer to Pressure Chart #401 for specifications. If pressures are low or all shifts are soft/slipping, go to main control. — Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage, contamination. Service as required. — Refer to electrical routine #213. — Inspect for damage. Service as required. Verify correct assembly is used. — Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — For specific Soft/Slipping shifts refer to the following application chart: <table><tr><th>Soft/Slipping Shift</th><th>Routine</th></tr><tr><td>1-2</td><td>226/326</td></tr><tr><td>2-3</td><td>227/327</td></tr><tr><td>3-4</td><td>228/328</td></tr><tr><td>Downshifts</td><td>229/329</td></tr></table>	Soft/Slipping Shift	Routine	1-2	226/326	2-3	227/327	3-4	228/328	Downshifts	229/329
Soft/Slipping Shift	Routine											
1-2	226/326											
2-3	227/327											
3-4	228/328											
Downshifts	229/329											

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: FEEL — HARSH (SOME/ALL)

#214	ELECTRICAL ROUTINE															
POSSIBLE COMPONENT		REFERENCE/ACTION														
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (EPC, TOT, TP, RPM, MLP) Engine Performance Issues		— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests "B, D and E" using the Transmission Tester (007-00085) and the MLP tester (D89T-70010-A) as outlined in this manual. Service as required. Clear codes, road test and rerun Self-Test. — Refer to Engine Service Manual and PC/ED Manual for diagnosis.														
#314	HYDRAULIC/MECHANICAL ROUTINE															
POSSIBLE COMPONENT		REFERENCE/ACTION														
Fluid — improper level. — condition. Improper Pressures — high line pressure. Main Controls — bolts not torqued to specification. — gaskets damaged. — line modulator valve/spring misassembled, stuck, damaged. — EPC solenoid malfunction. — accumulator assembly damaged or wrong assembly. Pump Assembly — bolts not torqued to specification. — gaskets damaged. — main regulator/booster valve damaged, misassembled. For diagnostics related to a specific shift see Reference/Action.		— Adjust fluid to proper level. — Inspect according to Service Manual instructions under Fluid Condition Check. — Check pressures at line pressure tap. Refer to Pressure Chart #401 for specifications. If pressures are high or all shifts are harsh, go to main control. — Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage, contamination. — Service as required. — Refer to electrical routine #214. — Inspect for damage. Service as required. Verify correct assembly is used. — Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. For diagnosis of a specific HARSH shift, refer to the following chart: <table><tr><th>HARSH Shift</th><th>Routine</th></tr><tr><td>1-2</td><td>232/332</td></tr><tr><td>2-3</td><td>233/333</td></tr><tr><td>3-4</td><td>234/334</td></tr><tr><td>4-3</td><td>235/335</td></tr><tr><td>3-2</td><td>236/336</td></tr><tr><td>2-1</td><td>237/337</td></tr></table>	HARSH Shift	Routine	1-2	232/332	2-3	233/333	3-4	234/334	4-3	235/335	3-2	236/336	2-1	237/337
HARSH Shift	Routine															
1-2	232/332															
2-3	233/333															
3-4	234/334															
4-3	235/335															
3-2	236/336															
2-1	237/337															

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: NO 1ST GEAR IN DRIVE, ENGAGES IN HIGHER GEAR

#215	ELECTRICAL ROUTINE									
POSSIBLE COMPONENT		REFERENCE/ACTION								
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (SS1/SS2, MLP)		— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests “A and D” using the Transmission Tester (007-00085) and the MLP Tester (D89T-70010-A) as outlined in this manual. Service as required. Clear codes, road test and rerun Self-Test.								
#315	HYDRAULIC/MECHANICAL ROUTINE									
POSSIBLE COMPONENT		REFERENCE/ACTION								
Shift Linkage (internal/external) or Cable/Sensor — damaged, not connected, misadjusted. Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — SS1, SS2 stuck or damaged. — solenoid regulator valve, 2-3 shift valve, 3-4 shift valve, D2 valve — stuck, missing, misassembled, damaged. — air bleeds for S1-S2 circuits missing. — wrong components used in rebuild. Mechanical — band servo, clutches damaged. For diagnosis related to a specific gear, use Transmission Tester to determine gear.		— Inspect and service as required. Adjust linkage as outlined in Service Manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual. — Retorque bolts to specification. — Inspect for damage and replace. — Refer to electrical routine #215. — Inspect for damage. Service as required. — Inspect for damage. Replace case. — Verify that proper components were used. Service as required. — Refer to Service Manual for proper disassembly procedures. — Refer to the following routines: <table><tr><td>Shift</td><td>Routine</td></tr><tr><td>1-2</td><td>220/320</td></tr><tr><td>2-3</td><td>221/321</td></tr><tr><td>3-4</td><td>222/322</td></tr></table>	Shift	Routine	1-2	220/320	2-3	221/321	3-4	222/322
Shift	Routine									
1-2	220/320									
2-3	221/321									
3-4	222/322									
Reverse Ring Gear — damaged gear lugs to reverse carrier. Low/Reaction One-Way Clutch — damaged, misassembled.		— Inspect for damage. Service as required. — Inspect for damage, proper assembly. Service as required.								

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: NO 1ST GEAR IN MANUAL 1

#216	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (SS1/SS2, MLP)		— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests "A and D" using the Transmission Tester (007-00085) and the MLP Tester (D89T-70010-A) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#316	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Shift Linkage (internal/external) or Cable, MLP sensor — damaged, misadjusted, not connected. Main Controls — bolts not torqued to specification. — gaskets damaged. — manual lever, manual valve, main regulator valve, low reverse modulator valve, 1-2 shift valve, 2-3 shift valve, BS1 check ball, 4-3-2 timing valve - stuck, damaged. — SS1 malfunction. — air bleed for SS1 circuit damaged or missing. — wrong parts used in rebuild. Low/Reaction OWC Assembly — damaged, misassembled.		— Inspect for damage. Service as required. Adjust linkage as outlined in Service Manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual. — Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as Required. — Refer to electrical routine #216. — Inspect for damage. Replace case. — Verify that proper parts were used. — Inspect for damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)**SHIFT CONCERNS: NO SECOND GEAR IN MANUAL 2.**

#217	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (SS1/SS2, MLP)		— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests "A and D" using the Transmission Tester (007-00085) and the MLP Tester (D89T-70010-A) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#317	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Shift Linkage (internal/external) or Cable. — damaged, misadjusted.		— Inspect for damage. Service as required. Adjust linkage/cable as outlined in Service Manual. After servicing linkage/cable, verify that the MLP sensor is properly adjusted. Refer Disassembly/Assembly procedures in Service Manual.
Main Controls — bolts not torqued to specification. — gaskets damaged. — 2-3 shift valve, 3-4 shift valve, manual 1-2 transition valve, spring - stuck, damaged, missing, misassembled. — VS1, BS2, BS6 - missing, leaks or seats damaged. — improper parts used in rebuild.		— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required.
Intermediate Clutch Assembly — assembly. — seals or piston damaged. — friction elements worn, missing, damaged, misassembled. — ball check stuck/missing. — feedbolt torque incorrect, leaks, missing. — cylinder assembly O.D./case bore damaged, leaking.		— Inspect for damage. Service as required. — Verify that proper part were used.
Intermediate OWC Assembly — case/sprags damaged, improperly assembled on inner race.		— Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect and retorque bolts as required. — Inspect for damage. Service as required.
		— Inspect for damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: NO 1-2 SHIFT (AUTOMATIC)

#220	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (TP, VSS, SS1/SS2)	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Test "A" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#320	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Shift Linkage (internal/external) or Cable — damage, misadjusted. — MLP damaged, misadjusted. Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — SS2 malfunction. — D2 valve, 1-2 shift valve, 1-2 manual transition valve, intermediate clutch accumulator regulator valve or plunger, springs - stuck, damaged, missing or misassembled. — air bleed for SS2 circuit damaged or missing. — wrong parts used in rebuild. Intermediate Clutch Assembly — assembly. — seals or piston damaged. — friction elements worn, missing, damaged, misassembled. — ball check stuck/missing. — feedbolt torque incorrect, leaks, missing. — cylinder assembly O.D./case bore damaged, leaking. Intermediate OWC Assembly — cage/sprags damaged, improperly assembled on inner race. — improper components used in rebuild.	— Inspect for damage. Service as required. Adjust linkage as outlined in Service Manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual. — Retorque bolts to specification. — Inspect for damage and replace. — Refer to electrical routine #220. — Inspect for damage. Service as required. — Inspect for damage. Replace case. — Verify that proper parts were used. — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect and retorque bolts as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Verify that proper components are used.

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: NO 2-3 SHIFT (AUTOMATIC)

#221	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harness, Powertrain Control Module (PCM). (TP, VSS, SS1/SS2)		— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Test "A" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#321	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Main Controls — bolts not torqued to specification. — gaskets damaged. — SS1 malfunction. — direct clutch accumulator regulator valve, 2-3 shift valve, springs - stuck, missing, damaged, misassembled. — air bleed for SS2 circuit damaged or missing. — improper components used in rebuild. Center Support Assembly — feedbolts missing, not torqued to specification. — seal rings damaged. — assembly damaged. — outside diameter or case bore damaged or leaking. Direct Clutch Assembly — assembly. — seals, piston, cylinder damaged. — friction elements missing or damaged. — ball check missing, damaged, missing.		— Retorque bolts to specification. — Inspect for damage and replace. — Refer to electrical routine #221. — Inspect for damage. Service as required. — Inspect for damage. Replace case. — Verify that proper components are used. — Inspect, install and retorque to specification. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as Required. — Inspect for damage. Service as Required. — Inspect for damage. Service as Required.

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: NO 3-4 SHIFT (AUTOMATIC)

#222	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (TP, VSS, SS1/SS2)	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Test "A" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#322	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged or misaligned. — SS1/SS2 malfunction. — overdrive accumulator regulator valve and spring, 3-4 shift valve and spring - damaged, stuck, misassembled, missing. — improper components used in rebuild.	— Retorque bolts to specification. — Inspect for damage and replace. — Refer to electrical routine #222. — Inspect for damage. Service as required. — Verify that proper components were used in the rebuild.
	Overdrive Clutch Assembly — assembly. — clutch plates burnt, missing. — cylinder damaged, feedbolts loose, missing, leaking, seals damaged. — cylinder check ball missing.	— Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.
	Overdrive OWC Assembly — damaged.	— Inspect for damage. Service as required.

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SHIFT CONCERNS: NO 4-3 SHIFT (AUTOMATIC)

#223	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (TP, VSS, SS2)	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Test "A" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#323	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — SS2 malfunction. — BS2, 3-4 shift valve damaged, missing, misassembled, stuck.	— Retorque bolts to specification. — Inspect for damage and replace. — Refer to electrical routine #223. — Inspect for damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: NO 3-2 SHIFT (AUTOMATIC)

#224	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (TP, VSS, SS1)	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests "A and D" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#324	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — SS1 malfunction. — 2-3 shift valve, stuck, damaged.	— Retorque bolts to specification. — Inspect for damage and replace. — Refer to electrical routine #224. — Inspect for damage. Service as required.

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SHIFT CONCERNS: NO 2-1 SHIFT (AUTOMATIC)

#225	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (TP, VSS, SS2)	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Test "A" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#325	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets, separator plate damaged, misaligned. — SS2 malfunction. — D2 shift valve damaged, stuck.	— Retorque bolts to specification. — Inspect for damage and replace. — Refer to electrical routine #225. — Inspect for damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: SOFT/SLIPPING 1-2 ONLY (AUTOMATIC)

#226	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).	— Run Self-Test. Refer to PC/ED Manual for diagnosis. Service as required.
#326	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — intermediate clutch accumulator regulator valve or plunger, springs - stuck, damaged, missing or misassembled. — wrong parts used in rebuild. Intermediate Clutch Assembly — assembly. — seals or piston damaged. — friction elements worn, missing, misassembled or damaged. — feedbolt torque incorrect, missing. — ball check missing, not seating. — cylinder assembly O.D./case bore damaged.	— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Verify that correct parts were used. — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect and retorque bolts to specification. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

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SHIFT CONCERNS: SOFT/SLIPPING 2-3 SHIFT ONLY (AUTOMATIC)

#227	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Service as required.
#327	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged. — direct clutch accumulator regulator valve, plungers, springs - stuck, missing, damaged, misassembled. — improper parts used in rebuild. Center Support Assembly — feedback missing, not torqued to specification. — seal rings damaged. — assembly damaged. — outside diameter or case bore damaged or leaking.	— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Verify that correct parts were used. — Inspect, install and retorque to specification. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.
	Direct Clutch Assembly — assembly. — seals, piston, cylinder damaged. — friction elements burnt, missing. — improper quantity of plates installed. — ball check missing, not seating. — brake drum I.D. damaged.	— Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for proper quantity. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

CD11881-A

DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: SOFT/SLIPPING 3-4 ONLY (AUTOMATIC)

#228	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Service as required.
#328	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged or misaligned. — overdrive accumulator regulator valve and spring, overdrive accumulator plunger and springs, damaged, misassembled, stuck, missing. — Improper parts used in rebuild.	— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Verify that correct parts were used.
	Overdrive Clutch Assembly — assembly. — friction elements burnt, missing. — cylinder damaged, feedbolts loose, missing, leaking, not torqued to specification, seals damaged. — cylinder check ball not seating, missing.	— Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. Retorque feedbolts to specification. — Inspect for damage. Service as required.

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SHIFT CONCERNS: SOFT/SLIPPING DOWNSHIFTS (AUTOMATIC)

#229	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Service as required.
#329	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — CB7 check ball missing, wrong. — separator plate damaged. — improper parts used in rebuild.	— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Verify that correct parts were used.

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: HARSH 1-2 ONLY (AUTOMATIC)

#232	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Service as required.
#332	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — intermediate clutch accumulator regulator valve or plunger springs - stuck, damaged, missing or misassembled. — wrong parts used in rebuild. Intermediate Clutch Assembly — assembly. — seals or piston damaged. — friction elements missing or misassembled, damaged or improper quantity of plates installed. — ball check missing.	— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Verify that proper parts were used. — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

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SHIFT CONCERNS: HARSH 2-3 SHIFT ONLY (AUTOMATIC)

#233	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Service as required.
#333	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged. — direct clutch accumulator regulator valve, line modulator valve, plungers, springs - stuck, missing, damaged, misassembled. — wrong parts used in rebuild. Center Support Assembly — seal rings damaged. — outside diameter or case bore damaged or leaking. Direct Clutch Assembly — assembly. — seals, piston or cylinder damaged. — friction elements damaged, missing or improper quantity of plates were installed. — ball check missing, not seating. — intermediate brake drum I.D. damaged or worn.	— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Verify that proper parts were used. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: HARSH 3-4 ONLY (AUTOMATIC)

#234	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).		— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Service as required.
#334	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Main Controls — bolts not torqued to specification. — gaskets damaged or misaligned. — overdrive accumulator regulator valve and spring, overdrive accumulator plunger and springs, stuck, damaged, misassembled, missing. — improper parts used in rebuild.		— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required.
Overdrive Clutch Assembly — assembly. — friction elements burnt, missing. — cylinder damaged, feedbolts loose, missing, leaking, seals damaged, retaining ring not seated. — cylinder check ball missing or not seating.		— Verify that proper parts were used. — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

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SHIFT CONCERNS: HARSH 4-3 ONLY (AUTOMATIC)

#235	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).		— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Service as required.
#335	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — CB7 check ball missing. — separator plate damaged.		— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

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DIAGNOSIS AND TESTING (Continued)

SHIFT CONCERNS: HARSH 3-2 ONLY (AUTOMATIC)

#236	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Service as required.
#336	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — CB6 check ball missing. — separator plate damaged.	— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

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SHIFT CONCERNS: HARSH 2-1 SHIFT ONLY (AUTOMATIC)

#237	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM).	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Service as required.
#337	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Main Controls — bolts not torqued to specification. — gaskets damaged, misaligned. — CB14 check ball missing. — separator plate damaged.	— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

CD11889-A

DIAGNOSIS AND TESTING (Continued)**TORQUE CONVERTER CLUTCH CONCERN: DOES NOT APPLY**

#240	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (TCC, BOO, ECT, TP, RPM, TOT)		— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Torque Converter Engagement Test and Pinpoint Tests "B and C" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#340	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Main Controls — bolts not torqued to specification. — TCC solenoid or TOT malfunction. — gaskets damaged.		— Retorque bolts to specification. — Refer to electrical routine #240. — Inspect gasket for damage and replace.
Pump Assembly — bolts not torqued to specification. — cross leaks, cup plugs missing. — gaskets damaged. — converter clutch control valve and regulator valve - stuck, misassembled, damaged..		— Retorque bolts to specification. — Inspect for porosity/leaks, cup plugs missing, replace pump as required. — Inspect and replace gaskets. — Inspect for damage. Replace pump.
Stator Support — Teflon® seal - damaged, leaking.		— Inspect for damage. Service as required.
Torque Converter Assembly — leakage, friction material damaged, internal seals damaged.		— Inspect according to Service Manual Procedures. Service as required.

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DIAGNOSIS AND TESTING (Continued)

TORQUE CONVERTER CLUTCH CONCERN: ALWAYS APPLIED/STALLS VEHICLE (SEE NOTE IN #241 BEFORE PROCEEDING)

#241	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
NOTE: Stalls in Drive and Manual 2 ONLY (Manual 1 and Reverse are OK) Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (ECT, BOO, TCC)		— Go to Hydraulic Mechanical #341. — Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Torque Converter Engagement Test and Pinpoint Test "C" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#341	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Improper Pressures — low line pressure. Main Controls — bolts not torqued to specification. — TCC solenoid malfunction. — gaskets damaged. Pump Assembly — bolts not torqued to specification. — converter clutch control valve misassembled, stuck, damaged. — porosity/cross leaks. — gaskets damaged. — excessive pump gear end clearance. Stator Support — Teflon® seal on nose of stator damaged, cut, leaking. Torque Converter Assembly — end clearance (NONE). — piston plate damaged/stuck to cover.		— Check line pressure at Line tap. Refer to Pressure Chart #401 for specification. — Retorque bolts to specification. — Refer to Electrical routine #341. — Inspect for damage and replace. — Retorque bolts to specification. — Inspect for damage. Service as required. — Inspect for porosity/leaks, valve damaged, replace pump as required. — Inspect for damage and replace. — Perform pump gear end clearance check as outlined in the Service Manual. — Inspect for damage. Service as required. — Perform end clearance check as outlined in the Service Manual. — Inspect for damage. Service as required. — Inspect transmission cooling system for proper lube flow. Follow the procedures in the Service Manual.

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DIAGNOSIS AND TESTING (Continued)

TORQUE CONVERTER CLUTCH CONCERN: CYCLING/SHUDDER/CHATTER

#242	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle harnesses, Powertrain Control Module (PCM). (TCC, MLP, BOO, TP, RPM) Speed Control Equipped Vehicles		— Run Self-Test. — Refer to PC/ED Manual for diagnosis. Perform Torque Converter Engagement Test and Pinpoint Tests "C and D" using the Transmission Tester (007-00085) or MLP tester (D89T-70010-A) as outlined in this manual. Clear codes, road test and rerun Self-Test. NOTE: Refer to Routines #212 before you proceed to #342.
#342	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Fluid Condition Main Controls — bolts not torqued to specification. — TCC Solenoid malfunction. — gaskets damaged. Pump Assembly — bolts not torqued to specification. — cross leaks. — gaskets damaged. — converter clutch regulator valve damaged. Stator Support — Teflon® seal on nose of stator damaged, cut, leaking. Torque Converter Assembly — end clearance (excessive), internal leakage.		— Inspect fluid condition. If burnt or contaminated drain fluid from the transmission assembly and converter assembly. Check control attaching bolts for proper torque. Retorque as required. Record and erase Self-Test codes. Bring vehicle to normal operating temperature. Perform Drive Cycle as outlined in Service Manual. Perform Self-Test. If condition still exists, continue diagnosis. — Retorque bolts to specification. — Refer to electrical Routine #242. — Inspect for damage and replace. — Retorque bolts to specification. — Inspect for porosity/leaks, valve damage; replace pump as required. — Inspect for damage and replace. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect per service manual procedures. Service as required.

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OTHER: SHIFT LEVER EFFORTS HIGH

#251	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
No Electrical		
#351	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Shift Linkage (internal/external) or Cable. — damaged, misadjusted. Manual Lever — retaining pin damaged, nut loose (inner or outer), detent spring-bent/damaged, park mechanism damaged. Main Controls — manual valve sticking. — bolts not torqued to specification.		— Inspect and service as required. Adjust linkage as outlined in Service Manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual. — Inspect for damage. Service as required. Inspect locking nuts for proper torque, retorque to proper specification as required. — Inspect for damage. Service as required. — Retorque bolts to specification.

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DIAGNOSIS AND TESTING (Continued)

OTHER: EXTERNAL LEAKS

#252	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	No Electrical Concerns	
#352	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Engine Rear Seal	— Locate source and service as required.
	Seals/Gaskets	— Locate source and service as required.
	— torque converter assembly, pump, pan, trans connector, extension housing - gasket/seal manual lever, fluid level indicator, fill tube, pump bolts.	
	Other	— Locate source and service as required.
	— cooler fitting, pressure taps, converter drain plug, band anchor pins, cooler lines, case porosity, case cracked.	— Check vent for damage or blockage. Service as required.
	— vent blocked or damaged.	— Check level and adjust as required.
	— overfilled transmission.	— Check for contamination, locate source of contamination. Service as required.
	— fluid contaminated (anti-freeze, water).	— Refer to routines #257/357.
	— overheating.	— Locate source and service as required.
	— pump assembly.	

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OTHER: POOR VEHICLE PERFORMANCE

#253	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System	— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Tests B, C and D using the Transmission Tester (007-00085) and the MLP Tester (D89T-70010-A) as outlined in this manual. Service as required. Clear codes, road test and rerun Self-Test.
	— electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM), other Engine related items.	
	(TCC, TP, MLP, TOT)	
#353	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Shift Linkage (internal/external) or Cable	— Inspect for damage. Service as required. Adjust linkage as outlined in Service Manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual.
	— damaged, misadjusted.	
	Proper Shift Scheduling	— Go to the appropriate diagnostic routines for shift concerns #210-211.
	Engagements	— Go to the appropriate diagnostic routines for engagement concerns.
	Converter Clutch Always Applied	— Go to routine #341.
	Converter OWC Clutch	
	— damaged.	— Go to Torque Converter Diagnosis in the Service Manual.

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DIAGNOSIS AND TESTING (Continued)

OTHER: NOISE/VIBRATION — FORWARD/REVERSE

#254	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
No Electrical		
#354	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
For Noises/Vibrations that change with engine speed: — converter components. — fluid level (low) pump cavitation. — pump assembly. — engine drive accessories. — cooler lines grounding out. — flywheel. — fill tube grounding out.		— Locate source of disturbance. Service as required.
For Noise/Vibrations that change with vehicle speed: — engine mounts. • loose, damaged — driveline concerns. • u-joints • rear axle • suspension • modifications/misalignment — 1st gear. • OWC, gear set • friction elements — 2nd gear. • intermediate OWC • friction elements • torque converter assembly — 3rd gear. • OWC • torque converter assembly • friction elements — 4th gear. • OWC • gear set • friction elements • torque converter assembly — Reverse. • gear set • friction elements — Shaft spline fit. • slip yoke, park gear		— Locate source of disturbance. Service as required.

CD11896-A

DIAGNOSIS AND TESTING (Continued)

OTHER: ENGINE WILL NOT CRANK

#265	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (MLP)	— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Test "D" using the MLP Tester (D89T-70010-A) as outlined in this manual. Service as required. Clear codes, and rerun On-Board Diagnostics.
#355	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Shift Linkage (internal/external) or Cable/MLP Sensor — damaged, misadjusted.	— Inspect and service as required. Adjust linkage as outlined in Service Manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual.
	Pump Assembly — seized.	— Refer to the Disassembly section of the Service or Reference Manual. Inspect for damage. Service or replace as required.
	Flywheel — damaged.	— Inspect for damage. Service as required.

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OTHER: NO PARK RANGE

#266	ELECTRICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	No Electrical Concerns	
#356	HYDRAULIC/MECHANICAL ROUTINE	
	POSSIBLE COMPONENT	REFERENCE/ACTION
	Shift Linkage (internal/external) or Cable. — damaged, misadjusted.	— Inspect for damage. Service as required. Adjust linkage as outlined in Service Manual. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Disassembly/Assembly procedures in Service Manual.
	Park Mechanism — park gear, parking pawl, parking pawl return spring, park rod guide plate, parking pawl shaft, parking pawl actuating rod, manual lever, manual lever detent spring. — damaged, misassembled.	— Inspect for damage. Service as required.
	4x4 Applications — transfer case and linkages damaged.	— Refer to Service Manual for transfer case and linkage diagnosis.

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DIAGNOSIS AND TESTING (Continued)

OTHER: TRANSMISSION OVERHEATING

#257	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (TCC)		— Run On-Board Diagnostics. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Test "C" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun On-Board Diagnostics.
#357	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Excessive Vehicle or Towing Loads Severe Vehicle Usage Fluid — improper level. — condition, contamination. Transmission Cooling System — damaged, blocked, restricted, or improperly installed. Vehicle Concerns Causing Engine Overheating Torque Converter Clutch — not engaging.		— Refer to the Vehicle Specification Manual for load and GVW/GCW information. Refer to Owner's Manual. NOTE: If auxiliary cooler is desired use ONLY Ford Original Factory Equipment installed to factory specifications. — Adjust fluid to proper level. Inspect according to Service Manual instructions under Fluid Condition Check. — Inspect for damage, restrictions. Service as required. — Refer to Engine Condition and Cause charts in the Service Manual. — See Routine #240/340.

CD11899-A

OTHER: NO ENGINE BRAKING IN MANUAL 2 POSITION — ONLY

#258	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
No Electrical Concerns		
#358	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Main Controls — bolts not torqued to specification. — BS1, BS6, BS2, CB1 check balls missing, seat damaged. — separator plate damaged. — 4-3-2 timing valve, D2 valve, 2-3 shift valve, coast clutch shift valve, 1-2 manual transition valve, 3-4 shift valve damaged, stuck, misassembled. Coast Clutch Assembly — assembly. — seals or piston damaged. — stator support damaged or holes blocked, seal rings damaged. — cylinder hub damaged or holes blocked. — friction elements damaged, burnt. Intermediate Servo/Band Assembly — servo piston or bore damaged. — band or drum burnt, damaged.		— Retorque bolts to specification. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

CD11900-A

DIAGNOSIS AND TESTING (Continued)**OTHER: NO ENGINE BRAKING IN MANUAL 1 POSITION — ONLY**

#259	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
No Electrical Concerns		
#359	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Main Controls — bolts not torqued to specification. — gaskets damaged. — 3-4 shift valve, low reverse clutch modulator valve, D2 valve, 4-3-2 timing valve, 2-3 shift valve, coast clutch shift valve damaged, misassembled, stuck. — BS1, CB1 ball damaged, missing. — separator plate damaged.		— Retorque bolts to specification. — Inspect for damage and replace. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.
Coast Clutch Assembly — assembly. — seal or piston damaged. — stator support damaged or holes blocked, seal rings damaged. — cylinder hub damaged or holes blocked. — friction elements damaged, burnt.		— Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Service as required.
Low/Reverse Clutch Assembly — assembly. — seals or piston damaged. — friction elements damaged, worn. — sealing area in case damaged.		— Air check clutch assembly as outlined in the service manual. — Inspect for damage. Service as required. — Inspect for damage. Service as required. — Inspect for damage. Replace case.

CD11901-A

OTHER: NO ENGINE BRAKING WITH OVERDRIVE CANCELLED (MANUAL 1ST AND MANUAL 2ND HAVE ENGINE BRAKING)

#260	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Powertrain Control System — electrical inputs/outputs, vehicle wiring harnesses, Powertrain Control Module (PCM). (CCS)		— Run Self-Test. Refer to PC/ED Manual for diagnosis. Perform Service Manual Pinpoint Test "G" using the Transmission Tester (007-00085) as outlined in this manual. Service as required. Clear codes, road test and rerun Self-Test.
#360	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
Main Controls — bolts not torqued to specification. — gaskets damaged. — solenoid #4 (CCS) damaged, stuck. — BS2, BS3 check balls missing or separator plate seat damaged. — 3-4 shift valve stuck, damaged or misassembled.		— Retorque bolts to specification. — Inspect for damage and replace. — Refer to electrical routine #260. — Inspect for damage. Service as required. — Inspect for damage. Service as required.

CD11902-A

DIAGNOSIS AND TESTING (Continued)

OTHER: FLUID VENTING/FOAMING

#261	ELECTRICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
No Electrical Concerns		
#361	HYDRAULIC/MECHANICAL ROUTINE	
POSSIBLE COMPONENT		REFERENCE/ACTION
<ul style="list-style-type: none"> — vent blocked or damaged. — overfilled transmission. — fluid contaminated (anti-freeze, water). — overheating. — pump inlet filter and seal assembly damaged or misassembled. — pump to case gasket damaged, misaligned. 		<ul style="list-style-type: none"> — Check vent for damage or blockage. Service as required. — Check level and adjust as required. — Check for contamination, locate source of contamination. Service as required. — Refer to Routine #257/357. — Inspect filter and seal assembly for damage. Service as required. — Inspect for damage and replace.

CD11903-A

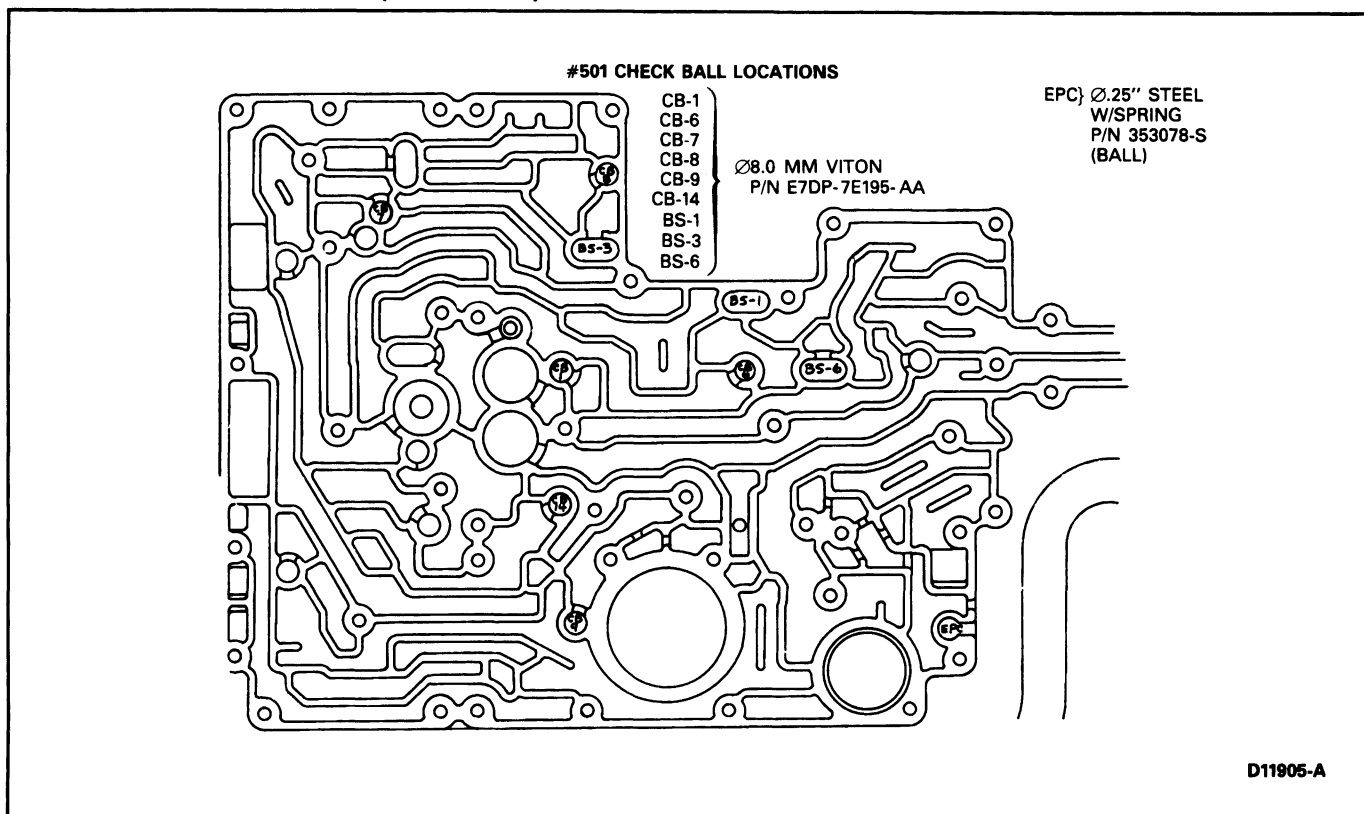
CAUTION: Transmission Tester **MUST BE REMOVED** from the transmission and the Vehicle Harness reinstalled to verify these pressures.

DIAGNOSTIC ROUTINE
#401 — Pressure Chart

LINE PRESSURE	IDLE		STALL	
GEAR	KPA	PSI	KPA	PSI
P	379-448	55-65	---	---
R	517-683	75-99	1655-1827	240-265
N	379-448	55-65	---	---
OD/D	379-448	55-65	1076-1200	156-174
2	379-448	55-65	1076-1200	156-174
1	517-683	75-99	1082-1282	157-186

CD11904-A

DIAGNOSIS AND TESTING (Continued)

**Quick Tests**

CAUTION: Prior to performing any Quick Tests, first perform the Preliminary Inspection and Verification of Condition as outlined in this section.

The Quick Tests are in the Powertrain Control / Emissions Diagnosis Manual.³ These tests can be used to diagnose the PCM, sensors and actuators of the E4OD transmission.

The following is a guide for using the Quick Tests, with some special considerations to remember.

Quick Test 1.0

Perform the Visual Check and Vehicle Preparation procedures as outlined in the Powertrain Control / Emissions Diagnosis Manual.³

Quick Test 2.0

Connect SUPER STAR II Tester 007-0041-A or equivalent to Data Link Connector.

The following are procedures to run the EEC-IV On-Board Diagnostics.

NOTE: The On-Board Diagnostics can be entered only once each time the key is turned on. To re-enter the On-Board Diagnostics, turn the key off and wait 10 seconds.

NOTE: Depending on the vehicle, On-Board Diagnostic Trouble Codes can either be displayed in a two digit or three digit format. On vehicles that display DTCs in the two digit format, either the STAR or SUPERSTAR II Tester may be used. However, on vehicles that display DTCs in the three digit format, the SUPERSTAR II Tester must be used on fast mode to properly display the DTCs.

All Tests

- Transmission in PARK
- Emergency brake set
- Electrical accessories OFF (lamps, A / C, defrost, etc.). If A / C is ON, Diagnostic Trouble Code 67, 539 will be set
- Engine at operating temperature

Quick Test 3.0 Key On, Engine Off (KOEO)

Some special considerations for Key On, Engine Off On-Board Diagnostics include the following:

- The KOEO test provides both "hard" diagnostic trouble codes (DTC) (present at the time of testing) and continuous memory codes.
- **Always service the "hard" DTCs first. These are displayed first on the tester.**
- On 7.3L diesel engines, the throttle pedal must be fully depressed (WOT) for the entire KOEO test. DO NOT depress the throttle pedal for gasoline engines.

³ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Performing KOEO On-Board Diagnostics**

1. Connect SUPER STAR II Tester.

NOTE: If SUPER STAR II Tester is unavailable, refer to the Powertrain Control/Emissions Diagnosis Manual⁴ for alternate methods to run the On-Board Diagnostics.

NOTE: For diesel engines, before activating the On-Board Diagnostic, the throttle must be depressed to WOT and held there for the entire KOEO On-Board Diagnostics.

2. Activate On-Board Diagnostic by pressing center button on SUPER STAR II Tester.
3. Turn ignition switch to ON position.
4. PCM will run On-Board Diagnostics and then output "hard" DTCs (or Code 11 or 111-pass test). "Hard" DTCs are repeated to make it easier to verify sequence. After "hard" DTCs have been repeated (or Code 11 or 111 repeated) a single pulse occurs to signal that next set of DTCs will be from continuous test (or Code 11 or 111-pass).
5. To display codes unlatch center button and use memory buttons to scroll through codes. (SUPER STAR II — Fast Mode Only).

Quick Test 4.0 Continuous Memory Codes

Continuous memory codes are from malfunctions which were detected during normal vehicle operation. These codes are retained for 40 warm up cycles.

After servicing any KOEO or KOER "hard" DTCs and a pass code 11 or 111 is received on both, service the continuous memory codes.

Some special considerations for continuous testing include the following:

- The cause of some continuous memory codes may have been eliminated if KOEO and/or KOER DTCs were serviced. Always re-test and service any DTCs that still remain.
- If DTCs are present, go to the EEC-IV On-Board Diagnostic Trouble Code Description Chart in this Section for service information. Erase DTC, perform drive cycle and repeat the Quick Test after completing service on the DTCs.
- If the continuous test passes (11 or 111) and a concern is still present, refer to the Hydraulic/Mechanical charts, Oasis and TSBs for concern diagnostics.

CAUTION: DTCs in continuous memory can be erased by disconnecting the battery or by ungrounding the Self Test Input (STI) while the codes are being displayed during the KOEO On-Board Diagnostics. The STI is ungrounded by disconnecting the small Data Link connector or unlatching the STAR Tester button. Always write down the DTCs to avoid losing information that can be used to diagnose the customer's concern.

- Service any non-transmission DTCs first as they can directly affect the operation of the transmission. Repeat the Quick Test and Road Test to verify the correction.

Special Test Modes

1. Wiggle test mode:
 - a. After all DTCs have been received the wiggle test may be entered by pressing the center button on STAR Tester twice. This will unlatch and relatch STI.
NOTE: The wiggle test may also be entered by "latching" STI; ON, OFF, ON.
 - b. The wiggle test allows the technician to attempt to re-create an intermittent malfunction. Tap, move and wiggle the suspected sensor and/or wire harness. When a malfunction is detected the Self Test Output (STO) will be turned on as long as the concern is present. STO ON will cause the STAR Tester to sound a continuous tone. The check engine lamp will also illuminate.
2. TP (FIPL) test mode:
 - a. Diesel engines also have a Transmission Control (IP-FNPL) test mode that may be entered by activating the gauge switch. This test is to check and adjust TP (FIPL) sensor gauge block setting by monitoring the Self-Test Output with VRV Gauge Block T83T-7B200-AH installed. For more information, refer to the procedures in this manual.
3. Output cycling test mode:
 - a. After all KOEO DTCs have been received, the output test mode may be entered. Actuator outputs will turn ON and OFF each time the throttle is depressed to WOT and then returned to closed position.

Quick Test 5.0 Key On Engine Running (KOER)

The Engine Running On-Board Diagnostic provides "hard" DTCs only.

Some special considerations for Engine Running On-Board Diagnostics include the following:

- After the engine ID code, push and release the brake pedal.
- Push and release the TCS.
- If a DTC appears after the KOER test, a malfunction is present. Refer to and look up the DTC on the On-Board Diagnostic Trouble Code Description Chart in this section for service information.

Performing KOER On-Board Diagnostics

NOTE: Engine must be warm or DTC 21 or 116 — ECT out of On-Board Diagnostic range will occur.

1. Connect SUPER STAR II Tester.
2. Start and run engine until engine reaches operating temperature.
3. Turn OFF engine and wait 10 seconds.

⁴ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

4. Activate On-Board Diagnostics (press center button on STAR Tester).
5. Start engine.
 - a. On-Board Diagnostics begin when the engine ID code is received. (This code consists of the number of cylinders divided by 2 plus an added zero).
 - b. Example: a four-cylinder would be divided by 2=2 plus an added 0 would = 20. A six-cylinder would be a code of 30. An eight-cylinder would be a code of 40.
 - c. On the 7.3L diesel engine, a Code "50" should appear on the "Engine ID" display. If this does not appear, allow the test to complete. Repeat On-Board Diagnostics. If the Code "50" still does not appear, go directly to the Pinpoint Tests in the appropriate year Powertrain Control/Emissions Diagnosis Manual for Engine RPM Sensor (Diesel).
 NOTE: With RPM sensor failures you may not receive a Code "50" ID. The On-Board Diagnostics will run KOEO instead of KOER; if test is interrupted DTCs may be lost.
 - d. After the ID code is received, the technician must cycle the TCS. Then press and release the brake service pedal.
 - e. A signal output pulse (10) is sent to signal the technician to quickly press the throttle to wide open and immediately release. SUPER STAR II Tester will display the word Dynamic response (gas only).
 - f. DTCs are then sent (or Code 11 or 111-pass test).
 - g. If a DTC appears after the KOER test, a malfunction is present. Refer to the EEC-IV On-Board Diagnostic Trouble Code Description Chart in this Manual for service information.
6. The Engine Running wiggle test may be entered automatically upon completion of the Engine Running On-Board Diagnostics.

Special Test Mode

1. Wiggle test mode:
 - a. After all DTCs have been received the wiggle test may be entered by pressing the center button on STAR Tester twice. This will unlatch and relatch STI.
 The wiggle test allows the technician to attempt to re-create an intermittent malfunction. Tap, move and wiggle the suspected sensor and/or wire harness. When a malfunction is detected the STO will be turned on as long as the concern is present. STO ON will cause the STAR Tester to sound a continuous tone. The check engine lamp will also illuminate.
 NOTE: The wiggle test may also be entered by "latching" STI; ON, OFF, ON.

Quick Test 6.0 (Computed Timing Check)

This Quick Test is used to diagnose engine idle concerns only. Any engine concerns or DTCs should be serviced BEFORE the transmission concerns are serviced.

Drive Cycle Test

NOTE: The Drive Cycle Test must be followed exactly. Malfunctions have to occur four times consecutively for codes 49, 59, 617, 618, and 619 to be set, and give times consecutively for continuous code 62 or 628.

After performing the Quick Test, use the following Drive Cycle Test for checking AODE continuous codes:

NOTE: When performing the Drive Cycle Test, refer to the Solenoid Application Chart for proper solenoid operation. Refer to the Table of Contents.

1. Record and then erase Quick Test codes.
2. Warm engine to normal operating temperature.
3. Make sure transmission fluid level is correct.
4. With transmission in DRIVE, press TCS (LED lamp should illuminate) and moderately accelerate from stop to 64 Km/H (40 mph). This allows transmission to shift into third gear. Hold speed and throttle opening steady for a minimum of 15 seconds (30 seconds above 4000 altitude).
5. Press TCS (LED lamp should turn off) and accelerate from 64 Km/h (40 mph) to 80 Km/H (50 mph). This allows transmission to shift into fourth gear. Hold speed and throttle position steady for a minimum of 15 seconds.
6. With transmission in fourth gear and maintaining steady speed and throttle opening, lightly apply and release brake (to operate stoplamps). Then hold speed and throttle steady for an additional five seconds (minimum).
7. Brake to a stop and remain stopped for a minimum of 20 seconds.
8. Repeat Steps 4 through 6 at least five times.
9. Perform Quick Test and record continuous codes.

After On-Board Diagnostics

After the On-Board Diagnostics procedures are completed, service all DTCs.

DIAGNOSIS AND TESTING (Continued)

Begin with non-transmission related DTCs, then service any transmission related DTCs. Refer to the EEC-IV On-Board Diagnostic Trouble Code Description Chart for information on Condition and Symptoms. This chart will be helpful in referring to the proper manual(s) and to aid in diagnosing internal transmission concerns and external non-transmission inputs. The Pinpoint Tests are used in diagnosing electrical concerns of the E4OD transmission. Make sure that the vehicle wiring harness and the PCM are diagnosed as well. The Powertrain Control / Emissions Diagnosis Manual⁵ will aid in diagnosing non-transmission electronic components.

NOTE: The vehicle wiring harness, PCM and non-transmission sensors may affect transmission operations. Service these concerns first.

If DTCs appear while performing the On-Board Diagnostics refer to the EEC-IV On-Board Diagnostic Trouble Code Description Chart for the appropriate service procedure. Prior to entering Pinpoint Tests, refer to any TSBs and Oasis messages for E4OD transmission concerns.

NOTE: After Electrical Diagnosis has been performed and a concern still exists, refer to the Hydraulic / Mechanical Diagnosis charts in this section.

Pinpoint Tests

NOTE: Prior to entering Pinpoint Tests, check the PCM wiring harness for proper connections, bent or broken pins, corrosion, loose wires, proper routing, proper seals and their condition. Check the PCM, sensors and actuators for damage. Refer to the Powertrain Control / Emissions Diagnosis Manual.⁵

⁵ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

FAULT CODE		COMPONENT	DESCRIPTION	CONDITION	SYMPTOMS/ACTIONS
TWO DIGIT	THREE DIGIT				
11	111	SYSTEM	Pass	No concern detected.	Concern not detected by PCM ①②
29	452	VSS	Insufficient input from VSS.	PCM detected a loss of vehicle speed signal during operation.	Harsh engagements, firm shift feel, abnormal shift schedule, unexpected downshifts may occur at closed throttle, abnormal torque converter clutch operation or engages only at WOT. May flash TCIL. ①
26	636	TOT	TOT out of On-Board Diagnostics range.	Transmission not at operating temperature during On-Board Diagnostics	Warm vehicle to normal operating temperature and rerun On-Board Diagnostics.
56	637	TOT	-40°C (-40°F) indicated, TOT sensor circuit open.	Voltage drop across TOT sensor exceeds scale set for temperature -40°C (-40°F).	Torque converter clutch and stabilized shift schedule may be enabled sooner after cold start. Refer to Pinpoint Test B
66	638	TOT	157°C (315°F) indicated, TOT sensor circuit grounded.	Voltage drop across TOT sensor exceeds scale set for temperature of 157°C (315°F).	
67	539	ACC	A/C switch error.	A/C or defrost ON condition may result from A/C clutch being "ON" during pre-check.	Failed on — EPC pressure slightly low with A/C off. Failed off — EPC pressure slightly low with A/C on. ①
67	654	MLP	MLP not in park.	On-Board Diagnostics not run in park.	Rerun On-Board Diagnostics in park.
67	634	MLP	MLP out of range.	Indicated voltage drop across MLP exceeds limits established for each position.	Harsh engagements, firm shift feel. Refer to Pinpoint Test D
74	536	BOO	Brake not actuated during On-Board Diagnostics.	Brake not cycled during KOER.	Failed on or not connected — Torque converter clutch will not engage at less than 1/3 throttle. Failed off — Torque converter clutch will not disengage when brake is applied ①
			BOO switch circuit failed.	Brake on/off circuit failure.	
47	633	4x4 LOW SWITCH	4x4 Low switch closed.	4x4 Low switch closed/or 4x4 Low indicator lamp circuit open.	Failed on — Early shift schedules in 4x2 and 4x4 HI range. Failed off — Shifts delayed in 4x4 Low. NOTE: If the 4x4 low indicator light fuse is blown, the transmission will shift according to the 4x4 Low shift schedule regardless of the transfer case position. ①②
97	631	TCIL	TCIL circuit failure.	TCIL circuit open or shorted.	Failed on — Overdrive cancel mode always indicated, no flashing for EPC failure. Failed off — Overdrive cancel mode never indicated, no flashing for EPC failure. ①
65	632	TCS	TCS not changing state.	TCS not cycled during On-Board Diagnostics/circuit open or shorted.	Rerun diagnostics and cycle switch. No overdrive cancel when switch is cycled. ①
68	657	TOT	Transmission Overtemp Condition	Transmission oil temperature exceeded 270°F.	Slight increase in EPC Pressure. May flash TCIL. Refer to Pinpoint Test B

① Refer to the Powertrain Control/Emissions Diagnosis Manual.

② Refer to the appropriate section in this manual.

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DIAGNOSIS AND TESTING (Continued)

FAULT CODE		COMPONENT	DESCRIPTION	CONDITION	SYMPTOMS/ACTIONS
TWO DIGIT	THREE DIGIT				
23	121	TP (FIPL)	TP out of On-Board Diagnostics range.	TP sensor (gasoline engines) not at idle position during KOEO. TP (FIPL) sensor (diesel engines) not at WOT position during KOEO.	Rerun at appropriate TP (FIPL) position per the engine application. May flash TCIL.
33	—	TP (FIPL)	Sensor signal input noisy.	Noisy signal indicated at processor (PCM).	Harsh engagements, firm shift feel, abnormal shift schedule, abnormal converter clutch operation or does not engage. May flash TCIL. ①
43	—	TP (FIPL)	Sensor signal indicates below idle voltage.	Indicated voltage signal below idle specifications.	Harsh engagements, firm shift feel, abnormal shift schedule, abnormal converter clutch operation or does not engage. May flash TCIL. ①
53	123	TP (FIPL)	TP circuit above maximum voltage.	Voltage above or below specification for On-Board Diagnostics or during normal vehicle operation.	Harsh engagements, firm shift feel, abnormal shift schedule, abnormal torque converter clutch operation or does not engage. May flash TCIL. ①
63	122	TP-(FIPL)	TP (FIPL) circuit below minimum voltage.		
73	167	TP	Insufficient TP change dynamic response test.	Throttle not depressed during KOER.	Rerun On-Board Diagnostics and depress (goose) throttle when indicated.
14	211	RPM-PIP	RPM sensor/PIP circuit fault.	Engine RPM sensor circuit failure. With RPM sensor failure may not run On-Board Diagnostics KOER.	Harsh engagements and shifts, late WOT upshifts, abnormal torque converter clutch operation or does not engage. (PIP sensor failure/engine will stall or not run). May flash TCIL. ①
22	126	MAP/BARO	MAP/BARO out of On-Board Diagnostics range.	MAP/BARO sensor signal higher or lower than expected or no response during Dynamic Response (Goose) Test.	Rerun On-Board Diagnostics.
	128	MAP	MAP vacuum circuit failure.		Firm shift feel, late shifts at altitude. ①
72	129	MAP	Insufficient MAP change dynamic response test (gasoline engines only).		
91*	621*	SS1	SS1 solenoid circuit failure.	Solenoid 1 circuit failed to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during KOEO.	Improper gear selection depending on failure mode and manual lever position. Refer to Shift Solenoid Application Chart. Refer to Pinpoint Test A
49**	617**	SS1, SS2 OR INTERNAL TRANSMISSION COMPONENTS	1-2 shift error.	Engine RPM drop not detected when 1-2 shift was commanded by PCM.	Improper gear selection depending on failure mode and manual lever position: Refer to Shift Application Chart. Shift errors may also be due to other internal transmission concerns such as stuck valves or damaged friction material.
59**	618**	SS1, SS2 OR INTERNAL TRANSMISSION COMPONENTS	2-3 shift error.	Engine RPM drop not detected when 2-3 shift was commanded by PCM.	
69**	619**	SS1, SS2 OR INTERNAL TRANSMISSION COMPONENTS	3-4 shift error.	Engine RPM drop not detected when 3-4 shift was commanded by PCM.	May flash TCIL. Refer to Pinpoint Test A

① Refer to the Powertrain Control/Emission Diagnosis Manual.

* Output circuit check, generated only by electrical conditions.

** May also be generated by other non-electronic related transmission hardware condition.

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DIAGNOSIS AND TESTING (Continued)

FAULT CODE		COMPONENT	DESCRIPTION	CONDITION	SYMPTOMS/ACTIONS
TWO DIGIT	THREE DIGIT				
92*	622*	SS2	SS2 solenoid circuit failure.	Solenoid 2 circuit fails to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during KOEO.	Improper gear selection depending on failure mode and manual lever position. Refer to the Shift Solenoid Application Chart. Refer to Pinpoint Test A
94*	627* 629*	TCC	TCC solenoid circuit failure.	TCC circuit fails to provide voltage drop across solenoid. Circuit open or shorted or processor driver failure during KOEO. Shorted TCC driver manual stall.	Short circuit — Engine stalls in Drive or manual 2 at idle with brake applied. Open circuit — Torque converter clutch never engaged. Refer to Pinpoint Test C
62**	628**	TCC	Torque converter clutch failure.	Excessive amount of torque converter clutch slippage was detected.	Erratic or no torque converter clutch operation. May flash TCIL. Refer to Pinpoint Test C
93*	626*	CCS	CCS solenoid circuit failure.	CCS failed to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during KOEO.	Failed off — No third gear engine braking in overdrive cancel. Failed on — Third gear engine braking in overdrive range. Coast Clutch may be damaged/ eventual failure. Refer to Pinpoint Test G
98*	998*		Failure Mode Effects Management (FMEM) failure.	Failure detected in one or more critical inputs.	PCM enables alternate functions. Check for other error codes. ①
99*	624*	EPC	EPC circuit failure, shorted circuit or output driver.	Voltage through EPC circuit is checked and compared after a time delay. An error will be noted if tolerance is exceeded during KOEO and continuous On-Board Diagnostics.	Short circuit — (Gasoline engines): causes minimum EPC pressure (minimum capacity). Limits engine torque (partial fuel shut-off, heavy misfire). Flashing TCIL. Diesel engines — Cuts power on ECA pin 35 (EPC power) to attain maximum EPC (maximum capacity). Harsh engagements and shifts, flashing TCIL. Open circuit — (Gasoline and Diesel engines): Causes maximum EPC, harsh engagements and shifts. May flash TCIL. Refer to Pinpoint Test E
	625*	EPC	Shorted EPC output driver.		

① Refer to the Powertrain Control/Emissions Diagnosis Manual.

* Output circuit check, generated only by electrical symptoms.

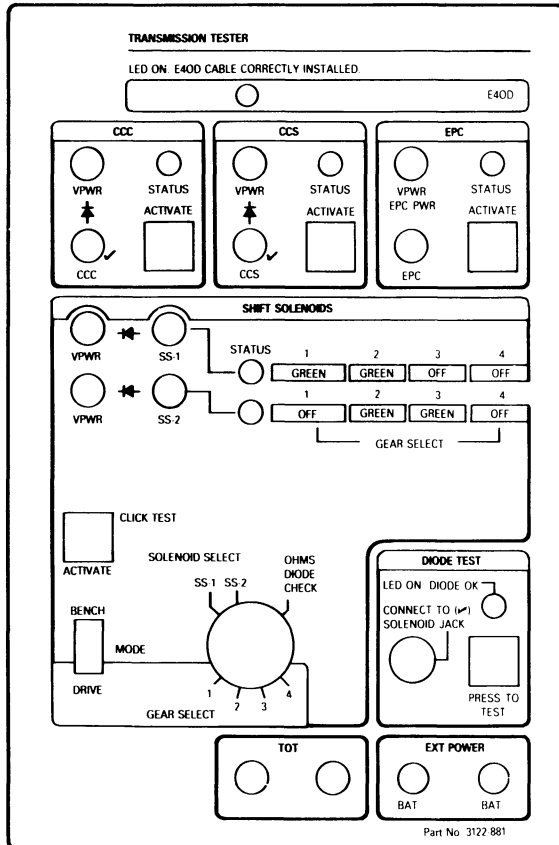
** May also be generated by other non-electronic related transmission hardware system.

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DIAGNOSIS AND TESTING (Continued)

Transmission Tester 007-00085 Instructions

NOTE: The Transmission Tester 007-00085 must be used to perform the Pinpoint Tests.



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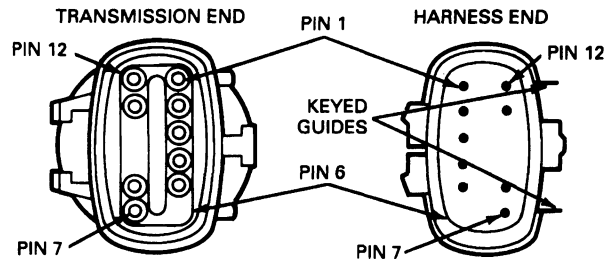
CAUTION: When connecting the tester to the transmission, Pins 7 through 12 must be facing outward. If tester is unavailable refer to the appropriate year shop manual for procedures using the pigtail harness.

TRANSMISSION CONNECTOR PIN ASSIGNMENTS

12-WAY CONNECTOR PIN	DESCRIPTION	EEC-IV 80-WAY CONNECTOR PIN	
		GAS	DIESEL
1	VPWR	37, 57	37, 57
2	SS2	19	19
3	SS1	52	52
4	TCC	53	53
5	CCS	55	55
6	—	—	—
7	TOT	42	7
8	SGRTN	46	46
9	—	—	—
10	—	—	—
11	EPC	38	38
12	EPCPWR	37, 57	35*

*This is a unique EPC power feed for DIESEL application only.

12-WAY CONNECTOR



NOTE: BOTH VIEWS ARE "LOOKING INTO" THE CONNECTORS MATING ENDS.

D11838-A

DIAGNOSIS AND TESTING (Continued)

The Rotunda Transmission Tester 007-00085 or equivalent allows a technician to operate the electrical portion of the transmission independent of the vehicle electronics which allows the technician to determine transmission concerns. The Transmission Tester usage is divided in five steps:

- I. Preliminary Testing and Diagnosis
- II. Installing the Transmission Tester
- III. Static Testing — Vehicle Running
- IV. Dynamic Testing — Vehicle Running
- V. Removing Transmission Tester and Clearing DTCs

Preliminary Testing and Diagnosis

Before any diagnostic testing is done on vehicle some preliminary checks must be performed, as outlined below. Be sure to write down findings, especially any DTCs found, for future reference.

- a. Check transmission fluid level and condition.
- b. Check for add-on items (phones, computers, CB radio, etc.).
- c. Visually inspect wiring harness and connectors.
- d. Check for vehicle modifications.
- e. Check shift linkage for proper adjustment.
- f. Verify customer concern:
 - Upshift, Downshift, Coasting, Engagement, Noise/Vibration.
- g. Vehicle must be at normal operating temperature.
- h. Perform vehicle On-Board Diagnostics.
- i. Record all DTCs.
- j. Service all non-transmission codes.

Installing the Transmission Tester (Set-Up Procedures)

Installing the transmission tester at the bulkhead connector (at the transmission) allows separation of the vehicle electronics from transmission electronics. Disconnecting normal vehicle electronics will set additional codes and cause firm shifts. (Disconnecting the bulkhead connector defaults transmission to maximum line pressure).

NOTE: During tester usage additional DTCs may be set. Therefore, it is important that all codes are erased after service has been made. To verify elimination of all codes rerun On-Board Diagnostics.

NOTE: The following manuals should be available to assist in diagnosis of electronically controlled transmissions:

- Powertrain Control / Emissions Diagnosis Manual⁶.
- Transmission Tester Manual (provided with tester).

CAUTION: Do not attempt to pry off connectors with a screwdriver. This will damage the connector and could result in transmission concerns. If vehicle is equipped with heat shields, remove them. Always replace heat shields after service.

1. Disconnect vehicle wiring harness at transmission connector.
2. Turn tester solenoid select switch to the OHMS / DIODE CHECK position.

CAUTION: Route all cables away from heat sources.

3. Install appropriate overlay onto tester. Connect appropriate interface cable to transmission tester and then to the appropriate transmission connectors.
4. Install a line pressure gauge into line pressure tap on transmission.

CAUTION: Route gauge line away from heat sources.

5. Plug transmission tester power supply into lighter receptacle. At this time, all LEDs should illuminate for a short period and then turn off. This is the tester internal circuit check.
6. Position Bench / Drive switch to BENCH mode.

Static Testing, Vehicle Off

Static testing procedures allow for shop testing of the transmission in the vehicle or on the bench. Completion of these tests prove out transmission electronics.

CAUTION: For resistance checks, be sure the tester solenoid select switch is set to the OHMS/DIODE CHECK position or damage to the ohmmeter may result.

Resistance / Continuity Tests

- Refer to the appropriate Pinpoint Test to be performed based on the DTCs displayed.
- Using a Rotunda Digital Volt-Ohmmeter and the Transmission Tester perform the Pinpoint Tests as indicated based on the DTCs which were displayed.
- Service as indicated by the pinpoint tests. Always retest and road test vehicle after service.

Transmission Solenoids and Sensors Resistance Tests

EPC Solenoid

- Set ohmmeter to 100-200 ohm range.
- Connect negative lead of ohmmeter to the EPC jack.

⁶ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

- Connect positive lead of ohmmeter to the VPWR jack.
- Record resistance.
- Refer to the following charts for values.

If out of specification, refer to Pinpoint Test E in this Section.

Solenoids (SS1, SS2, TCC (CCC), CCS)

- Set ohmmeter to 100-200 ohm range.
- Connect positive lead of ohmmeter to the appropriate VPWR jack for the solenoid being tested.
- Connect negative lead of the ohmmeter to the appropriate solenoid (SS-1, SS-2, TCC (CCC), CCS) jack and record resistance.

Refer to following charts for values.

If out of specification, refer to Pinpoint Test A (SS-1, SS-2); Pinpoint Test C; Pinpoint Test G (CCS).

Solenoid	Transmission Application E4OD Solenoid Resistance (ohms)
S1	20-30
S2	20-30
TCC (CCC)	20-30
CCS	20-30
EPC	4.0-6.5

Transmission Operating Temperature (TOT)

- Set ohmmeter to 1000 ohm (k) scale.
- Connect ohmmeter positive lead to +TOT jack.
- Connect ohmmeter negative lead to -TOT jack.
- Record resistance. Resistance will vary with temperature.
- Refer to the following chart.

If out of specification, refer to Pinpoint Test B in this Section.

Temperature		Resistance
°C	°F	Ohms (K)
0-20	32-68	100K-37K
21-40	69-104	37K-16K
41-70	105-158	16K-5K
71-90	159-194	5K-2.7K
91-110	195-230	2.7K-1.5K
110-130	230-266	1.5K-0.8K

Sensors Short to Ground and Solenoid Voltage Test

NOTE: LED will turn GREEN when solenoid activates and turn OFF when deactivated. LED will turn RED if an activated solenoid / harness is shorted to B+. LED will remain OFF if an activated solenoid / harness is shorted to ground or on continuity.

1. Set tester Bench / Drive switch to BENCH mode.

2. Set voltmeter to 20 volt DC range.
3. Connect voltmeter positive lead to the appropriate solenoid VPWR. Connect voltmeter negative lead to the appropriate solenoid.
4. Using a DVOM, check for voltage across each solenoid by activating the solenoid switches. Depress the appropriate switch. The LED should illuminate, the voltage should change and an audible click may be heard. If LED does not illuminate, a short to ground condition exists.

NOTE: TCC (CCC) solenoid click may or may not be audible.

5. Observe and record values.

Solenoid Diode Test

1. Only used on SOLENOIDS with a DIODE symbol (✱).
2. Using a test lead from a VOM, connect the test lead at the DIODE test jack and to the appropriate solenoid signal jack (marked with check symbol).
3. Depress diode switch and observe diode test LED. LED should illuminate green if correct.

NOTE: A bad diode may cause PCM concerns. Rerun On-Board Diagnostics and road test vehicle.

Dynamic Testing, Vehicle Running

Dynamic testing is the final step in the transmission tester usage. It allows the transmission to be proven out electronically and hydraulically.

Transmission Solenoid Cycling and Drive Test Procedures**Preliminary Set Up**

1. Set Bench / Drive switch to DRIVE mode.
2. Set rotate gear select switch to GEAR SELECT "1" position.
3. Place vehicle in PARK.
4. Start vehicle.

EPC Solenoid

CAUTION: Do not attempt to hold the EPC switch depressed (minimum line pressure) and stall the transmission (holding the vehicle with the brake while depressing the throttle with the transmission in gear), transmission damage will result.

5. Observe line pressure. Record value. Line pressure should go to maximum. If not, refer to the Hydraulic / Mechanical Diagnosis charts for diagnostic tips or Pinpoint Test E concerning EPC solenoid.
6. Depress EPC switch. Line pressure should drop to a minimum value. Record value. If not, refer to the Hydraulic / Mechanical Diagnostic charts or Pinpoint Test E for the EPC solenoid.

Engagements

7. Set Bench / Drive switch to DRIVE mode.

DIAGNOSIS AND TESTING (Continued)

8. Rotate gear select switch to GEAR SELECT "1" position.
9. Depress EPC switch. Line pressure should drop to idle pressure. While holding EPC switch down, shift vehicle from PARK to REVERSE.

Does vehicle shift into Reverse?

Shift vehicle from REVERSE to DRIVE.

Does vehicle shift into Drive?

Release the EPC switch, pressure should return to maximum. Repeat engagements. With the EPC switch released, engagements should be firm.

Upshift/Downshift

NOTE: Upshifts and Downshifts will be firm during this procedure. Pressure gauges may be removed. These tests should be performed on the road. If performed on the hoist, feel at all shifts when they are engaged may not be possible.

LEDs will turn GREEN when solenoids are activated and turn OFF when deactivated. Refer to the appropriate overlay for the proper status shift sequence of the shift solenoids during upshifts and downshifts.

10. Move shift lever into OVERDRIVE and accelerate to 24 km/h (15 mph), select second gear by rotating gear selector to second.
Did vehicle upshift to second gear?
Did appropriate shift solenoids activate/deactivate?
11. Accelerate to 40 km/h (25 mph) and select third gear.
Did vehicle upshift to third gear?
Did appropriate shift solenoids activate/deactivate?
12. Accelerate to 56-72 km/h (35/45 mph) and select fourth gear.
Did vehicle upshift to fourth gear?
Did appropriate shift solenoids activate/deactivate?
13. Reverse the order to Downshift.
Does vehicle downshift from fourth to third, third to second, and second to first?
Did appropriate shift solenoids activate/deactivate?

Torque Converter Clutch (TCC) Engagement

NOTE: This test should be performed on the road. If performed on a hoist, feeling the torque converter clutch engage may not be possible.

CAUTION: Do not depress TCC (CCC) switch with transmission in gear and the vehicle at a stop. Damage to torque converter clutch may result.

14. Accelerate and shift vehicle up into third gear. Hold speed steady and depress the TCC (CCC) switch.

Does the converter engage?

Does the engine rpm drop?

Did TCC (CCC) solenoid activate?

Coast Clutch Engagement (CCS)

NOTE: This test should be performed on the road. If performed on the hoist the technician may not feel the coast clutch engage.

15. Accelerate and shift vehicle up into third gear. Depress the CCS switch and immediately back off the throttle.

Did the Coast Clutch engage? Did engine braking occur?

Did the CCS solenoid activate?

Removing Transmission Tester and Clearing DTCs

CAUTION: Do not attempt to pry off connectors with a screwdriver. This will damage the connector and could result in a transmission concern.

1. Disconnect transmission tester from transmission connector.
2. Re-install vehicle wiring harnesses. Verify connection by pulling up on the harness.
3. Re-install all heat shields that were previously removed.
4. Disconnect transmission tester power lead from vehicle.
5. Erase all DTCs using the procedures in the Powertrain Control/Emissions Diagnosis Manual⁷.
6. Rerun EEC-IV On-Board Diagnostics to receive a pass code (11 or 111).
7. Verify customer concern has been eliminated.

⁷ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A: DIAGNOSTIC TROUBLE CODES: 49/617, 59/618, 69/619, 91/621, 92/622 SHIFT ERRORS
SOLENOID CIRCUIT FAILURES

TEST STEP		RESULT	ACTION TO TAKE
A1	E4OD ELECTRONIC DIAGNOSTICS		
	<ul style="list-style-type: none"> The following items must be checked before proceeding: <ul style="list-style-type: none"> Check the Powertrain Control Module (PCM) assembly for proper function (On-Board Diagnostics). Check vehicle wiring harness for continuity and shorts to ground. Make sure all connectors are engaged properly seated. Make sure all terminals in connectors are properly. Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals. Have items been checked? 	Yes No	GO to A2. PERFORM checks.
A2	CHECK HARNESS CONNECTIONS		
	<ul style="list-style-type: none"> Check that vehicle harness connector is fully engaged on transmission connector. Check that vehicle harness connector terminals are fully engaged in connector and in good condition. Is the harness/terminal fully engaged? 	Yes No	GO to A3. SERVICE as required.
A3	SOLENOID FUNCTIONAL TEST		
	<p>CAUTION: Remove heat shield from the transmission before removing connector. Remove the solenoid body connector by pushing on the center tab and pulling on the wiring harness. Do not attempt to pry the tab with a screwdriver. Reinstall heat shield after service.</p> <ul style="list-style-type: none"> Disconnect vehicle harness at transmission. Install tester (007-00085) at the transmission connector. Using tests outlined under Tester Instructions perform the SOLENOID function test. <p>NOTE: LED will turn GREEN when solenoid activates and turn OFF when deactivated. LED will turn RED if an activated solenoid is shorted to B+. LED will remain OFF if an activated solenoid is shorted to ground or no continuity (open circuit).</p> <ul style="list-style-type: none"> Perform the Diode Check <ul style="list-style-type: none"> Do the solenoids (LED) activate? (LED GREEN) Are the Diodes OK (diode LED GREEN)? 	Yes No	GO to A4. If a diode is bad, replace solenoid body assembly. A bad diode may cause a processor concern. Record and erase codes and repeat On-Board Diagnostics. Road test vehicle after solenoid body replacement. If the diodes are OK and NO function, Go to A5.
A4	TRANSMISSION DRIVE TEST		
	<ul style="list-style-type: none"> Perform the Transmission Solenoid Cycling and Drive Test as outlined under tester instructions Step IV. Does the vehicle upshift when commanded by the tester? 	Yes No	REFER to the Powertrain Control/Emissions Diagnosis Manual ⁸ to diagnose PCM or vehicle harness concerns. ERASE all codes and PERFORM the Drive Cycle Test as outlined. RE-RUN On-Board Diagnostics. If codes are still present, REFER to the Hydraulic/Mechanical Diagnosis. GO to A5.

8 Can be purchased as a separate item

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A: DIAGNOSTIC TROUBLE CODES: 49/617, 59/618, 69/619, 91/621, 92/622 SHIFT ERRORS
SOLENOID CIRCUIT FAILURES (Continued)

TEST STEP		RESULT	ACTION TO TAKE						
A5	CHECK RESISTANCE OF SOLENOID								
<p>NOTE: Refer to the E4OD Transmission Tester for terminal locations.</p> <ul style="list-style-type: none">● Set Bench / Drive switch to BENCH mode.● Rotate gear selector switch to OHMS / DIODE position.● Connect power plug into cigar lighter receptacle.● Connect ohmmeter negative lead to SS-1 jack and positive lead to VPWR jack on tester. This is to test SS-1.● Record resistance.● Resistance should be between 20 and 30 ohms.● Connect ohmmeter negative lead to SS-2 jack and positive lead to VPWR jack on tester. This is to test SS-2.● Record resistance.● Resistance should be between 20 and 30 ohms.● Is resistance between 20 and 30 ohms?		Yes No	GO to A6. REPLACE solenoid body assembly. RECORD and ERASE codes. Repeat On-Board Diagnostics.						
A6	CHECK SOLENOID FOR SHORT TO GROUND								
<ul style="list-style-type: none">● Check for continuity between B- (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Solenoid</th><th>Tester Jack</th></tr><tr><td>SS-1</td><td>SS-1 / VPWR</td></tr><tr><td>SS-2</td><td>SS-2 / VPWR</td></tr></table> <ul style="list-style-type: none">● Connection should show infinite resistance (no continuity).● Is there continuity?		Solenoid	Tester Jack	SS-1	SS-1 / VPWR	SS-2	SS-2 / VPWR	Yes No	REPLACE solenoid body assembly. RECORD and ERASE codes, Repeat On-Board Diagnostics. Refer to Service manual Condition / Cause charts for Shift Concern diagnosis.
Solenoid	Tester Jack								
SS-1	SS-1 / VPWR								
SS-2	SS-2 / VPWR								

PINPOINT TEST B: DIAGNOSTIC TROUBLE CODES: 56/637, 66/638 TOT SENSOR CIRCUIT OPEN OR GROUNDED;
68/657 TRANSMISSION OVERTEMP INDICATED

TEST STEP		RESULT	ACTION TO TAKE
B1	E4OD ELECTRONIC DIAGNOSTICS		
<ul style="list-style-type: none"> The following items must be checked before proceeding: <ul style="list-style-type: none"> Check the Powertrain Control Module (PCM) assembly for proper function (On-Board Diagnostics). Check the vehicle wiring harness for continuity and shorts to ground. Make sure all connectors are engaged properly. Make sure all terminals in the connectors are properly seated. Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals. Have the items above been checked? 		Yes	GO to B2.
		No	PERFORM checks.
B2	CHECK HARNESS CONNECTIONS		
<ul style="list-style-type: none"> Check that vehicle harness connector is fully engaged on transmission connector. Check that vehicle harness connector terminals are fully engaged in connector. Are terminals fully engaged? 		Yes	GO to B3.
		No	SERVICE as required.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST B: DIAGNOSTIC TROUBLE CODES: 56/637, 66/638 TOT SENSOR CIRCUIT OPEN OR GROUNDED;
68/657 TRANSMISSION OVERTEMP INDICATED (Continued)

TEST STEP		RESULT	ACTION TO TAKE																								
B3	CHECK RESISTANCE OF TOT SENSOR/HARNESS																										
<p>NOTE: Refer to the E4OD Transmission Tester for terminal locations.</p> <p>CAUTION: Remove heat shield from the transmission before removing connector. Remove the solenoid body connector by pushing on the center tab and pulling on the wiring harness. Do not attempt to pry the tab with a screwdriver. Reinstall heat shield after service.</p> <ul style="list-style-type: none">● Disconnect vehicle harness at transmission.● Install Transmission Tester 007-00085 or equivalent to transmission connector.● Set Bench/Drive switch to BENCH mode.● Rotate Gear selector switch to OHMS/DIODE Check position.● Connect ohmmeter negative lead to -TOT jack and positive lead to +TOT jack on tester.● Perform Tests 1 and 2. <p>NOTE: While performing Tests 1 and 2 observe resistances. Code 56/637 is set if resistance value exceeds 869K ohms (OPEN circuit). Code 66/638 is set if resistance value falls below 597 ohms (Short circuit).</p> <p>TEST No. 1</p> <ul style="list-style-type: none">● Record resistance.● Resistance should be approximately in the following ranges.● Is resistance in range? <table><tr><th colspan="3">Transmission Fluid Temperature</th></tr><tr><th>°C</th><th>°F</th><th>Resistance (Ohms)</th></tr><tr><td>0-20</td><td>32-58</td><td>100K-37K</td></tr><tr><td>21-40</td><td>59-104</td><td>37K-16K</td></tr><tr><td>41-70</td><td>105-158</td><td>16K-5K</td></tr><tr><td>71-80</td><td>150-194</td><td>5K-2.7K</td></tr><tr><td>91-110</td><td>195-230</td><td>2.7K-1.5K</td></tr><tr><td>111-130</td><td>231-266</td><td>1.5K-0.8K</td></tr></table> <p>TEST No. 2</p> <ul style="list-style-type: none">● Check for intermittent short or open.● If resistance was between 0.8K and 100K ohms, perform the following test. If transmission is cold, run transmission to warm it up. If transmission is warm, allow transmission to cool. Check TOT sensor resistance again. Compare resistance with initial resistance. Resistance should decrease if transmission was warmed and should increase if transmission was allowed to cool. If correct change in resistance occurs, repeat On-Board Diagnostics.● Is the resistance within range?		Transmission Fluid Temperature			°C	°F	Resistance (Ohms)	0-20	32-58	100K-37K	21-40	59-104	37K-16K	41-70	105-158	16K-5K	71-80	150-194	5K-2.7K	91-110	195-230	2.7K-1.5K	111-130	231-266	1.5K-0.8K	Yes No	► GO to B4. ► REPLACE solenoid assembly. RECORD and ERASE DTCs. Repeat On-Board Diagnostics.
Transmission Fluid Temperature																											
°C	°F	Resistance (Ohms)																									
0-20	32-58	100K-37K																									
21-40	59-104	37K-16K																									
41-70	105-158	16K-5K																									
71-80	150-194	5K-2.7K																									
91-110	195-230	2.7K-1.5K																									
111-130	231-266	1.5K-0.8K																									

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST B: DIAGNOSTIC TROUBLE CODES: 56/637, 66/638 TOT SENSOR CIRCUIT OPEN OR GROUNDED;
68/657 TRANSMISSION OVERTEMP INDICATED (Continued)**

TEST STEP		RESULT	ACTION TO TAKE
B4	CHECK TOT SENSOR / HARNESS FOR SHORT TO GROUND		
	<ul style="list-style-type: none"> Check for continuity between B- (engine ground) and appropriate jack (-TOT and +TOT) with ohmmeter or other low current tester (less than 200 milliamps). Connection should show infinite resistance (no continuity). Is there continuity? 	<p>Yes</p> <p>No</p>	<p>REPLACE solenoid assembly. Repeat On-Board Diagnostics.</p> <p>Repeat Quick-Test. If codes are still present, Refer to the PC/ED manual to diagnose harness or PCM. If overtemp condition existed determine if fluid is burnt. If burnt, disassemble unit and repair as required. RECORD and ERASE codes. Repeat On-Board Diagnostics.</p>

**PINPOINT TEST C: DIAGNOSTIC TROUBLE CODES: 62/628 TORQUE CONVERTER CLUTCH ERROR DETECTED;
94/627, 629 TCC SOLENOID CIRCUIT FAILURE**

TEST STEP		RESULT	ACTION TO TAKE
C1	E4OD ELECTRONIC DIAGNOSTICS		
	<ul style="list-style-type: none"> The following items must be checked before proceeding: <ul style="list-style-type: none"> Check the Powertrain Control Module (PCM) assembly for proper function (On-Board Diagnostics). Check vehicle wiring harness for continuity and shorts to ground. Make sure all connectors are engaged properly. Make sure all terminals in connectors are properly seated. Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals. Have items been checked? 	<p>Yes</p> <p>No</p>	<p>GO to C2.</p> <p>PERFORM checks.</p>
C2	CHECK HARNESS CONNECTIONS		
	<ul style="list-style-type: none"> Check that vehicle harness connector is fully engaged on transmission connector. Check that vehicle harness connector terminals are fully engaged in connector and in good condition. Are connector / terminals fully engaged? 	<p>Yes</p> <p>No</p>	<p>GO to C3.</p> <p>SERVICE as required.</p>

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST C: DIAGNOSTIC TROUBLE CODES: 62/628 TORQUE CONVERTER CLUTCH ERROR DETECTED;
94/627, 629 TCC SOLENOID CIRCUIT FAILURE (Continued)

TEST STEP		RESULT	ACTION TO TAKE						
C3	SOLENOID FUNCTIONAL TEST								
	<p>CAUTION: Remove heat shield from the transmission before removing connector. Remove the solenoid body connector by pushing on the center tab and pulling on the wiring harness. Do not attempt to pry the tab with a screwdriver. Reinstall heat shield after service. Pull up on the vehicle harness.</p> <ul style="list-style-type: none">● Disconnect vehicle harness at transmission.● Install tester (007-00085) to transmission connector.● Using tests outlined in the tester instructions perform TCC (CCC) solenoid function test. <p>NOTE: LED will turn GREEN when solenoid activates and turn OFF when deactivated. LED will turn RED when activated solenoid is shorted to B+. LED will remain OFF if an activated solenoid is shorted to ground or no continuity (open circuit).</p> <ul style="list-style-type: none">● Perform the Diode Check.<ul style="list-style-type: none">— Does the TCC (CCC) (LED-GREEN) activate when the tester switch is depressed?— Is the Diode OK (Diode LED-GREEN)?	Yes No	<p>▶ GO to C4.</p> <p>▶ If a diode is bad, replace solenoid body assembly. A bad diode may cause a PCM concern. RECORD and ERASE codes and repeat On-Board Diagnostics. Road test after solenoid body replacement. If diode is OK, and solenoid functions, go to C5.</p>						
C4	TRANSMISSION DRIVE TEST								
	<ul style="list-style-type: none">● Perform the Drive Cycle Test as outlined under Testing Instructions.● While in third gear depress the TCC (CCC) switch.● Does the TCC (CCC) activate (LED GREEN)?● Does the engine rpm drop?	Yes No	<p>▶ REFER to Powertrain Control/Emissions Diagnosis Manual⁹ to diagnose processor and vehicle harness concerns.</p> <p>▶ GO to C5.</p>						
C5	CHECK RESISTANCE OF SOLENOID								
	<p>NOTE: Refer to E4OD Transmission Tester for terminal locations.</p> <ul style="list-style-type: none">● Set Bench / Drive switch to Bench mode.● Rotate gear select switch to Ohms / Diode Check position.● Connect ohmmeter negative lead to TCC (CCC) (jack) and positive lead to VPWR on tester. This is to test TCC (CCC).● Record resistance.● Resistance should be between 20 and 30 ohms.● Is resistance between 20 and 30 ohms?	Yes No	<p>▶ GO to C6.</p> <p>▶ REPLACE solenoid body assembly.</p>						
C6	CHECK SOLENOID FOR SHORT TO GROUND								
	<ul style="list-style-type: none">● Check for continuity between B- (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Solenoid</th><th>Tester Jack</th></tr><tr><td>TCC (CCC)</td><td>CCC</td></tr><tr><td>VPWR</td><td>VPWR</td></tr></table> <ul style="list-style-type: none">● Connection should infinite resistance (no continuity).● Is there continuity?	Solenoid	Tester Jack	TCC (CCC)	CCC	VPWR	VPWR	Yes No	<p>▶ REPLACE solenoid body assembly.</p> <p>▶ Refer to symptom diagnosis to diagnose torque converter clutch concerns.</p>
Solenoid	Tester Jack								
TCC (CCC)	CCC								
VPWR	VPWR								

9 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST D: DIAGNOSTIC TROUBLE CODE: 67,654, MLP SENSOR ERROR DETECTED

TEST STEP		RESULT	ACTION TO TAKE																							
D1	E4OD ELECTRONIC DIAGNOSTICS																									
<p>NOTE: Code 67 / 654 may also be set by running On-Board Diagnostic with the transmission not in Park or the A.C. on. Make sure On-Board Diagnostic is performed properly!</p> <ul style="list-style-type: none">The following items must be checked before proceeding:<ul style="list-style-type: none">Check the Powertrain Control Module (PCM) for proper function (On-Board Diagnostic).Check the vehicle wiring harness for continuity and shorts to ground.Make sure all connectors are engaged properly.Make sure all terminals in the connectors are properly seated.Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals.Have the items above been checked?		Yes No	GO to D2. PERFORM checks.																							
D2	CHECK HARNESS CONNECTIONS																									
<ul style="list-style-type: none">Check that vehicle harness connector is fully engaged on transmission manual lever position (MLP) sensor connector.Check that vehicle harness connector terminals are fully engaged in connector and in good condition.Are connector / terminals fully engaged?		Yes No	GO to D3. SERVICE as required.																							
D3	ADJUST MANUAL LEVER POSITION SENSOR																									
<ul style="list-style-type: none">Apply parking brake.Place transmission gear selector in NEUTRAL.Verify manual lever position using Gear Position Sensor Adjuster Tool T91P-70010-A.Verify that MLP retaining bolts are tightened to 6-8 N-m (55-75 In-Lb).Is sensor adjusted properly?		Yes No	GO to D4. ADJUST sensor as outlined under Transmission Assembly. RECORD and ERASE codes. REPEAT Quick Test.																							
D4	CHECK OPERATION OF MANUAL LEVER POSITION SENSOR																									
<p>CAUTION: Do not pry connector. Squeeze tabs and pull up on vehicle harness.</p> <ul style="list-style-type: none">Disconnect vehicle harness at transmission.Insert MLPS Tester Harness or equivalent into MLP sensor.Plug ohmmeter into MLP Tester.Using procedures provided with tester verify sensor functions in all positions.<ul style="list-style-type: none">Check continuity and resistances in all positions.		Yes No	REFER to Powertrain Control / Emissions Diagnosis Manual ¹⁰ for diagnosis of PCM assembly and vehicle wiring harness. REPLACE MLPS and RERUN Quick Test.																							
<table><tr><th rowspan="2">Transmission Shift Position</th><th colspan="2">Resistance (ohms)</th></tr><tr><th>Min</th><th>Max</th></tr><tr><td>P</td><td>3770</td><td>4607</td></tr><tr><td>R</td><td>1304</td><td>1593</td></tr><tr><td>N</td><td>660</td><td>807</td></tr><tr><td>D</td><td>361</td><td>442</td></tr><tr><td>2</td><td>190</td><td>232</td></tr><tr><td>1</td><td>78</td><td>95</td></tr></table> <ul style="list-style-type: none">Is MLPS OK?				Transmission Shift Position	Resistance (ohms)		Min	Max	P	3770	4607	R	1304	1593	N	660	807	D	361	442	2	190	232	1	78	95
Transmission Shift Position	Resistance (ohms)																									
	Min	Max																								
P	3770	4607																								
R	1304	1593																								
N	660	807																								
D	361	442																								
2	190	232																								
1	78	95																								

TD10439B

10 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST E: DIAGNOSTIC TROUBLE CODE: 99/624, 625, EPC CIRCUIT FAILURES

TEST STEP		RESULT	ACTION TO TAKE				
E1	E4OD ELECTRONIC DIAGNOSTICS						
<ul style="list-style-type: none">● The following items must be checked before proceeding:<ul style="list-style-type: none">— Check the Powertrain Control Module (PCM) assembly for proper function (On-Board Diagnostics).— Check the vehicle wiring harness for continuity and shorts to ground.— Make sure all connectors are engaged properly.— Make sure all terminals in the connectors are properly seated.— Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals.● Have the items above been checked?		Yes No	► GO to E2. ► PERFORM checks.				
E2	CHECK HARNESS CONNECTIONS						
<ul style="list-style-type: none">● Check that vehicle harness connector is fully engaged on transmission connector.● Check that vehicle harness connector terminals are fully engaged in connector and in good condition.● Are connector / terminals fully engaged?		Yes No	► GO to E3. ► SERVICE as required.				
E3	CHECK RESISTANCE OF SOLENOID						
<p>NOTE: Refer to the E4OD Transmission Tester for terminal locations.</p> <p>CAUTION: Remove heat shield from the transmission before removing connector. Remove solenoid body connector by pushing on the center tab and pulling up on the wiring harness. Do not attempt to pry tab with a screwdriver. Reinstall heat shield after service.</p> <ul style="list-style-type: none">● Disconnect vehicle harness at transmission.● Install Line pressure gauge at Line tap on case.● Install transmission tester (007-00085) to transmission connector.● Set Bench / Drive switch to BENCH mode.● Rotate gear select switch to OHMS / DIODE Check position.● Connect ohmmeter positive lead to VPWR jack and negative lead to EPC jack on tester. This is to test EPC solenoid.● Record resistance.● Resistance should be between 4.0 and 6.5 ohms.● Is the resistance between 4.0 and 6.5 ohms?		Yes No	► GO to E4. ► REPLACE solenoid body assembly. RECORD and ERASE codes. Repeat On-Board Diagnostics.				
E4	CHECK SOLENOID FOR SHORT TO GROUND						
<ul style="list-style-type: none">● Check for continuity between B- (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps). <table><tr><td>Solenoid</td><td>Tester Jack</td></tr><tr><td>EPC</td><td>EPC / VPWR</td></tr></table> <ul style="list-style-type: none">● Connection should show infinite resistance (no continuity).● Is there continuity?		Solenoid	Tester Jack	EPC	EPC / VPWR	Yes No	► REPLACE solenoid body assembly. RECORD and ERASE codes. Repeat On-Board Diagnostics. ► GO to E5.
Solenoid	Tester Jack						
EPC	EPC / VPWR						

DIAGNOSIS AND TESTING (Continued)**PINPOINT TEST E: DIAGNOSTIC TROUBLE CODE: 99/624, 625, EPC CIRCUIT FAILURES (Continued)**

TEST STEP		RESULT	ACTION TO TAKE
E5	TRANSMISSION FUNCTIONAL TEST		
	<ul style="list-style-type: none"> Set Bench / Drive switch to DRIVE mode. Rotate gear selector switch to GEAR SELECT "1" position. Using tests outlined in the tester manual perform EPC function test. <p>NOTE: LED will turn GREEN when solenoid activates and turn OFF when deactivated. LED will turn RED when an activated solenoid is shorted to B+. LED will remain OFF if an activated solenoid is shorted to ground or no continuity (open circuit).</p> <p>Observe the line pressure on the gauge while depressing the EPC switch (vehicle must be running).</p> <ul style="list-style-type: none"> Does the EPC (LED GREEN) activate when the EPC switch is depressed? Does the line pressure drop? 	<p>Yes</p> <p>No</p>	<p>Refer to Powertrain Control/Emission Diagnosis Manual¹¹ to diagnose PCM or vehicle harness concerns.</p> <p>REPLACE solenoid assembly.</p>

PINPOINT TEST G: DIAGNOSTIC TROUBLE CODE: 93/626 COAST CLUTCH SOLENOID CIRCUIT FAILURE (CCS)

TEST STEP		RESULT	ACTION TO TAKE
G1	E4OD ELECTRONIC DIAGNOSTICS		
	<ul style="list-style-type: none"> The following items must be checked before proceeding: <ul style="list-style-type: none"> Check the Powertrain Control Module (PCM) for proper function (On-Board Diagnostics). Check vehicle wiring harness for continuity and shorts to ground. Make sure all connectors are engaged properly. Make sure all terminals in the connectors are properly seated. Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals. Have items above been checked? 	<p>Yes</p> <p>No</p>	<p>GO to G2.</p> <p>PERFORM checks.</p>
G2	CHECK HARNESS CONNECTIONS		
	<ul style="list-style-type: none"> Check that vehicle harness connector is fully engaged on transmission connector. Check that vehicle harness connector terminals are fully engaged in connector and in good condition. Are connector/terminals fully engaged? 	<p>Yes</p> <p>No</p>	<p>GO to G3.</p> <p>SERVICE as required.</p>

11 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)


PINPOINT TEST G: DIAGNOSTIC TROUBLE CODE: 93/626 COAST CLUTCH SOLENOID CIRCUIT FAILURE (CCS)
(Continued)

TEST STEP		RESULT	ACTION TO TAKE				
G3	SOLENOID FUNCTIONAL TEST						
<p>CAUTION: Remove heat shield from the transmission before removing connector. Remove the solenoid body connector by pushing on the center tab and pulling on the wiring harness. Do not attempt to pry the tab with a screwdriver. Reinstall heat shield after service. Pull up on the vehicle harness.</p> <ul style="list-style-type: none">● Disconnect vehicle harness at transmission.● Install Tester 007-00085 or equivalent to transmission connector.● Using tests outlined in the tester instructions perform CCS solenoid function test. <p>NOTE: LED will turn GREEN when solenoid activates and turn OFF when deactivated. LED will turn RED when activated solenoid is shorted to B+. LED will remain OFF if an activated solenoid is shorted to ground or no continuity (open circuit).</p> <p>Perform the Diode Check.</p> <ul style="list-style-type: none">— Does the CCS (LED GREEN) activate when the tester switch is depressed?— Is the Diode OK (Diode LED GREEN)?		Yes No	<p>▶ GO to G4.</p> <p>▶ If a diode is bad, REPLACE solenoid body assembly. A bad diode may cause a processor concern. Repeat On-Board Diagnostics. Road test after solenoid body replacement. If diode is OK and no function, GO to G5.</p>				
G4	TRANSMISSION DRIVE TEST						
<ul style="list-style-type: none">● Perform the Drive test as outlined in the Transmission tester instructions.● While in third gear depress the CCS switch and immediately back off the throttle.● Does the CCS activate (LED GREEN)?● Does engine braking occur?● Does the Coast Clutch engage?		Yes No	<p>▶ Refer to the Powertrain Control/Emission Diagnosis Manual to diagnose processor and vehicle harness concerns.</p> <p>▶ GO to G5.</p>				
G5	CHECK RESISTANCE OF SOLENOID						
<p>NOTE: Refer to the E4OD Tester for terminal locations.</p> <ul style="list-style-type: none">● Set Bench/Drive switch to BENCH mode.● Rotate gear select switch to Ohms/Diode Check position.● Connect ohmmeter negative lead to CCS jack and positive lead to VPWR jack on tester.● Record resistance.● Resistance should be between 20 and 30 ohms.● Is resistance between 20 and 30 ohms?		Yes No	<p>▶ GO to G6.</p> <p>▶ REPLACE solenoid body assembly.</p>				
G6	CHECK SOLENOID FOR SHORT TO GROUND						
<ul style="list-style-type: none">● Check for continuity between B- (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps). <table border="1"><thead><tr><th>Solenoid</th><th>Tester Jack</th></tr></thead><tbody><tr><td>CCS</td><td>CCS/VPWR</td></tr></tbody></table> <ul style="list-style-type: none">● Connection should show infinite resistance (no continuity).● Is there continuity?		Solenoid	Tester Jack	CCS	CCS/VPWR	Yes No	<p>▶ REPLACE solenoid body assembly.</p> <p>▶ Refer to symptom diagnosis to diagnose Coast Clutch concerns under No Engine Braking.</p>
Solenoid	Tester Jack						
CCS	CCS/VPWR						



Shift Point Tests

This test verifies that the shift control system is operating properly.

1. Bring engine and transmission up to normal operating temperature.

2. Operate the vehicle with the transmission selector in  range.
3. Apply minimum throttle and observe the speeds at which the upshift occurs and the torque converter engages.

DIAGNOSIS AND TESTING (Continued)

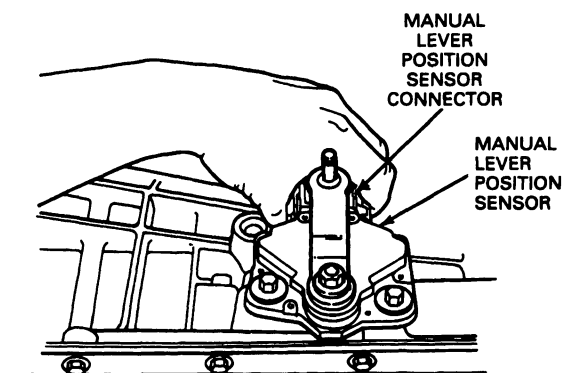
4. With the vehicle in OVERDRIVE (fourth gear), depress the Transmission Control Switch. The transmission should downshift to third gear. Remove foot from accelerator pedal; engine braking should occur.
5. Depress accelerator pedal to floor (WOT). Transmission should shift from third to second gear, or third to first depending on vehicle speed. Torque converter clutch should disengage and then reapply.
6. With vehicle  range above 80 km / h (50 mph) and less than half throttle, move the transmission selector from  range to manual 2 range and remove foot from accelerator pedal. The transmission should immediately downshift into second gear. With the vehicle remaining in manual 2 range, move transmission selector into manual 1 range, and release accelerator pedal. Transmission should downshift into first gear at speeds BELOW 48-56 km / h (30-35 mph).
7. If transmission fails to upshift / downshift or torque converter clutch does not apply and release, refer to Symptom charts for Condition / Cause diagnosis.

REMOVAL AND INSTALLATION**Transmission****Removal**

1. Disconnect negative battery cable at the battery.
2. Remove transmission dipstick.
3. Place transmission selector in NEUTRAL position.
4. Raise vehicle on a hoist and position suitable safety stands under vehicle.
5. Remove skid plate (4x4 vehicles).
6. On 4x4 models only, remove front driveshaft. Refer to Section 05-01.
7. Remove rear driveshaft. Refer to Section 05-01. On F-Super Duty vehicles, remove the transmission-mounted parking brake. Refer to Section 06-05.
8. Disconnect shift cable, or linkage on F-Super Duty Motorhome and Commercial vehicles. Refer to Section 07-05.
9. On 4x4 models only, (mechanical shift systems) remove shift linkage from transfer case shift lever. Refer to Section 07-05. Disconnect electrical connector at transfer case.

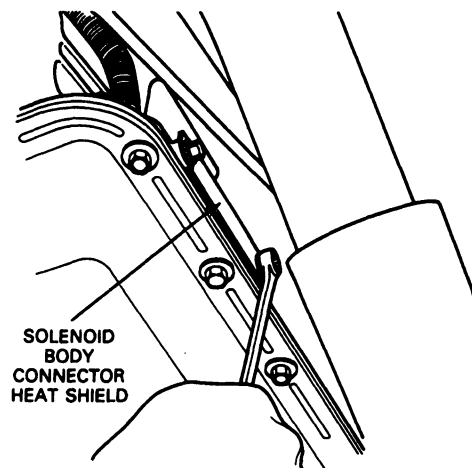
10. Remove manual lever position sensor connector by squeezing connector tabs and pulling on connector.

CAUTION: Do not attempt to pry tabs with pry bar or screwdriver.



D9160-C

11. Remove muffler and tail pipe assembly (5.8L Lightning Truck applications only).
12. Remove nuts retaining catalytic converter assembly to exhaust manifolds (5.8L Lightning Truck application only) and let assembly rest on frame.
13. To remove solenoid body connector heat shield, loosen two bolts using an 8mm wrench. Remove shield.

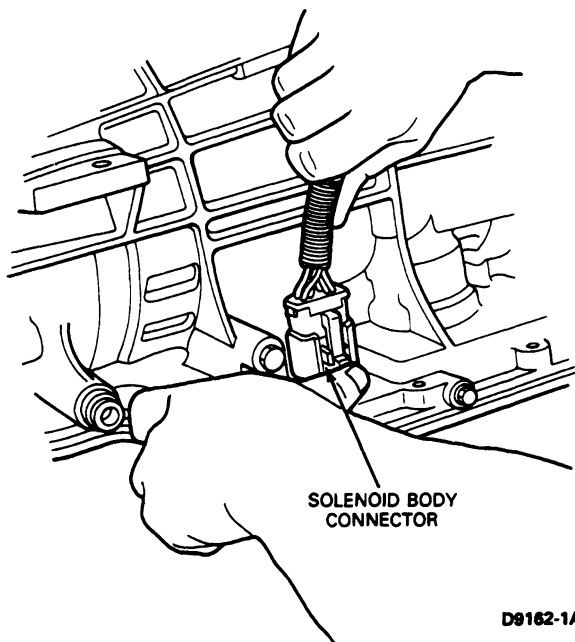


D9161-1A

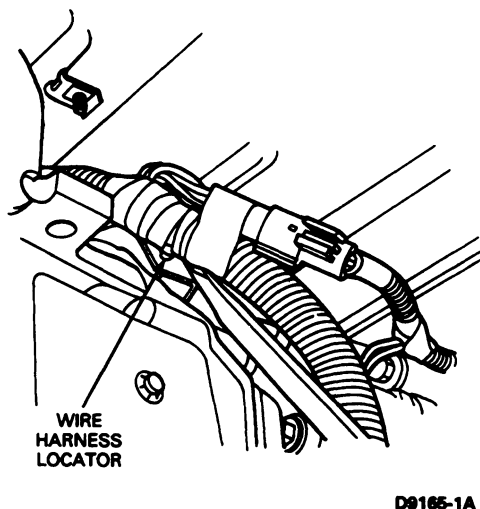
REMOVAL AND INSTALLATION (Continued)

14. Remove solenoid body connector carefully by pushing on the center tab and pulling on the wire harness.

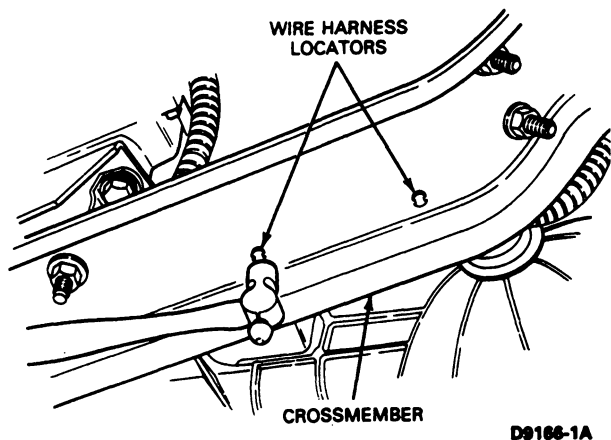
CAUTION: Do not attempt to pry tab with pry bar or screwdriver.



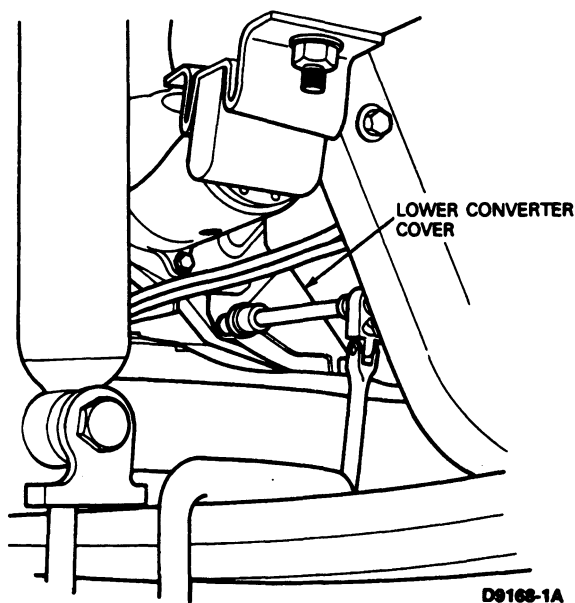
15. On 4x4 models only, remove four-wheel drive switch connector from transfer case. Use care not to overextend tabs.
16. Carefully pry wire harness locator from extension housing wire bracket.



17. On 4x4 models only, remove wire harness locators from left side of crossmember. Discard locators.

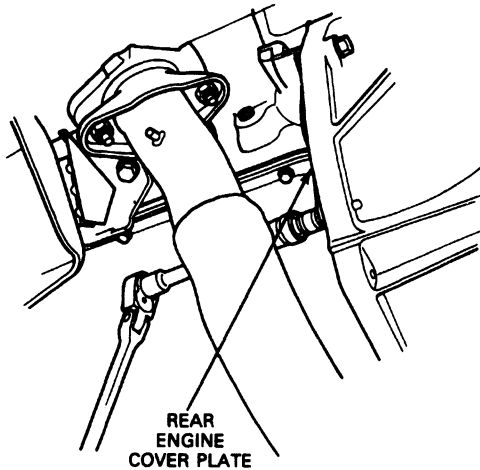


18. Remove lower converter cover bolts using a 10mm socket and remove cover.



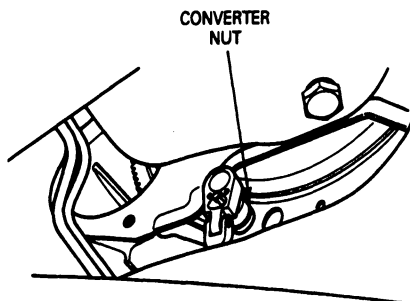
REMOVAL AND INSTALLATION (Continued)

19. Remove rear engine cover plate bolts.



D9169-1A

20. Remove starter. Refer to Section 03-06A.
 21. Remove access hole rubber plug. Use a 15/16 inch socket to rotate crankshaft to gain access to the converter drain plug. Remove plug. Drain converter.
 22. Rotate crankshaft bolt to gain access to converter nuts. Using a 9/16 inch socket, remove four converter mounting nuts and discard.

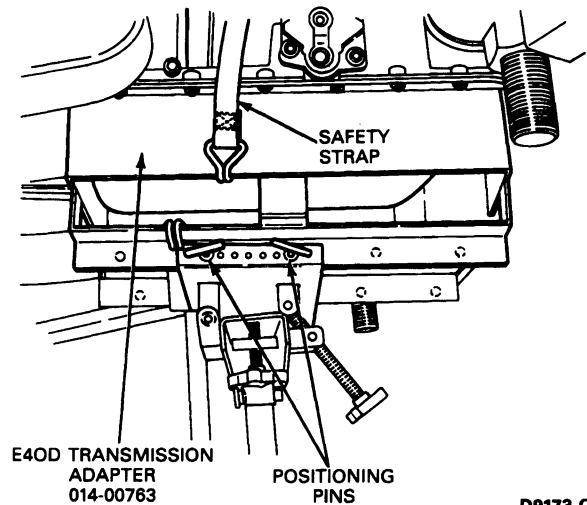


D9172-1A

23. Place Rotunda E4OD Transmission Adapter 014-00763 or equivalent on universal transmission jack and position adapter as in following illustration.

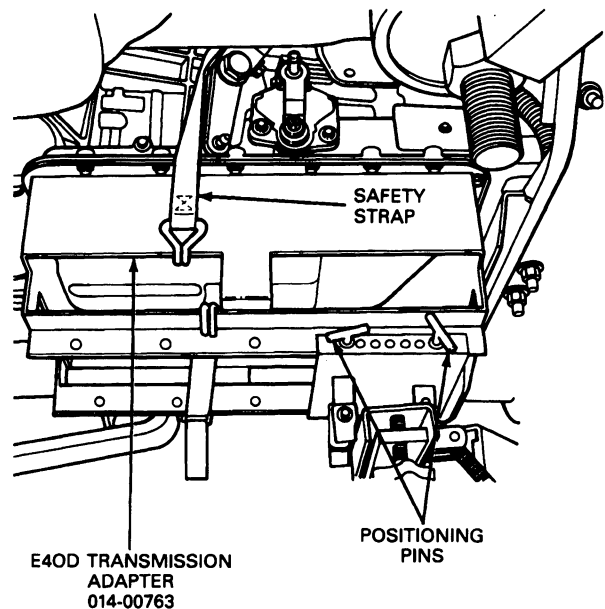
Placement of Positioning Pins

4 x 2 VEHICLES



D9173-C

4 x 4 VEHICLES



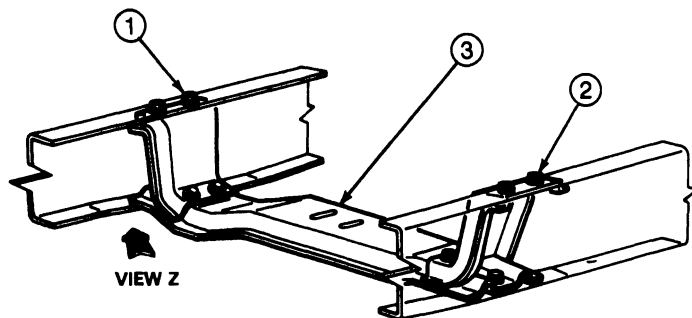
D9174-C

24. Use a safety strap to secure transmission.
 25. Remove the two rear transmission mounting pad nuts using an 18mm socket. Remove crossmember to frame bolts and remove crossmember from transmission.

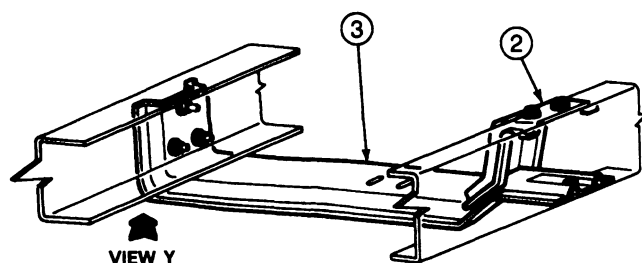
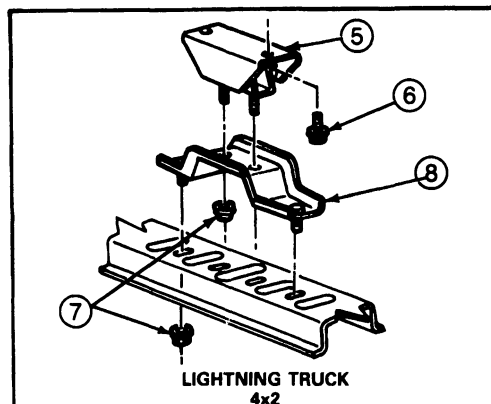
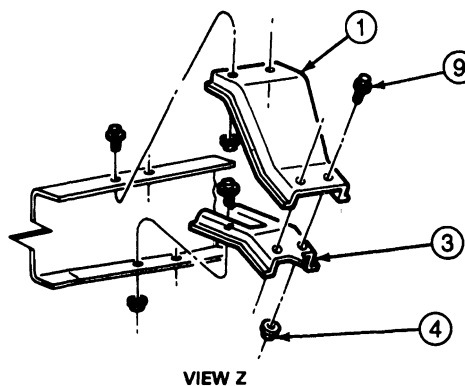
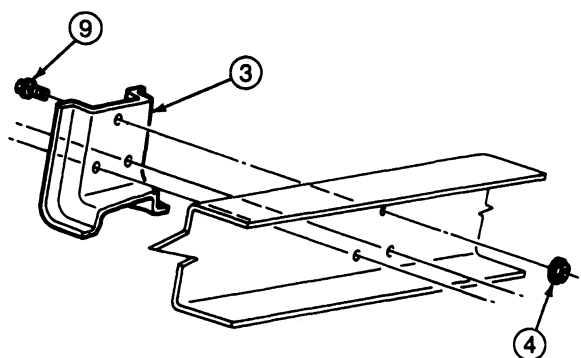
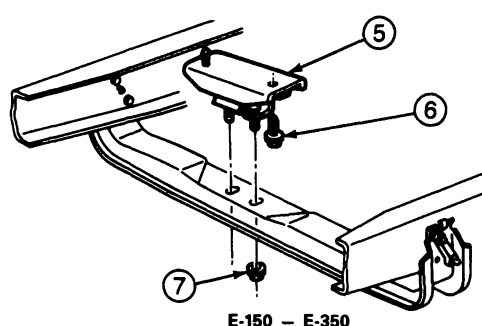
NOTE: Transmission may have to be raised to gain adequate clearance to remove crossmember.

REMOVAL AND INSTALLATION (Continued)

Crossmember Installation, E- and F-Series Vehicles



F-150-350 (4x2)

F-150 - F-350, BRONCO (4x4)
AND F-SUPER DUTY

D9955-B

Item	Part Number	Description
1	7R314	Gusset, RH
2	7F468	Gusset, LH
3	5060	Crossmember
4	N800937	Nut 59-77 N·m (43-57 Ft·Lb)
5	60091	Insulator and Retainer

(Continued)

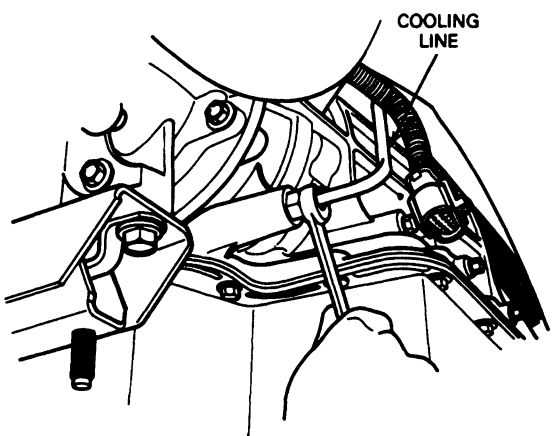
Item	Part Number	Description
6	390066	Screw and Washer
7	N621945	Nut and Washer 82-109 N·m (60-80 Ft·Lb)
8	7108	Transmission Support Bracket
9	N802114	Bolt

TD9955A

REMOVAL AND INSTALLATION (Continued)

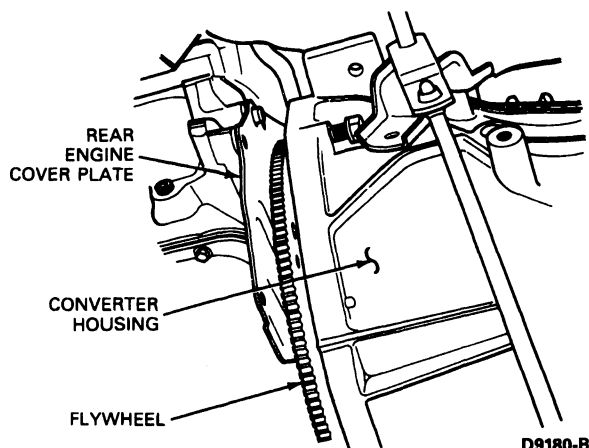
26. Remove transmission cooler lines using a 1/2-inch flare nut wrench from transmission case. Cap cooling lines and plug fittings at transmission. The F-Super Duty Motorhome Chassis requires the use of a 5/8-inch tube nut wrench.

NOTE: Case connector fitting should be held with wrench to prevent it from moving when loosening tube nut.



D9178-1A

27. Remove six converter housing bolts.
 28. Shift transmission assembly to the left and remove catalytic converter assembly from vehicle (5.8L Lightning Truck applications only).
 29. Back out transmission assembly from flywheel and gently lower while watching for any obstructions.

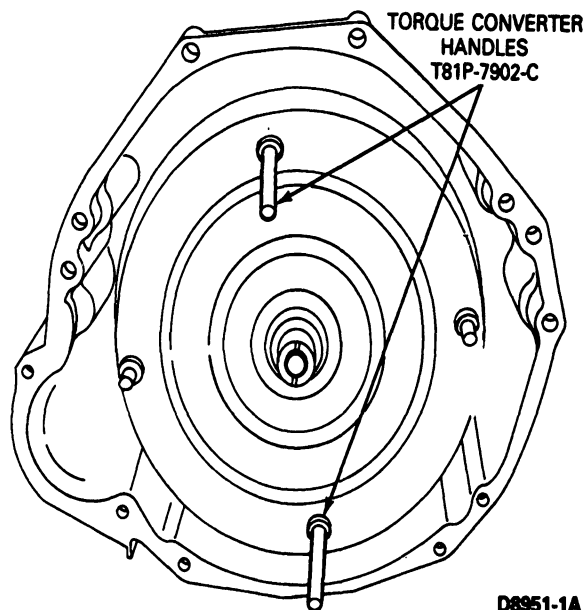


D9180-B

30. Install Torque Converter Handles T81P-7902-C on converter with handles in the 6 and 12 o'clock positions. Carefully remove converter assembly from transmission by pulling evenly on handles.

CAUTION: Torque converter is very heavy.

NOTE: Fluid loss will occur when torque converter is removed.



D8951-1A

31. Remove transmission filler tube from stub tube.
 32. On 4x4 models only, remove transfer case vent hose from detent bracket. Refer to Section 07-07A or 07-07B.
 33. On 4x4 models only, remove the transfer case from the transmission. Refer to Section 07-07A or 07-07B.

Installation

Before installing transmission, check wiring harness for damage. Check connectors for electrical integrity (terminal condition, corrosion, contamination and seal integrity). Repair or replace as required.

1. Place transmission onto E4OD Transmission Adapter 014-00763 or equivalent.
2. On 4x4 models only, install transfer case to transmission. Refer to Section 07-07A or 07-07B. On F-Super Duty Models, install transmission mounted parking brake. Refer to Section 06-05.

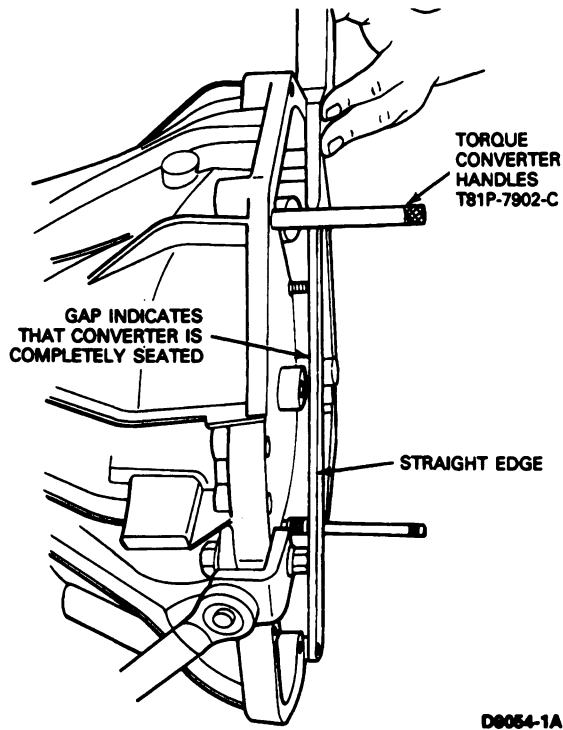
CAUTION: Use care when installing converter to avoid damage to the stator support Teflon® seal.

NOTE: Check the converter crankshaft pilot for nicks or damaged surfaces that could cause interference when installing the transmission to engine. Check the converter impeller hub for nicks or sharp edges that would damage the pump seal.

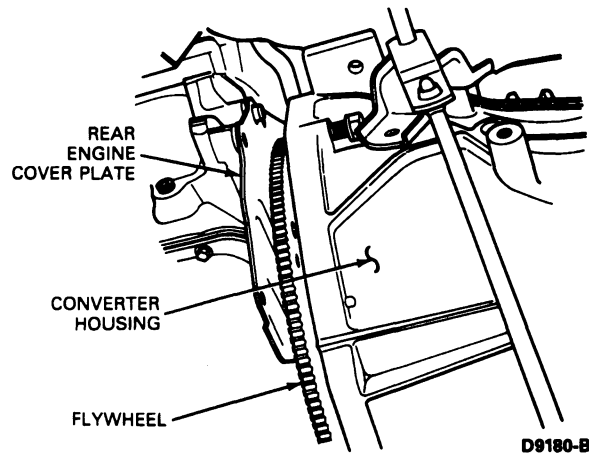
REMOVAL AND INSTALLATION (Continued)

3. Install torque converter using Torque Converter Handles T81P-7902-C. Carry converter with the handles in the 6 and 12 o'clock positions. Push and rotate the converter onto the pump until it bottoms out.

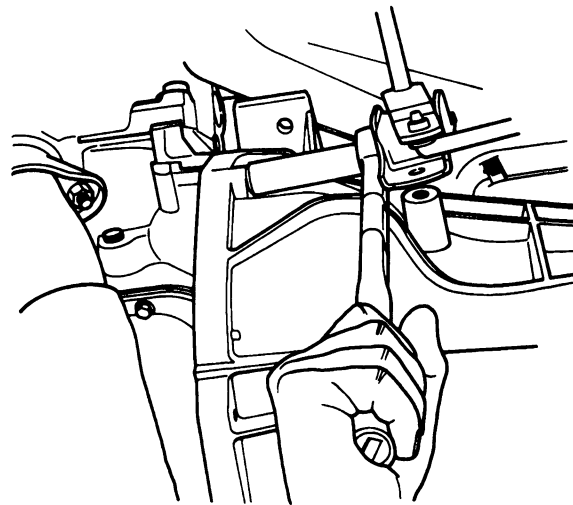
NOTE: Check the seating of the converter by placing a straightedge across the converter housing. There must be a gap between the converter pilot face and the straightedge.



4. Remove converter handles.
5. Check condition of filler tube O-ring, replace if damaged. Install filler tube.
6. Rotate converter studs to align with flywheel mounting holes.
7. Raise transmission into position while watching for any obstructions. Do not allow converter drive flats to disengage from pump gear. Rubber converter drain plug cover may be removed to aid in the alignment of the converter studs. Use care not to damage the flywheel and converter pilot. The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft.



8. Install transmission-to-engine bolts. Alternately snug-up bolts using a 5/8-inch socket. Alternately tighten bolts to 51-70 N·m (38-52 ft-lb) for gas engine applications, or to 66-90 N·m (49-66 ft-lb) for diesel engine applications.

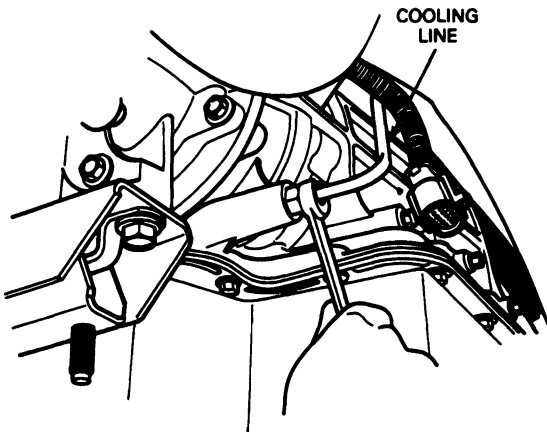


9. Install rubber converter drain plug cover, if removed.
10. Shift transmission assembly to the left and position catalytic converter assembly to the exhaust manifolds (5.8L Lightning Truck applications only). Refer to Section 09-00.

REMOVAL AND INSTALLATION (Continued)

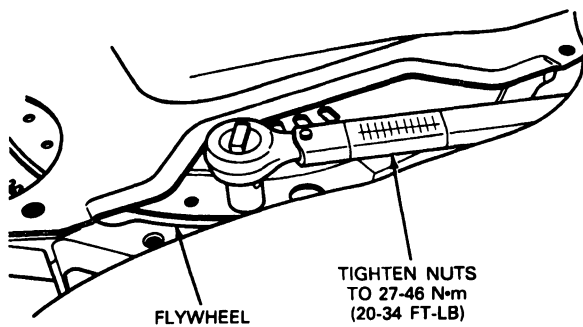
11. Install transmission cooling lines to transmission fittings. Tighten to 24-31 N·m (18-23 ft·lb) on all applications except F-Super Duty vehicles. Tighten cooler lines to 24-31 N·m (18-23 ft·lb) for F-Super Duty applications.

NOTE: Case connector fitting should be held with wrench to prevent it from moving when tightening tube nut.



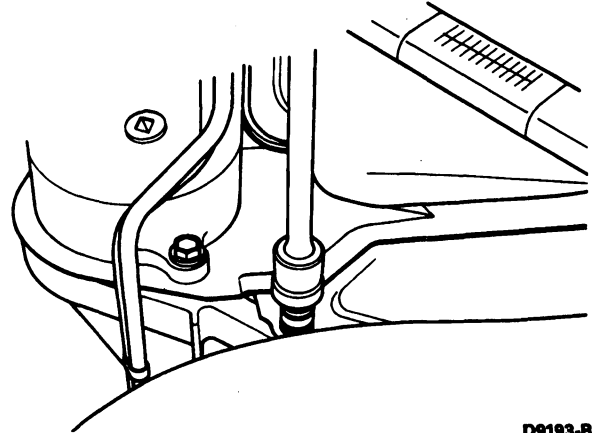
D9178-1A

12. Install crossmember and transmission retaining bolts. Make sure that wiring harness is properly routed.
13. Remove safety strap and universal high lift transmission jack.
14. Rotate crankshaft using a 15/16-inch socket on front pulley bolt to gain access to converter studs. Install new stud nuts using a 9/16-inch socket. Tighten to 27-46 N·m (20-34 ft·lb).



D9190-B

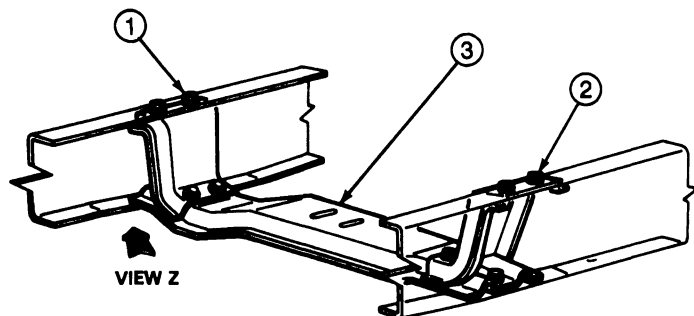
15. Install starter motor. Refer to Section 03-06A.
16. Install rear engine plate cover and lower dust cover bolts. Tighten to specifications.



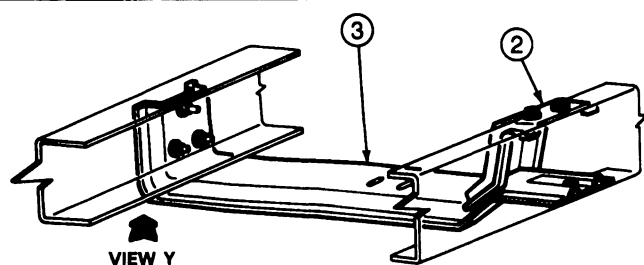
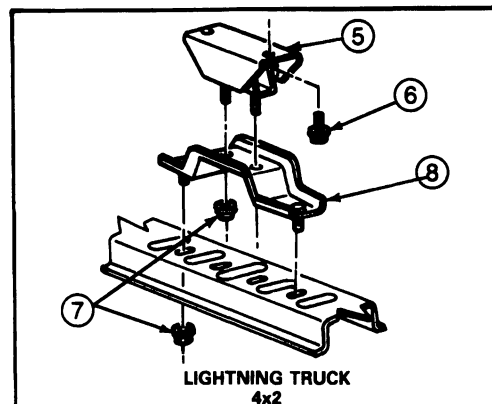
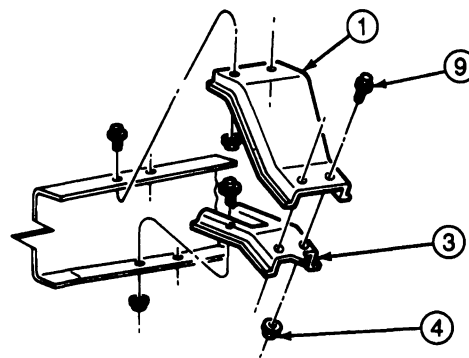
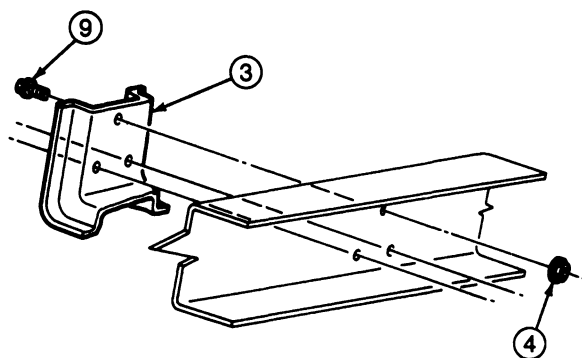
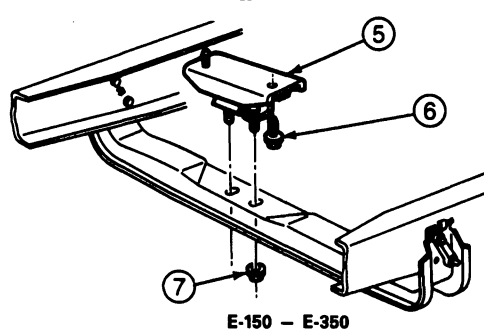
D9193-B

REMOVAL AND INSTALLATION (Continued)

Crossmember Installation, E- and F-Series Vehicles



F-150-350 (4x2)

F-150 - F-350, BRONCO (4x4)
AND F-SUPER DUTY

D9955-B

Item	Part Number	Description
1	7R314	Gusset, RH
2	7F468	Gusset, LH
3	5060	Crossmember
4	N800937	Nut 59-77 N·m (43-57 Ft·Lb)
5	60091	Insulator and Retainer

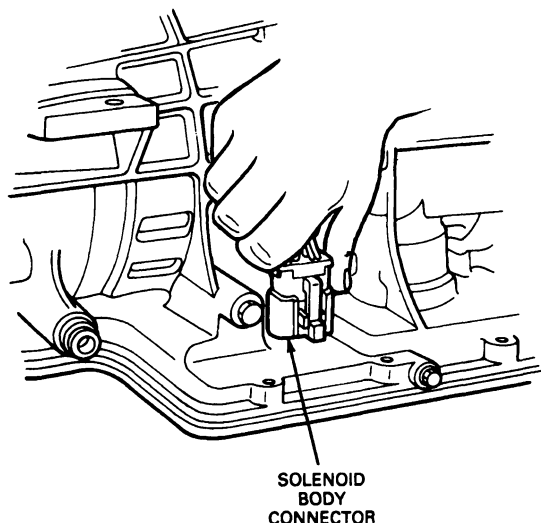
(Continued)

Item	Part Number	Description
6	390066	Screw and Washer
7	N621945	Nut and Washer 82-109 N·m (60-80 Ft·Lb)
8	7108	Transmission Support Bracket
9	N802114	Bolt

TD9955A

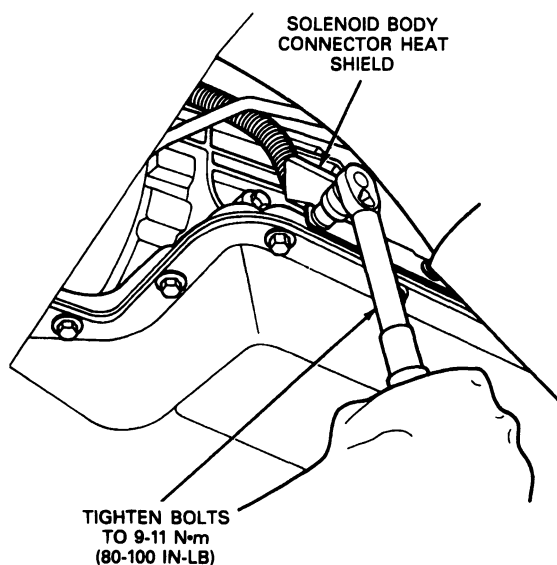
REMOVAL AND INSTALLATION (Continued)

17. Completely seat solenoid body connector into solenoid valve body receptacle by pushing on the top of the connector. An audible click indicates full contact. Verify connection by pulling on harness.



D9195-1B

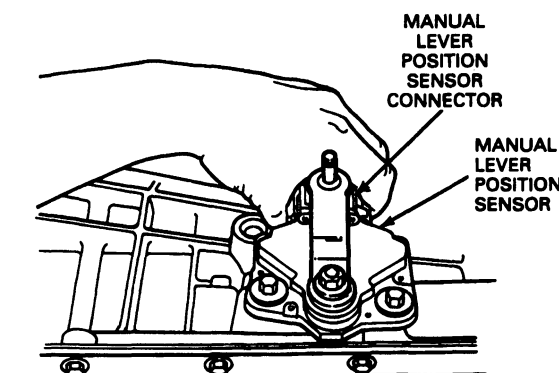
18. Install solenoid body connector heat shield with off-set bending inward. Tighten to 9-11 N·m (80-100 in-lb).



D9196-C

19. On 4x4 models only, install new wire harness locators into crossmember.
 20. Install new wire harness locator into extension housing wire bracket.
 21. Install four-wheel drive switch connector, if equipped.

22. Connect transfer case shift linkage, if equipped. Refer to Section 07-07B.
 23. Install manual lever position sensor connector. An audible click indicates full connection.



D9160-C

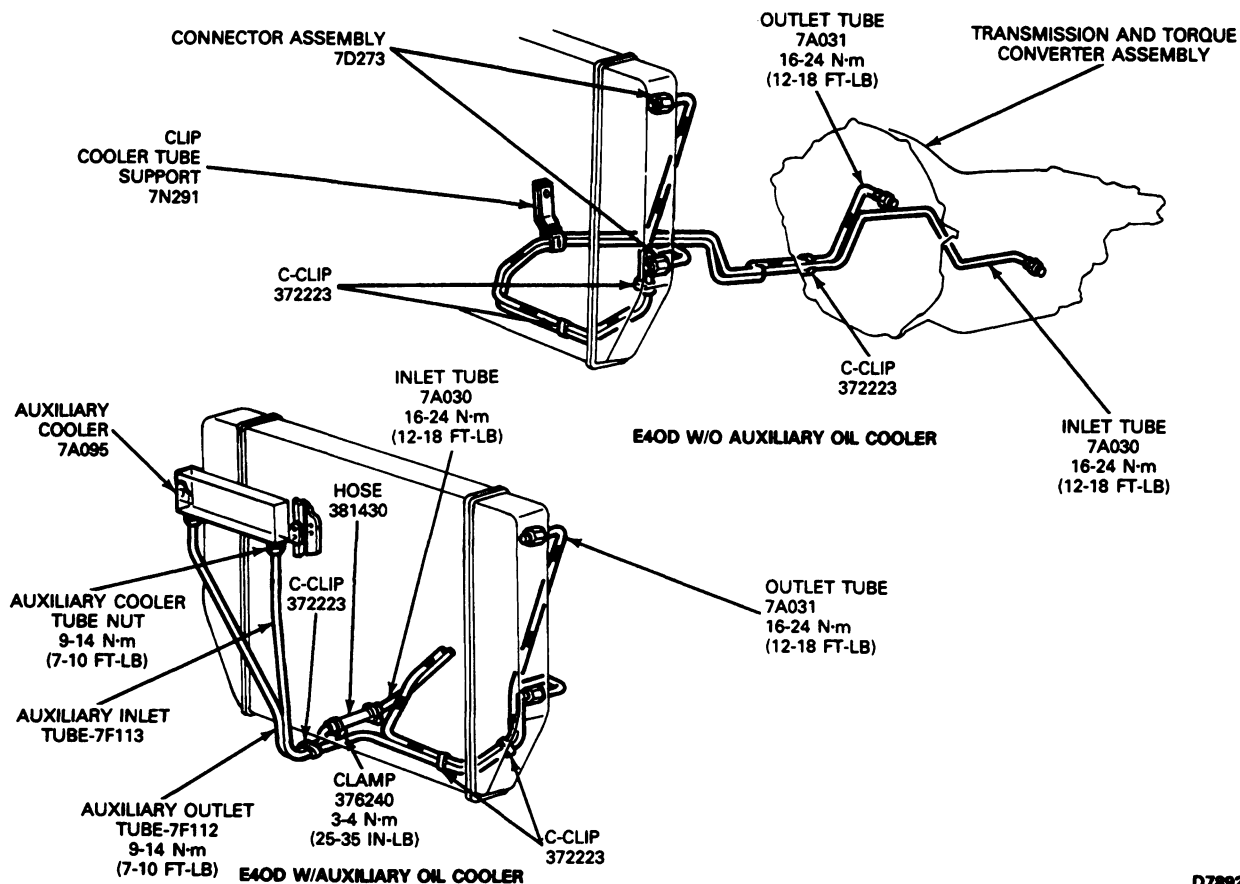
24. Install shift cable, or linkage on F-Super Duty Motorhome and Commercial vehicles. Refer to Section 07-05.
 25. Install parking brake cable (F-Super Duty). Refer to Section 06-05.
 26. Install muffler and tailpipe assembly. Refer to Section 09-00 (5.8L Lightning Truck applications only).
 27. Install rear driveshaft. Refer to Section 05-01.
 28. On 4x4 models only, install front driveshaft. Refer to Section 05-01.
 29. Remove safety stands and lower vehicle.
 30. Connect negative battery cable.
NOTE: On vehicles equipped with EEC-IV, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the PCM relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
 31. Fill the transmission to the proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) or equivalent. Refer to Fluid Capacity Chart under Specifications.

IN-VEHICLE SERVICE**Transmission Cooler Line Routing**

Refer to the following illustrations for transmission cooler line routing.

IN-VEHICLE SERVICE (Continued)

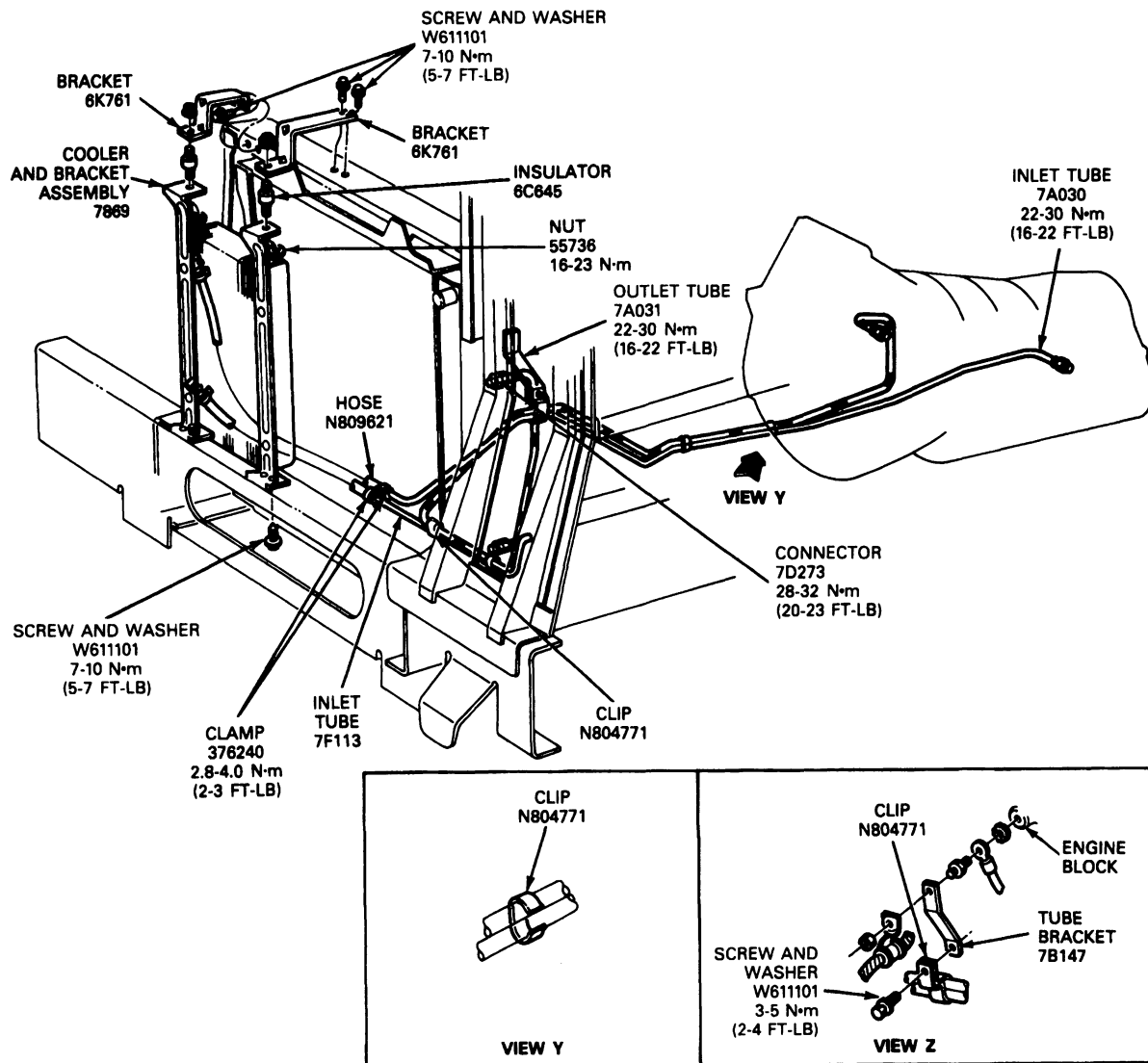
Transmission Cooler Lines, F-Series and Bronco (Except 4.9L Engine)



D7882-2A

IN-VEHICLE SERVICE (Continued)

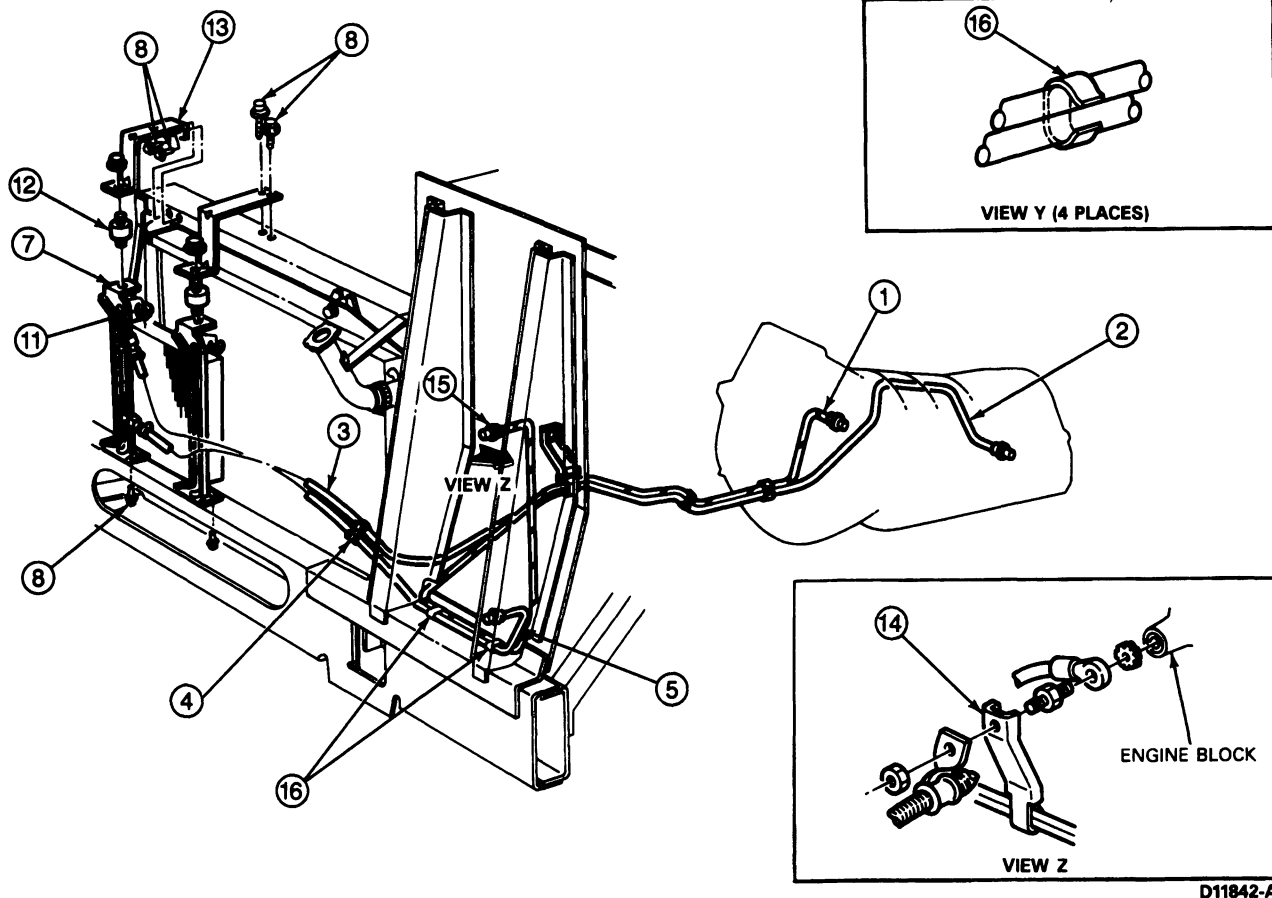
Transmission Cooler Lines, F-Super Duty Motorhome Chassis (Except Diesel)



D9954-B

IN-VEHICLE SERVICE (Continued)

1993-1/2 Transmission Cooler Lines, F-Super duty Motorhome Chassis (Except Diesel)



D11842-A

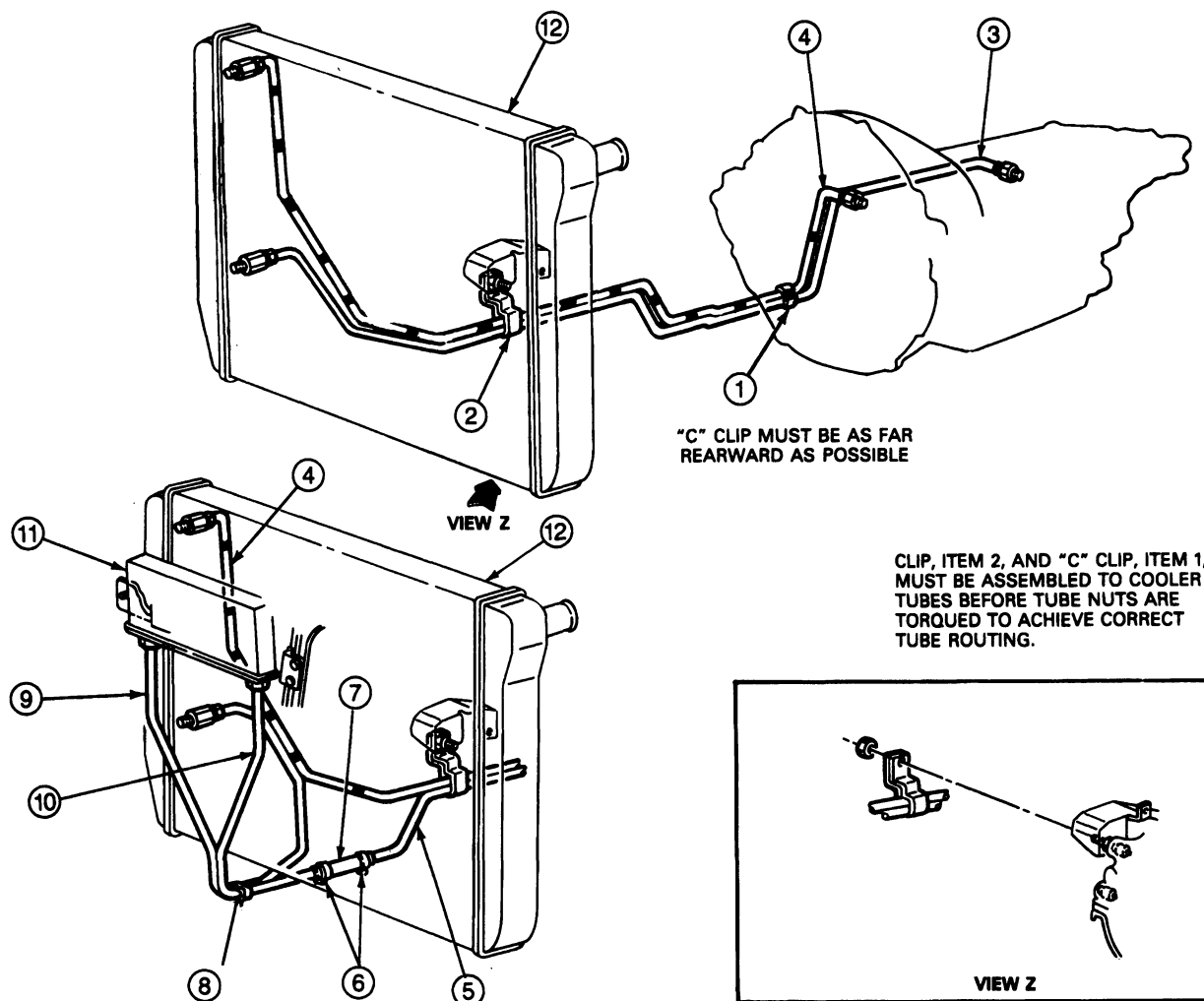
Item	Part Number	Description
1	7A031	Outlet Tube 16-24 N-m (12-18 Ft-Lb)
2	7A030	Inlet Tube 16-24 N-m (12-18 Ft-Lb)
3	N809635	Hose
4	376240	Clamp 3-4 N-m (2-3 Ft-Lb)
5	7F113	Inlet Tube 16-24 N-m (12-18 Ft-Lb)

(Continued)

Item	Part Number	Description
7	7869	Cooler and Bracket Assembly
8	N611102	Screw and Washer 7-10 N-m (5-7 Ft-Lb)
11	55736	Nut 16-23 N-m (12-17 Ft-Lb)
12	6C645	Insulator
13	6K761	Bracket
14	7N291	Clip
15	7D273	Connector 25-30 N-m (18-22 Ft-Lb)
16	372223	Clip

IN-VEHICLE SERVICE (Continued)

F-Series and Bronco (4.9L)



D10059-A

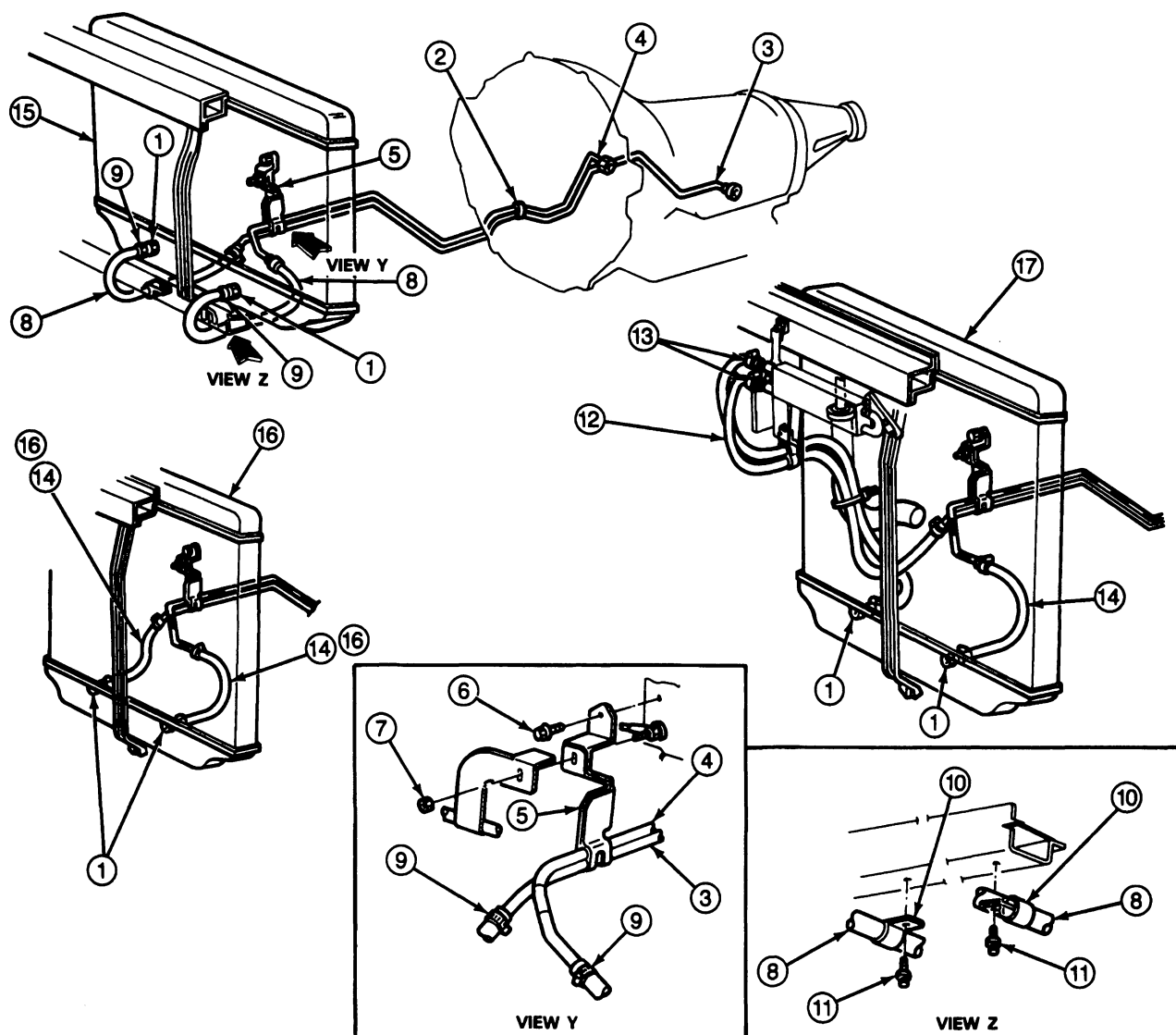
Item	Part Number	Description
1	372223-S56	C-Clip
2	7N291	Clip
3	7A030	Tube Assembly — Inlet 12-18 N·m (9-13 Ft·Lb)
4	7A031	Tube Assembly — Outlet 12-18 N·m (9-13 Ft·Lb)
5	7A030	Tube Assembly — Inlet (Aux.) 12-18 N·m (9-13 Ft·Lb)
6	376240-S	Clamp 3-4 N·m (25-35 Ft·Lb)

(Continued)

Item	Part Number	Description
7	381430-S035A	Hose
8	372223-S56	C-Clip
9	7F113	Tube Assembly — Inlet (Aux.) 12-18 N·m (9-13 Ft·Lb)
10	7F112	Tube Assembly — Outlet (Aux.) 12-18 N·m (9-13 Ft·Lb)
11	7A095	Oil Cooler Assembly — Auxiliary
12	8005	Radiator Assembly

IN-VEHICLE SERVICE (Continued)

F-250-350, F-Super Duty (7.3L)



D10061-A

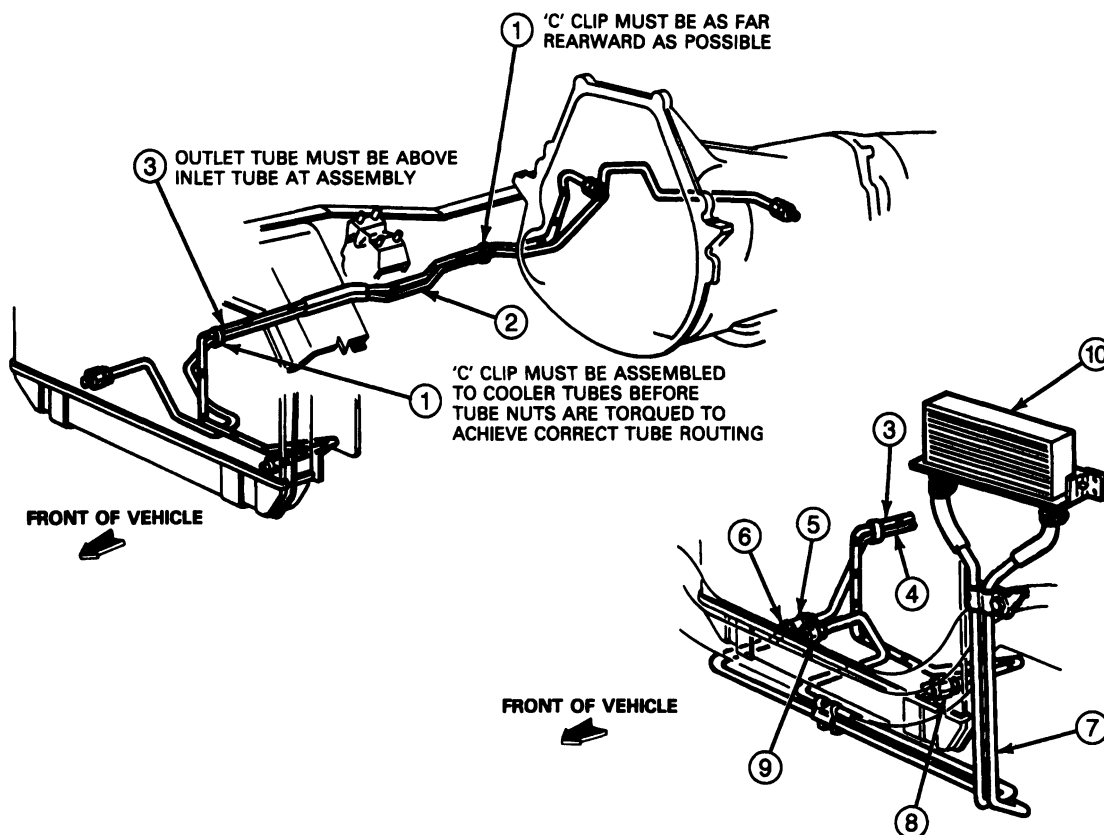
Item	Part Number	Description
1	390063	Connector (Part of 8005 Radiator)
2	372223-S56	C-Clip
3	7A030	Tube Assembly — Inlet 12-18 N-m (9-13 Ft-Lb)
4	7A031	Tube Assembly — Outlet 12-18 N-m (9-13 Ft-Lb)
5	7N291	Clip — Cooler Tube Support
6	57643	Screw and Washer 3/8-16 x .62
7	33799	Nut 3/8-16 12-18 N-m (9-13 Ft-Lb)
8	381430-S240A	Hose

(Continued)

Item	Part Number	Description
9	376240-S	Clamp 3-4 N-m (25-35 In-Lb)
10	357946-S100	Clip
11	W611101-S2	Screw and Washer 4-6 N-m (35-53 In-Lb)
12	7890	Hose Assembly
13	376240-S100	Clamp 3-4 N-m (25-35 In-Lb)
14	381430-S100A	Hose
15	8005	Radiator Assembly (585 Sq. In — Without Auxiliary Cooler)
16	8005	Radiator Assembly (735 Sq. In — Without Auxiliary Cooler)
17	8005	Radiator Assembly (735 Sq. In — With Auxiliary Cooler)

IN-VEHICLE SERVICE (Continued)

Econoline (Except 7.3L)



D10063-A

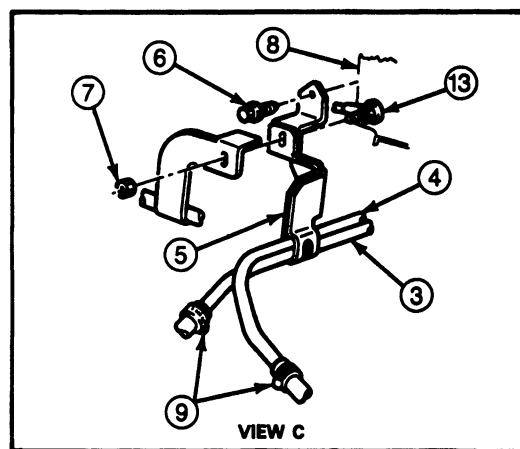
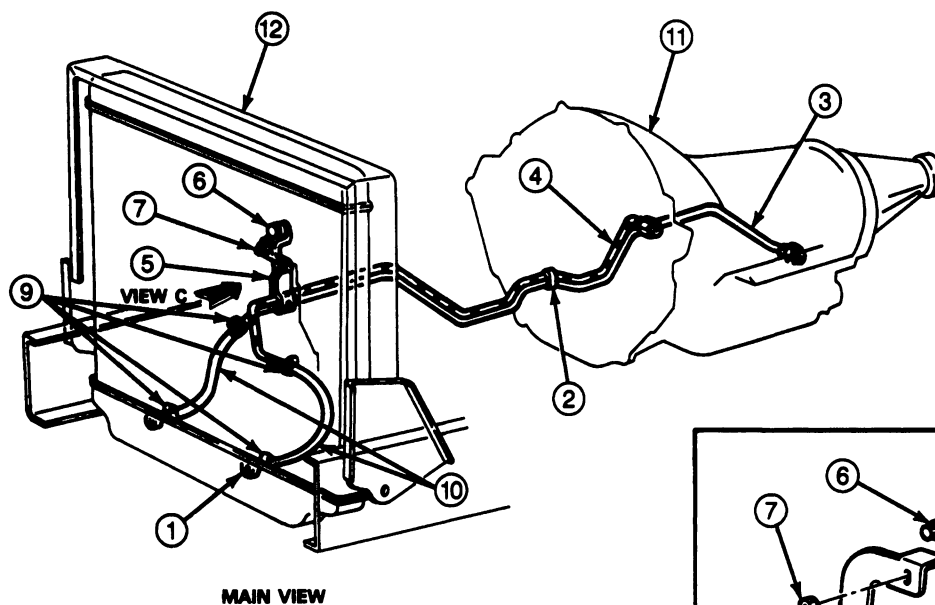
Item	Part Number	Description
1	372223-S56	C-Clip
2	7A030	Tube Assembly — Inlet 16-24 N·m (12-18 Ft-Lb)
3	7A031	Tube Assembly — Outlet 16-24 N·m (12-18 Ft-Lb)
4	7A030	Tube Assembly — Inlet (Auxiliary) 16-24 N·m (12-18 Ft-Lb)
5	381430-S035A	Hose

(Continued)

Item	Part Number	Description
6	376240-S	Clamp 3-4 N·m (25-35 Ft-Lb)
7	7H168	Tube Assembly — Transmission Oil — Dual
8	7D273	Connector Assembly (Part of Radiator) 23-31 N·m (17-23 Ft-Lb)
9	7D273	Connector Assembly (Part of Radiator) 23-31 N·m (17-23 Ft-Lb)
10	7A095	Cooler Assembly — Auxiliary

IN-VEHICLE SERVICE (Continued)

F-Super Duty Commercial Chassis (7.3L)



D10065-A

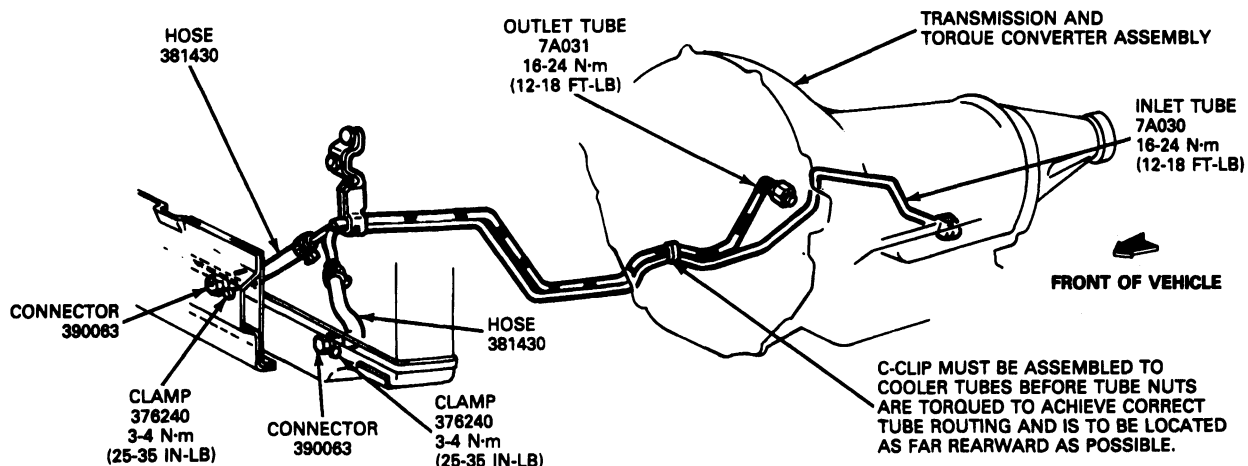
Item	Part Number	Description
1	390063	Connector (Part of 8005 Radiator)
2	372223-S56	C-Clip
3	7A030	Tube Assembly — Inlet 16-25 N-m (12-18 Ft-Lb)
4	7A031	Tube Assembly — Outlet 16-25 N-m (12-18 Ft-Lb)
5	7N291	Clip, Cooler Tube Support
6	57643	Screw and Washer 3/8-16 x .62 Hex Head

(Continued)

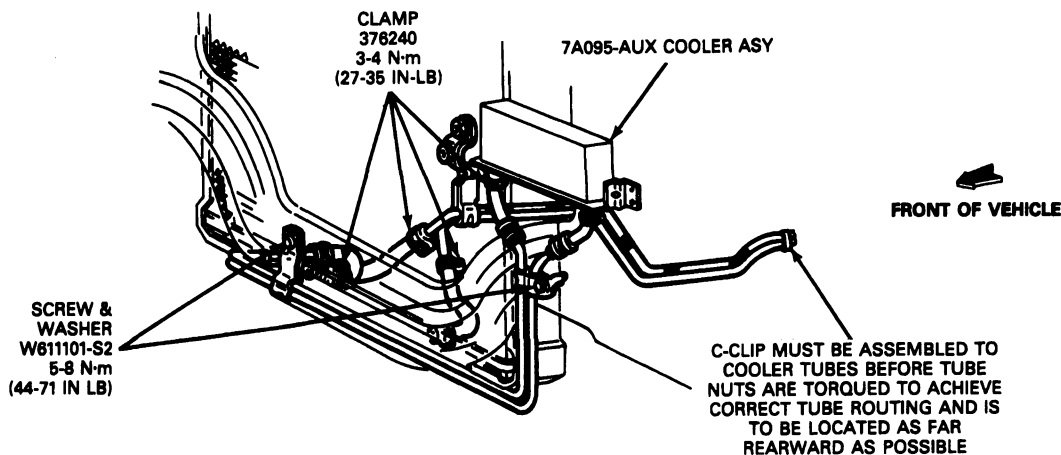
Item	Part Number	Description
7	33799	Nut 3/8-16 Hex 16-25 N-m (12-18 Ft-Lb)
8	6007	Engine Block
9	376240-S	Clamp, Hose 2.8-4.0 N-m (25-35 Ft-Lb)
10	N809635-S276A	Hose 7.9mm ID Hydraulic
11	7000	Transmission Assembly
12	8005	Radiator Assembly
13	—	Cable, Battery ground (Reference Only)

IN-VEHICLE SERVICE (Continued)

Transmission Cooler Lines, E-250-350 (7.3L Diesel)



E4OD W/O AUXILIARY OIL COOLER



E4OD W/AUXILIARY OIL COOLER

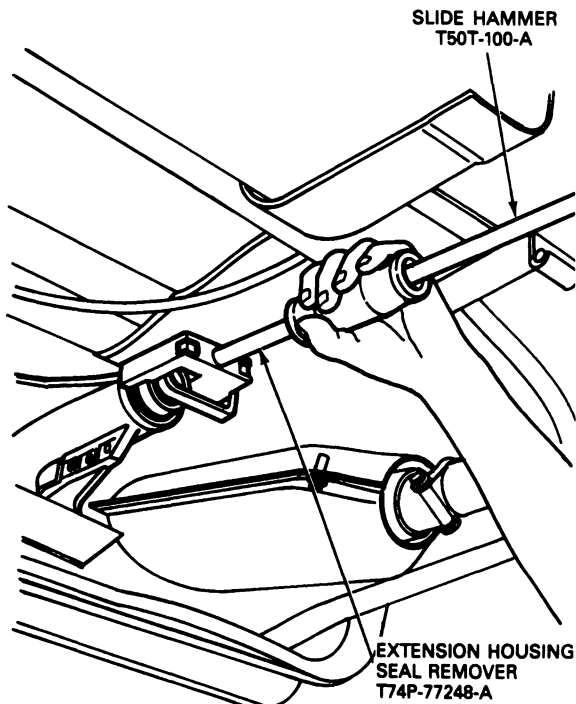
D7693-C

Extension Housing Seal and Bushing

Removal

1. Raise vehicle on a hoist and position suitable safety stands under vehicle.
2. Remove rear driveshaft. Refer to Section 05-01.

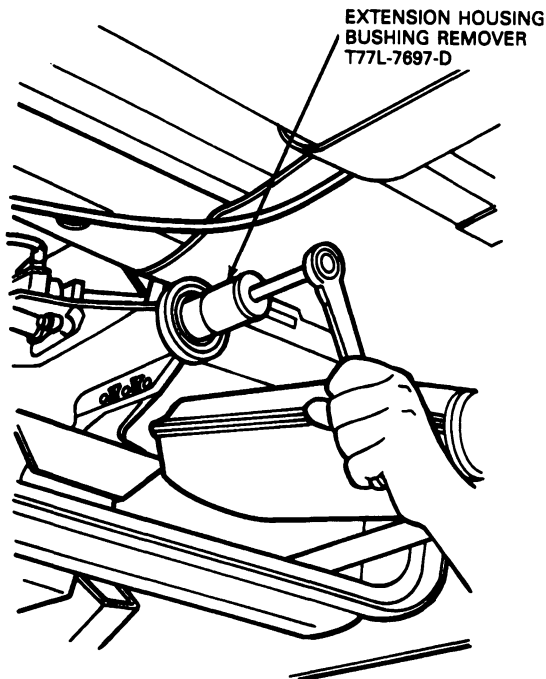
IN-VEHICLE SERVICE (Continued)



D10074-A

CAUTION: Use the bushing remover carefully so that the seal area is not damaged.

4. Remove the bushing using Extension Housing Bushing Remover T77L-7679-D.

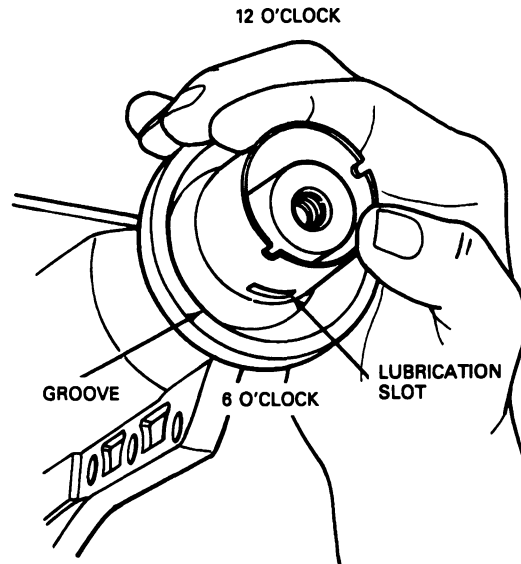


D10075-A

Installation

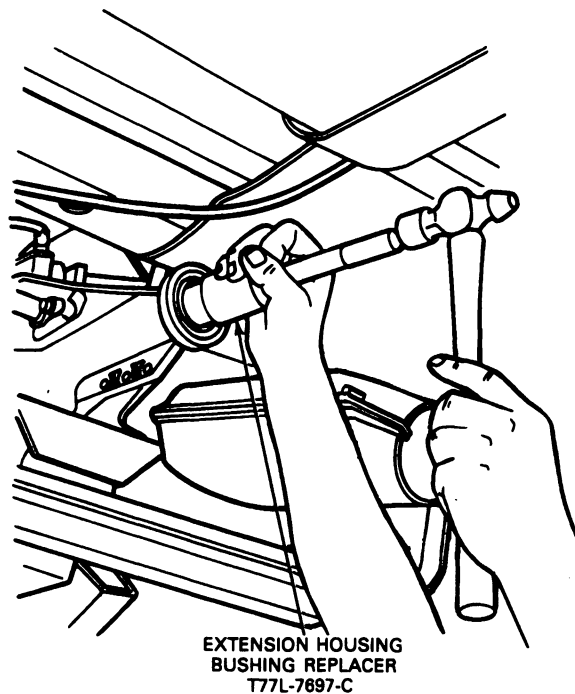
1. Inspect the counter bore of the housing for burrs. If necessary, remove burrs with an oil stone.

2. Align lubrication slots in the extension housing bushing with groove in extension housing (6 o'clock).



D10676-A

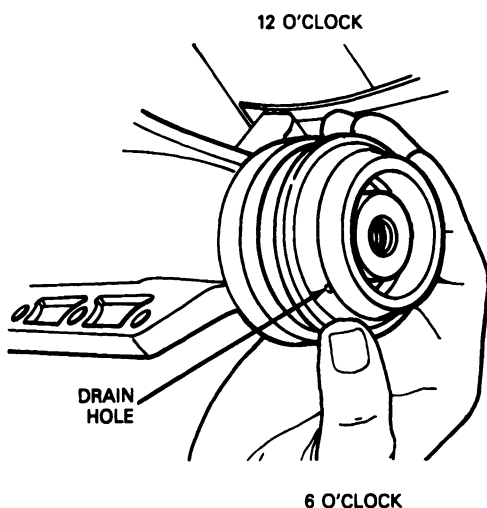
3. Install extension housing bushing using Extension Housing Bushing Replacer T77L-7697.



D10677-A

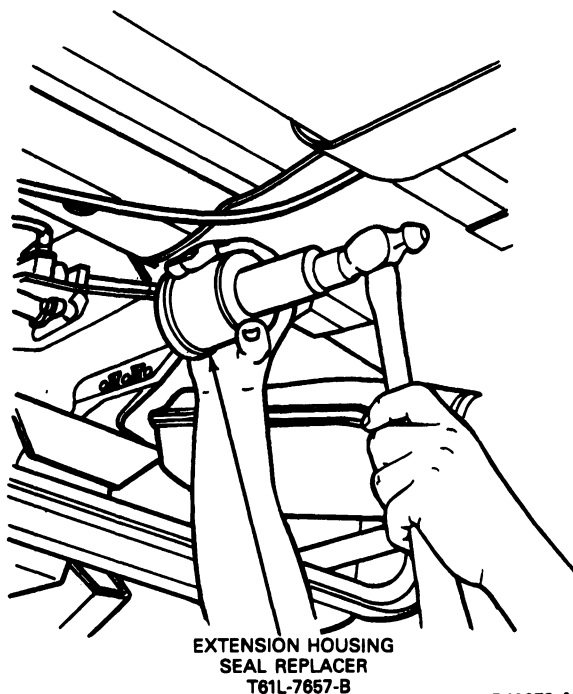
IN-VEHICLE SERVICE (Continued)

4. Position new extension housing seal with drain hole positioned downward (6 o'clock).



D10678-A

5. Seat seal using Extension Housing Seal Replacer T61L-7657-B.



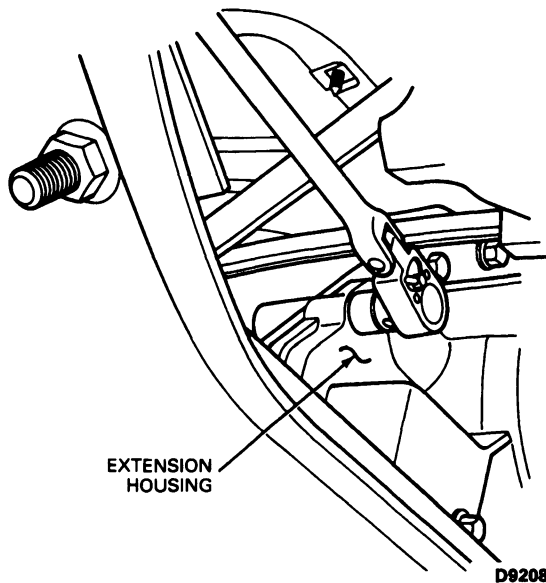
D10679-A

NOTE: Inspect driveshaft slip yoke. Replace if damaged or worn.

6. Install driveshaft as outlined in Section 05-01.
7. Remove safety stands and lower vehicle.

Extension Housing Gasket**Removal**

1. Raise vehicle on hoist and position suitable safety stands under vehicle.
2. Remove front (4x4 only) and rear driveshaft. Refer to Section 05-01.
3. Remove parking brake assembly (F-Super Duty vehicles). Refer to Body / Chassis Manual, Section 06-05.
4. Remove transfer case assembly (4x4 vehicle). Refer to Section 07-07A or 07-07B.
5. Remove transmission mounting pad nuts and bolts. Refer to the transmission removal procedures for crossmember illustrations.
6. Carefully remove wire harness locators from extension housing wire bracket.
7. Position jack under transmission and raise transmission.
8. Remove nine extension housing bolts using a 13mm wrench. Remove wiring bracket.



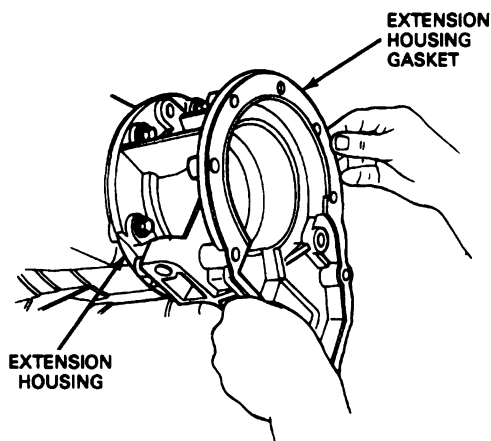
D9208-B

9. Remove and discard extension housing gasket from housing and mating surfaces.

IN-VEHICLE SERVICE (Continued)**Installation**

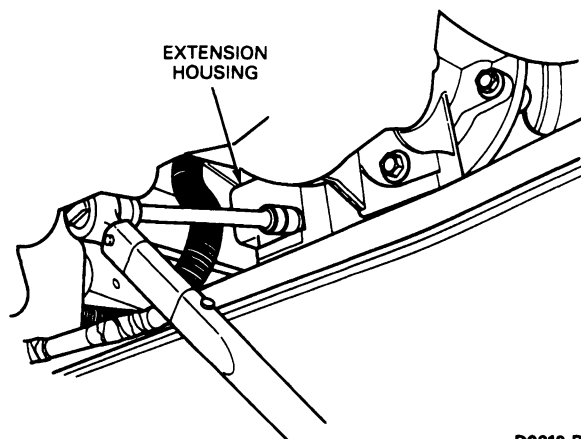
1. Clean extension housing and transmission mating surfaces. Place a light film of petroleum jelly on the extension housing gasket and position gasket on the extension housing.

NOTE: Make sure parking pawl spring is fully seated into the case prior to installing extension housing.



D9208-1A

2. Raise extension housing into position. Position wiring bracket.
3. Install nine extension housing bolts using a 13mm socket. Tighten to 27-39 N·m (20-29 ft·lb) on 4x2 applications, or to 33-54 N·m (24-40 Ft·Lb) for 4x4 applications.



D9210-B

4. On 4x4 models only, attach transfer case vent hose to detent plate. Refer to Section 07-07A or 07-07B.

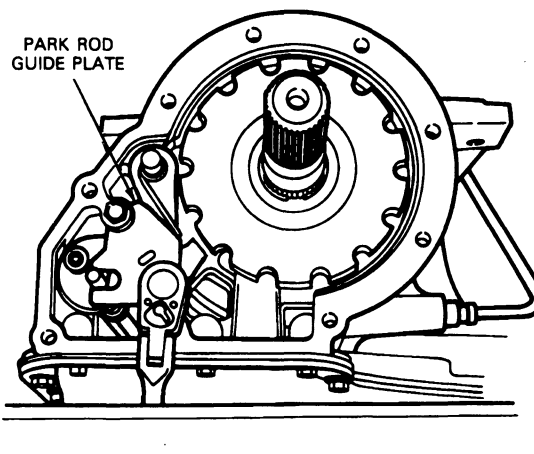
5. Install four-wheel drive connector, if equipped.
6. Install new wire harness locator into extension housing wire bracket.
7. Install transmission mounting pad bolts and nuts and tighten to 82-109 N·m (60-80 ft·lb) for all F-Series or 68-95 N·m (50-70 ft·lb) for all E-Series.
8. Remove universal high lift transmission jack.
9. Install front (4x4 only) and rear driveshaft. Refer to Section 05-01.
10. Fill the transmission to the proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) or equivalent as outlined.

Parking Mechanism

Follow extension housing gasket replacement procedure for removal and installation of extension housing.

Removal and Installation

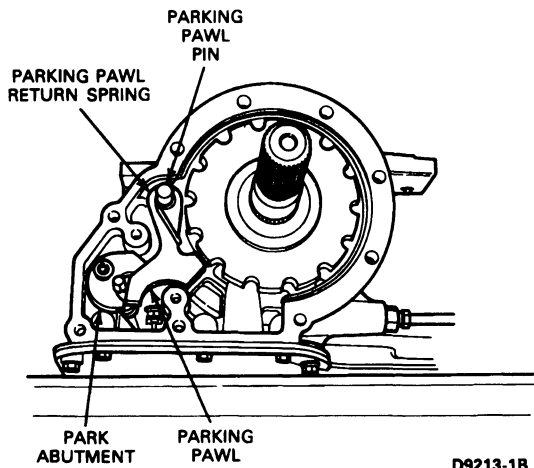
1. Remove two bolts using a 13mm socket from park rod guide plate, then remove guide plate.



D9212-1B

IN-VEHICLE SERVICE (Continued)

2. Remove parking pawl return spring, pin and parking pawl from case.



D9213-1B

For installation, follow removal steps in reverse order. Make sure spring end rests on inside surface of case. Also make sure dimple on guide plate faces inward when installed. Tighten guide plate bolts to 22-27 N·m (16-20 ft·lb).

NOTE: For internal park mechanism service, refer to manual lever seal removal and installation procedures in this section.

Valve Bodies and Intermediate Band Servo

NOTE: If a transmission has been disassembled to replace worn or damaged parts and the valve body sticks repeatedly from foreign material, the torque converter must be removed and cleaned by using a mechanically agitated cleaner, such as Rotunda Torque Converter / Oil Cooler Cleaner 014-00028 or equivalent.

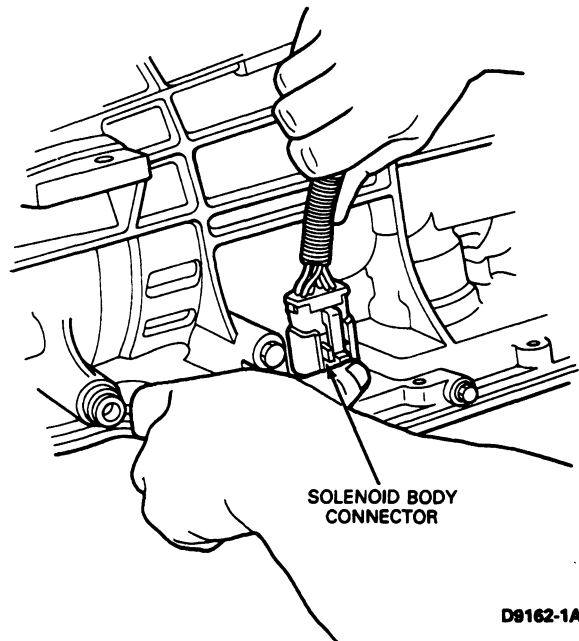
Removal

If solenoid valve body is going to be replaced:

- Remove solenoid body connector heat shield and loosen both bolts using an 8mm socket.
- Remove slotted heat shield.

CAUTION: Do not attempt to pry tab with pry bar or screwdriver. Remove the heat shield from the transmission before attempting to remove the connector.

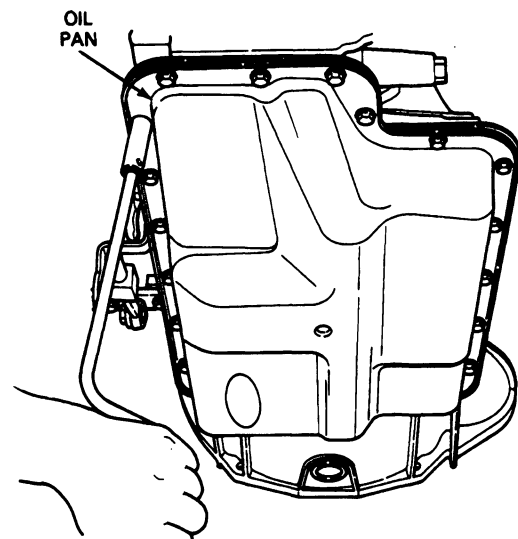
- Remove solenoid body connector by pushing on the center tab and pulling on the wire harness.



D9162-1A

- Check electrical connectors for terminal condition, corrosion and contamination. Repair or replace as required.

1. Position a drain pan under transmission.
2. Remove all transmission pan bolts except the front ones using a 10mm socket. Loosen only the front bolts at this time.



D8954-B

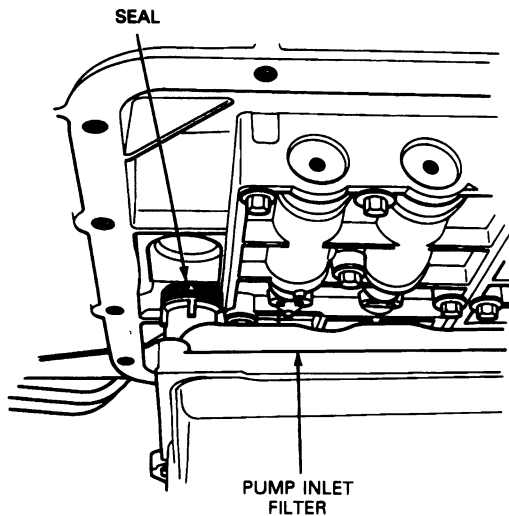
3. Pry the rear of the pan down and allow the fluid to drain.
4. Remove front pan bolts using a 10mm socket. Remove transmission pan.

IN-VEHICLE SERVICE (Continued)

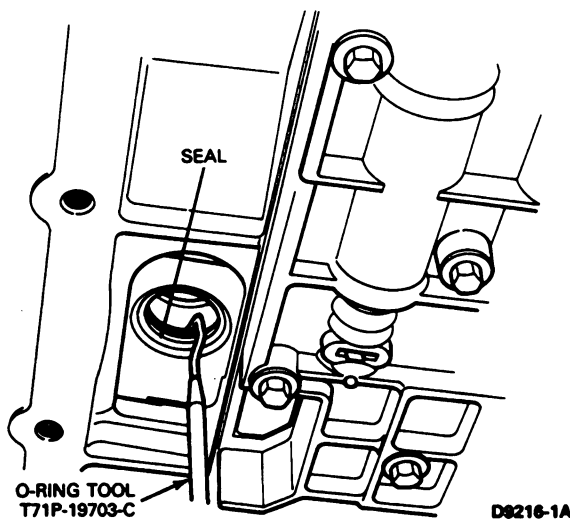
5. Remove pump inlet filter and seal assembly by carefully pulling and rotating the filter as necessary. If seal remains in bore, carefully remove using O-Ring Tool T7 1P-19703-C.

NOTE: Discard pump inlet filter and seal.

CAUTION: Use care not to scratch or damage aluminum pump bore.

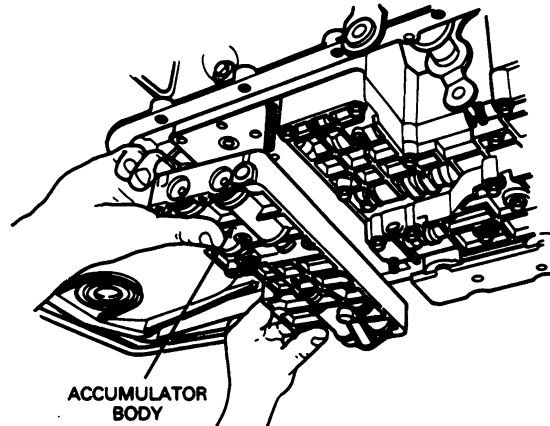


D9215-C



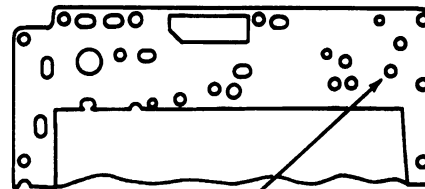
D9216-1A

6. Remove 11 accumulator body bolts using an 8mm socket and two nuts using a 10mm socket. Remove accumulator body assembly.



D9217-1A

NOTE: If separator plate is to be left on the transmission, use one of the reinforcing plate bolts in the hole shown to prevent front of plate from sagging and displacing balls.



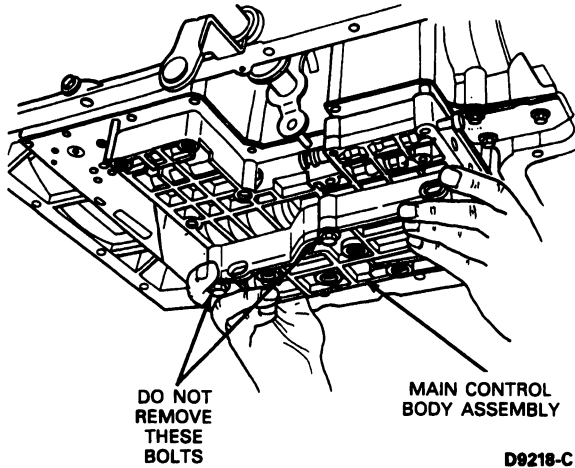
INSTALL REINFORCING PLATE BOLT HERE TO SECURE PLATE AND MAINTAIN BALL LOCATION IF BODIES ARE REMOVED AND PLATE IS LEFT ON TRANSMISSION

D8562-B

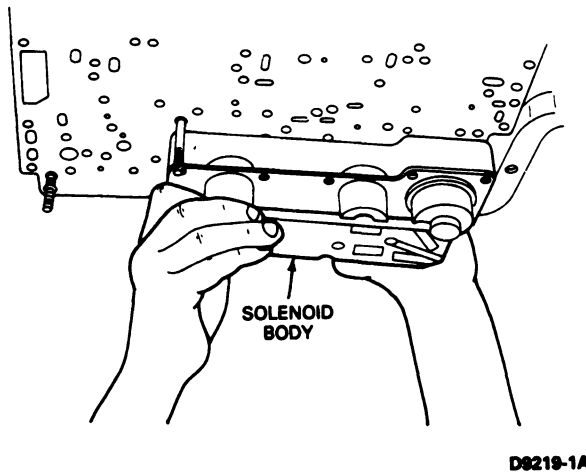
IN-VEHICLE SERVICE (Continued)

7. Remove 14 main control body bolts using an 8mm socket and two nuts using a 10mm socket. Remove main control body.

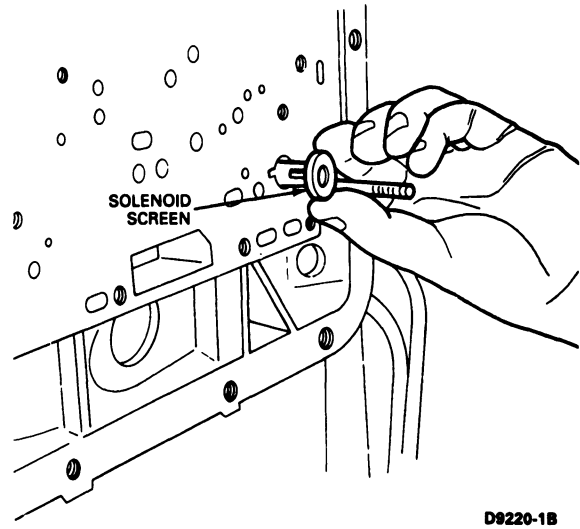
NOTE: Do not remove the two bolts as shown on illustration. This will keep the upper and lower control bodies attached as an assembly.



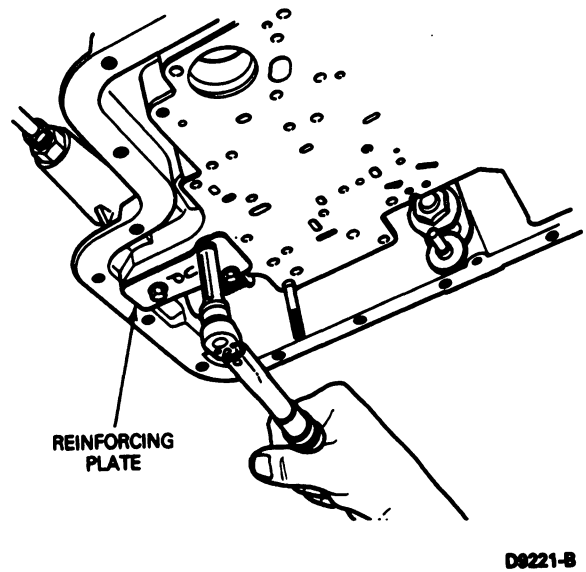
8. Remove nine solenoid body bolts using a T30 Torx® bit and one nut using a 10mm socket. Push down on solenoid body receptacle to remove solenoid body.



9. Remove solenoid screen by rotating and pulling it out.

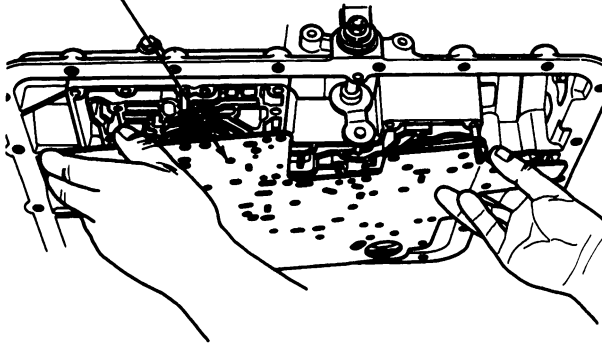


10. Remove reinforcing plate bolts using an 8mm socket. Remove plate.



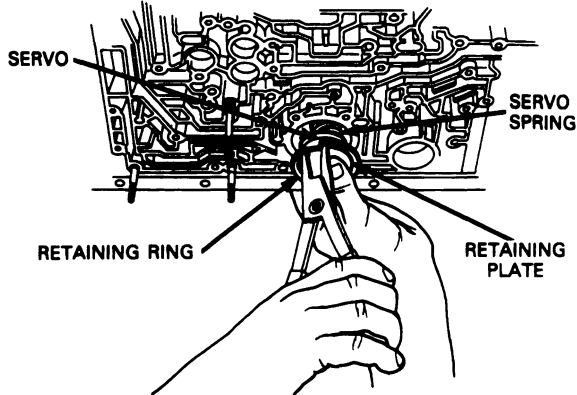
IN-VEHICLE SERVICE (Continued)

11. Lower separator plate and gasket carefully so that check balls, EPC ball and spring are retained.

SEPARATOR PLATES
AND GASKETS

D9222-B

12. Remove intermediate accumulator regulator filter and spring assembly. Clean or replace filter as required.
13. Depress retaining plate, remove retaining ring, retaining plate, servo piston and rod assembly and servo spring.



D9223-C

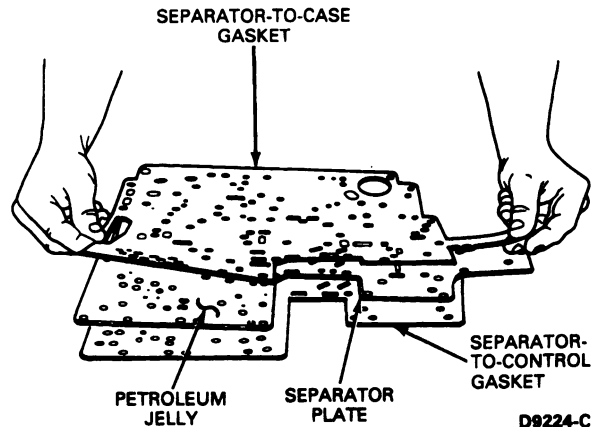
Installation

1. Install servo spring, servo piston and rod assembly.
2. Install servo retaining plate. Depress and install retaining ring.

NOTE: If the gasket and separator plate holes do not align, heat the gasket (if gasket is too large) or soak in transmission fluid (if gasket is too small) to obtain proper alignment before assembly.

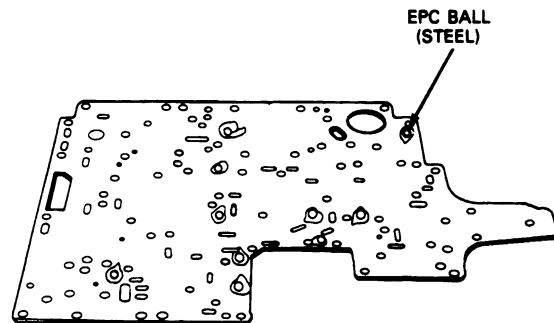
CAUTION: Do not overheat gasket. Damage may result.

3. Apply a light film of petroleum jelly to separator plate to hold new separator-to-control gasket.



D9224-C

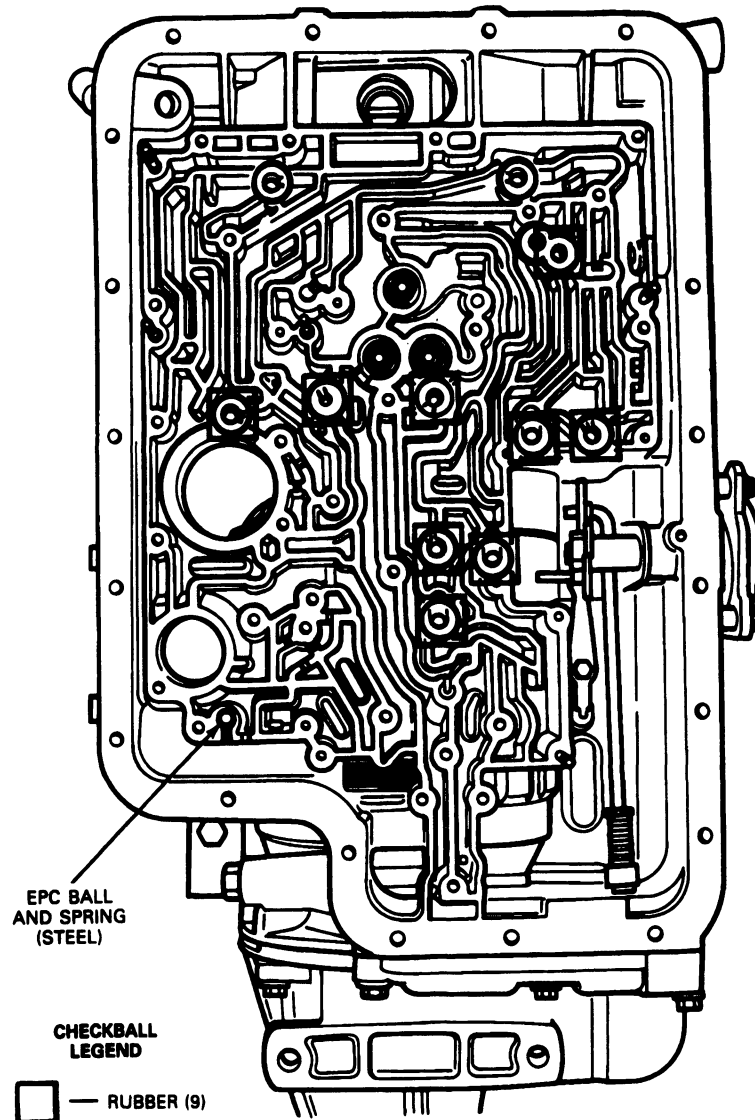
4. Apply light film of petroleum jelly to separator plate to hold new separator-to-case gasket on separator plate.
5. Place a dab of petroleum jelly on each of the nine rubber check balls and the EPC check ball. Position balls on the separator plate as shown.

9 CHECK BALL LOCATIONS
(RUBBER)

D9225-C

IN-VEHICLE SERVICE (Continued)

6. Place a daub of petroleum jelly onto intermediate accumulator regulator filter and spring assembly and EPC spring. Install them into their locations as shown.

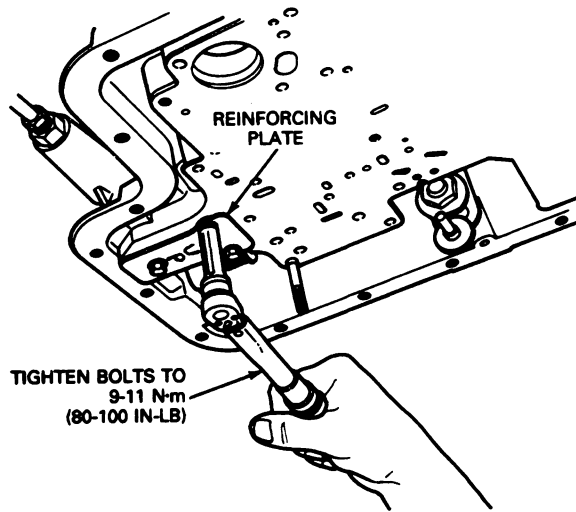


D7890-D

IN-VEHICLE SERVICE (Continued)

7. Install separator plate and gaskets. Install reinforcing plate using three reinforcing plate bolts. Tighten to 9-11 N·m (80-100 in-lb).

NOTE: Check location of check balls and EPC ball.

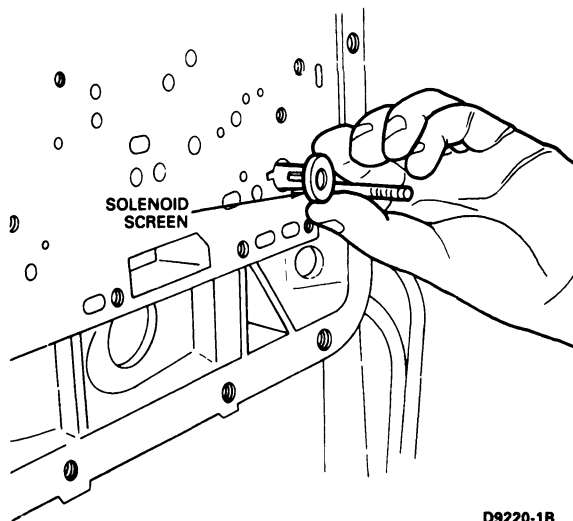


D9227-B

NOTE: If reinforcing plate bolt has been used to retain separator plate to case, do not reinstall in reinforcing plate until Step 10.

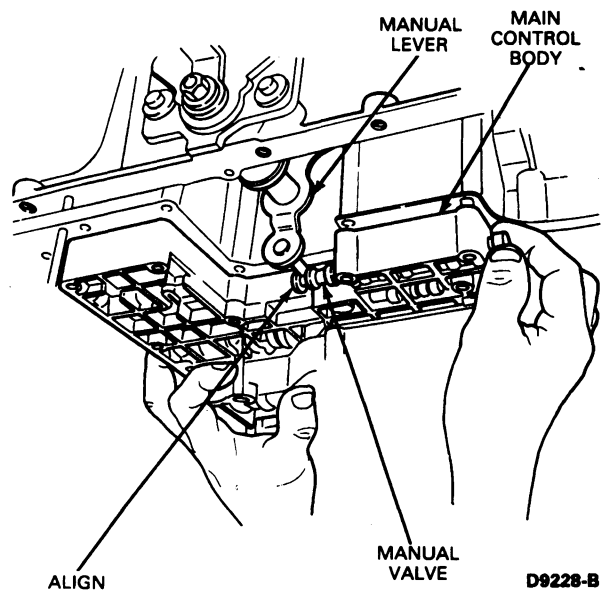
NOTE: The "UP" stamped on reinforcing plate must be visible.

8. Install solenoid screen and rotate lock in place.



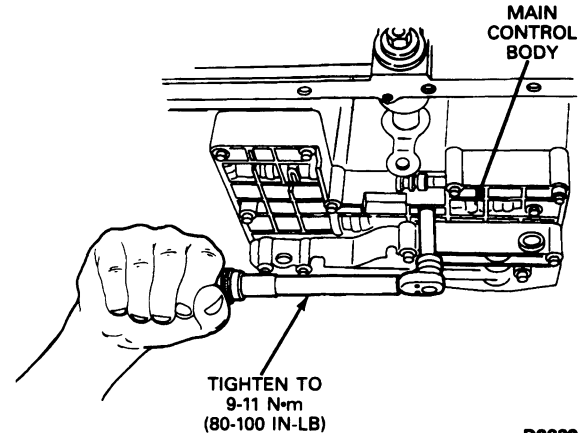
D9220-1B

9. Install main control body over studs. Align manual valve with manual lever pin.



D9228-B

10. Attach valve body with two nuts using a 10mm socket and 14 bolts using an 8mm socket. Tighten to 9-11 N·m (80-100 in-lb).

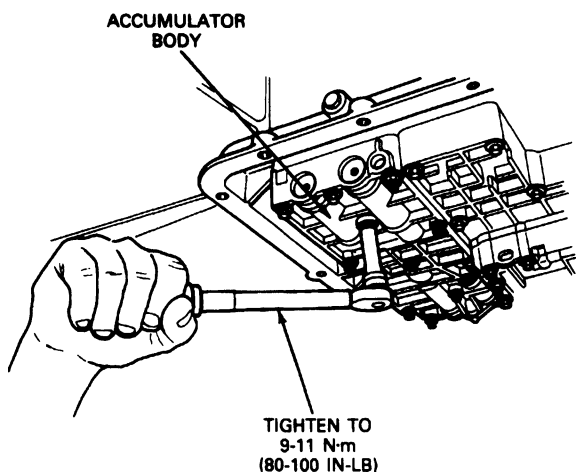


D9229-B

NOTE: If reinforcing plate bolt has been used to retain separator plate to case, reinstall after main body is attached.

IN-VEHICLE SERVICE (Continued)

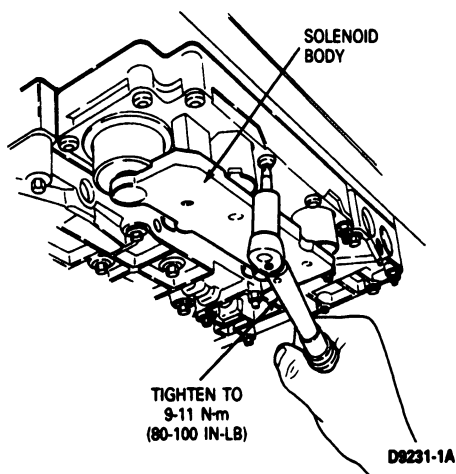
11. Install accumulator body over studs and attach with two nuts using a 10mm socket and 11 bolts using an 8mm socket. Tighten to 9-11 N·m (80-100 in-lb).



D9230-1A

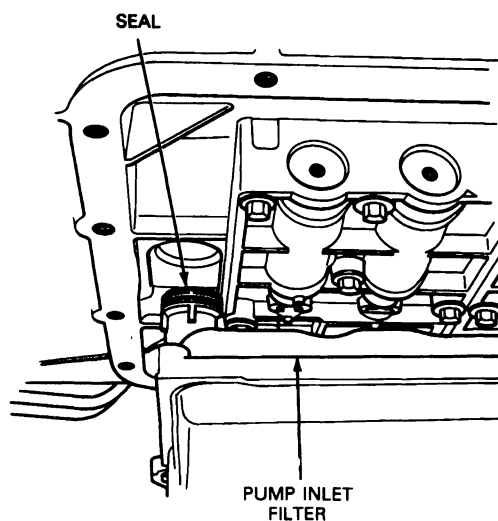
NOTE: Prior to solenoid body assembly installation, coat the case connector bore with D7AZ-19590-A (ESA-MIC 172-A) or equivalent. Inspect solenoid body electrical connector for proper seating and condition.

12. Install solenoid body over stud and attach with nine Torx® bolts using a T30 bit and one nut using a 10mm socket. Tighten to 9-11 N·m (80-100 in-lb).



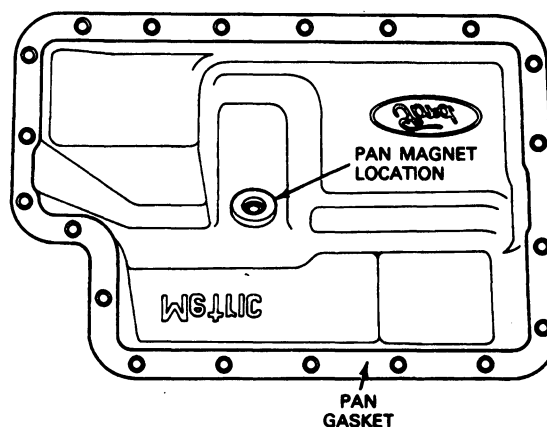
D9231-1A

13. Install a new pump inlet filter and seal assembly by lubricating the seal with transmission fluid and pressing the filter into place. Do not reuse old filter or seal.



D9215-C

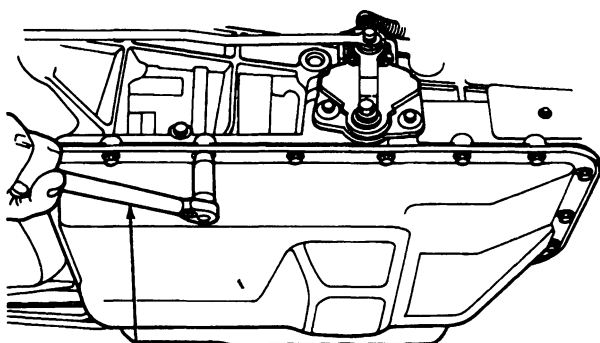
14. Check condition of pan magnet. Replace if damaged. Check for correct placement of magnet over dimple in pan. Install new pan gasket.



D9232-1A

IN-VEHICLE SERVICE (Continued)

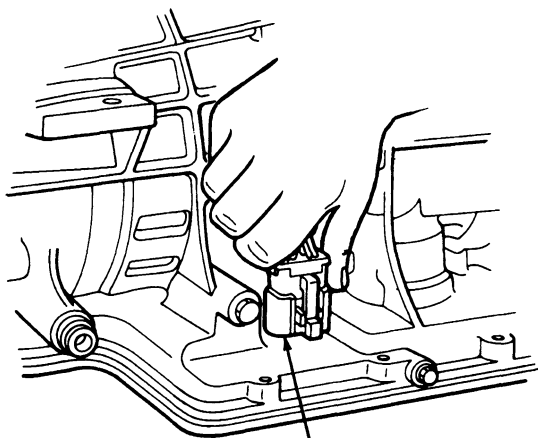
15. Install pan bolts using a 10mm socket. Tighten to 14-16 N·m (10-12 ft-lb).



TIGHTEN BOLTS TO
14-16 N·m
(10-12 FT-LB)

D9233-B

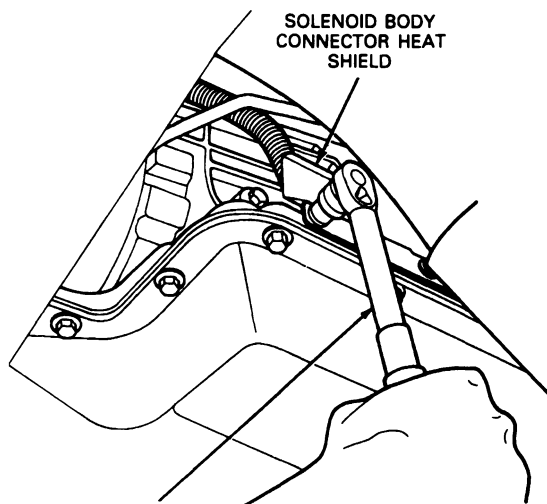
16. Completely seat solenoid body connector into solenoid valve body receptacle by pushing on top of connector. Audible click indicates full connection.



SOLENOID
BODY
CONNECTOR

D9195-1B

17. Install solenoid body connector heat shield with off-set bending inward. Tighten to 9-11 N·m (80-100 in-lb).



TIGHTEN BOLTS
TO 9-11 N·m
(80-100 IN-LB)

D9196-C

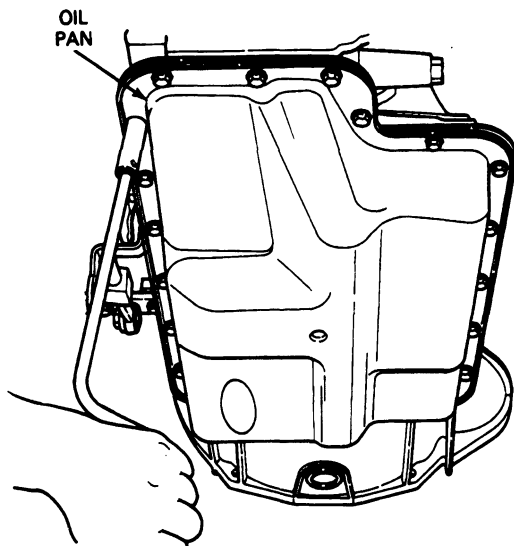
18. Lower vehicle.
19. Fill the transmission to the proper level with a minimum of 6.1 liters (6.5 quarts) Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) or equivalent.

Manual Lever Seal**Removal**

1. Remove shift cable or linkage from transmission manual lever assembly. Use a screwdriver and remove the cable and fitting from the transmission lever ball stud.

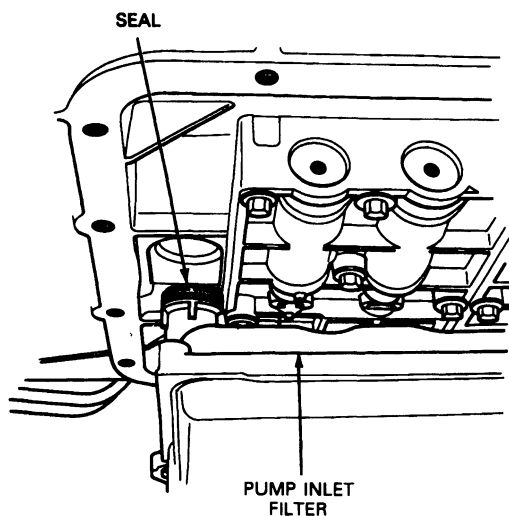
IN-VEHICLE SERVICE (Continued)

2. Place a drain pan under the transmission pan. Remove rear and side pan bolts using a 10mm socket.



D8954-B

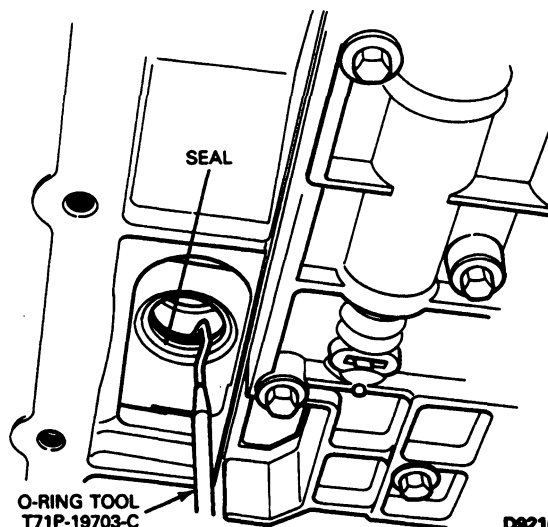
3. Loosen the front pan bolts using a 10mm socket. Pry the rear of the pan from the case and allow fluid to drain.
4. Remove front pan bolts using a 10mm socket. Remove pan.
5. Remove pump inlet filter and seal assembly by carefully pulling and rotating filter as necessary.
NOTE: Discard filter and seal assembly.



D9215-C

CAUTION: Use care not to scratch or damage aluminum pump bore.

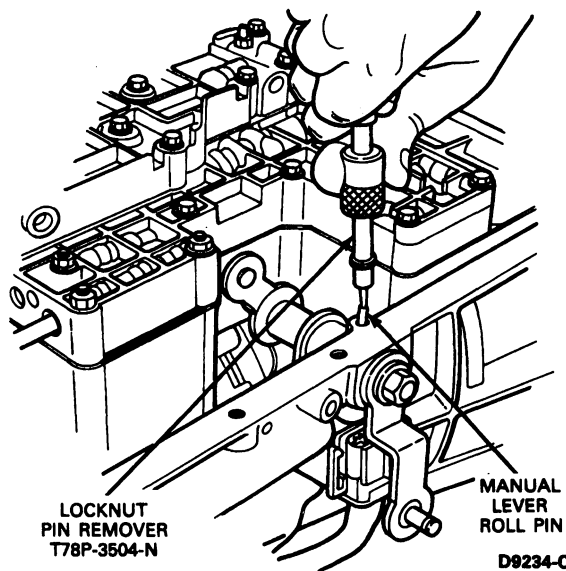
6. If seal remains in bore, carefully remove using O-Ring Tool T71P-19703-C, or a small screwdriver.



D9216-1A

7. Remove manual lever roll pin using Locknut Pin Remover T78P-3504-N.

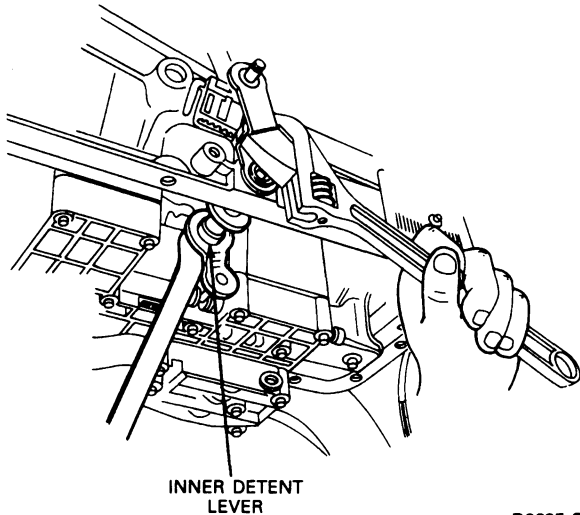
NOTE: A number 53 drill bit (1 / 16-inch) may be used as an alternative method to remove the manual lever roll pin.



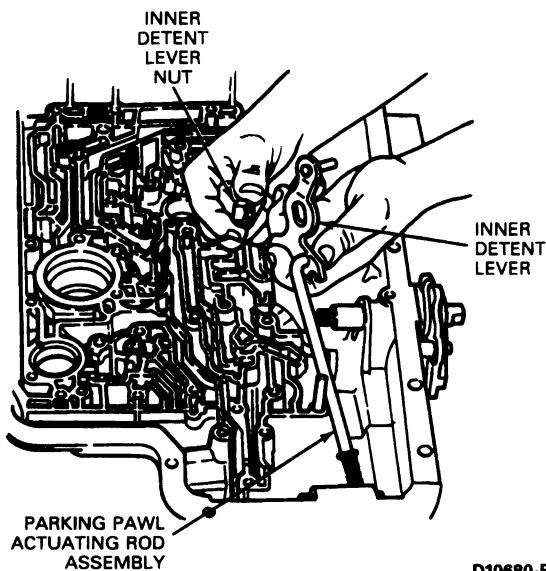
D9234-C

IN-VEHICLE SERVICE (Continued)

8. Remove manual valve inner detent lever nut using a 21mm box wrench while holding manual lever assembly with a crescent wrench.



9. Remove manual valve inner detent lever and park actuating rod assembly from manual lever shaft.
NOTE: Discard manual lever assembly nut. Do not reuse.



10. Remove manual lever assembly nut using a 15mm socket while holding lever with crescent wrench.
11. Remove manual lever assembly.
NOTE: Discard manual lever assembly nut. Do not reuse.

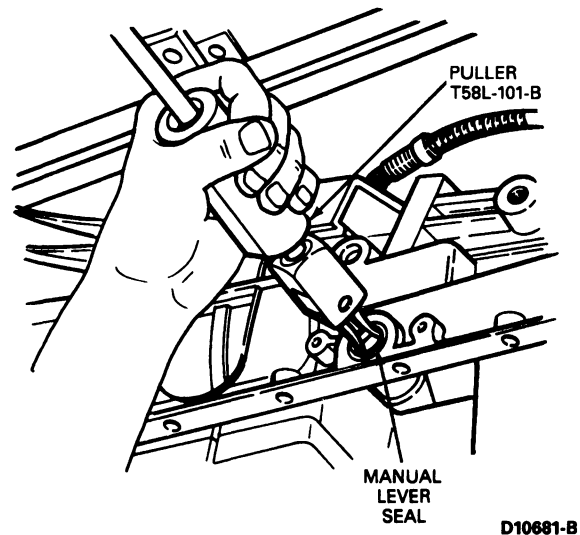
12. Remove MLP sensor connector by squeezing connector tabs and pulling on connector harness.
NOTE: Check connector for terminal condition, corrosion and contamination. Check connector seal for damage. Repair or replace as required.

13. Remove two MLP sensor bolts and washers using an 8mm socket and remove sensor.

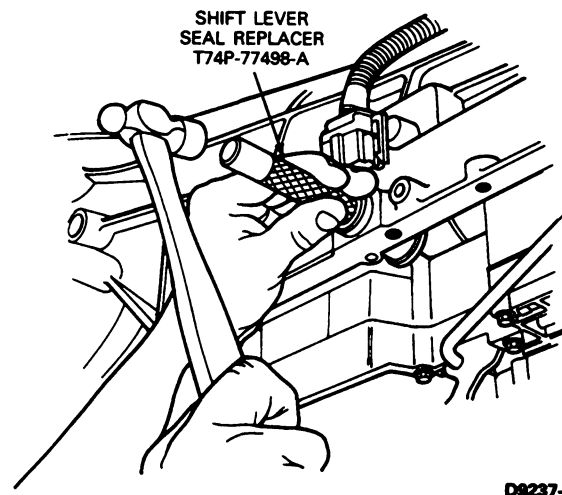
14. Remove manual lever shaft.

CAUTION: Use care not to damage the manual lever shaft bore.

15. Remove manual lever seal using Seal Remover T74P-77248-A and Slide Hammer T50T-100-A.

**Installation**

1. Clean bore opening with mineral spirits. Install seal using Shift Lever Seal Replacer T74P-77498-A.



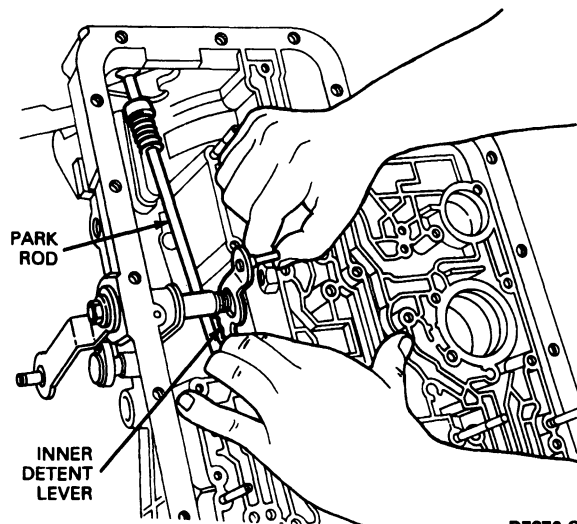
2. Install manual lever shaft.

IN-VEHICLE SERVICE (Continued)

3. Install MLP sensor with two bolts and washers. **Do not** tighten bolts at this time.

NOTE: Manual valve inner detent lever must be seated on flats of shaft, and rod assembly must be through guide plate. Detent lever pin must be properly engaged with manual valve.

4. Install manual valve detent lever, park actuating rod assembly and nut.

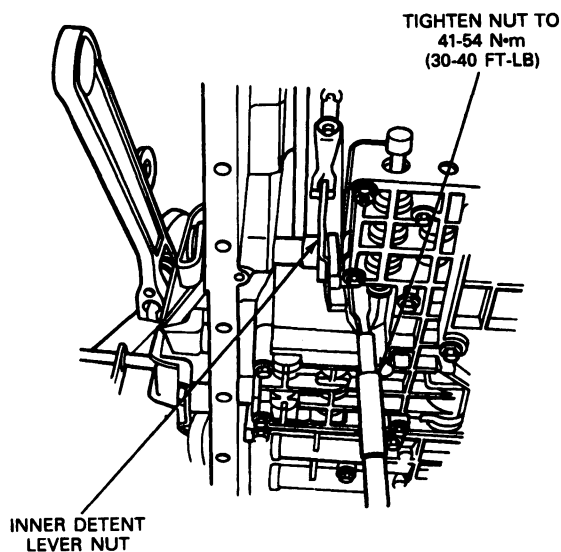


D7876-C

5. Tighten manual valve inner detent lever nut using a 21mm crowfoot while holding manual lever assembly flats with crescent wrench. Tighten nut to 41-54 N·m (30-40 ft-lb).

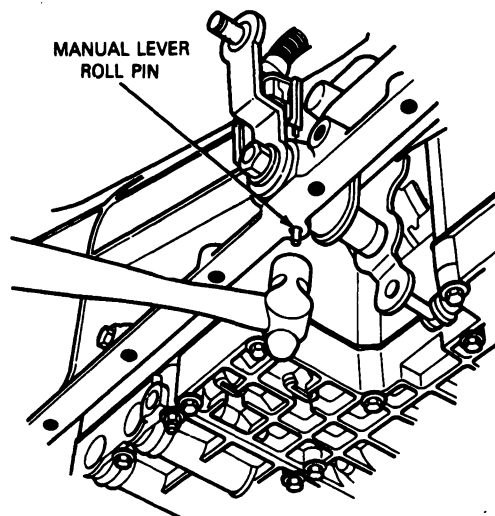
CAUTION: Use care not to damage the oil pan sealing surface.

NOTE: Manual valve detent spring must be on detent lever and detent lever pin must align with manual valve.



D9238-B

6. Install manual lever roll pin past case surface.

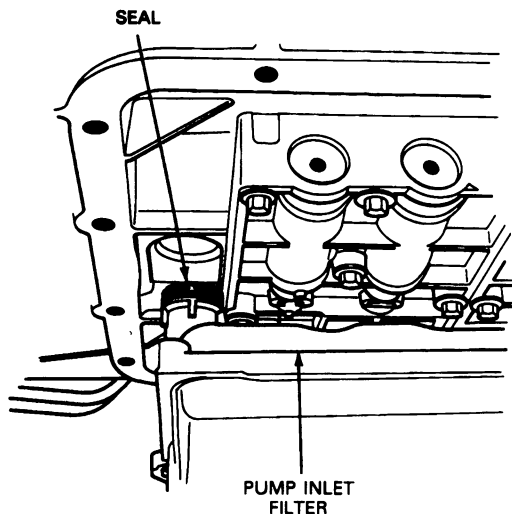


D9239-D

7. Shift manual lever to all detent positions to check proper engagement of all positions and parking mechanism.

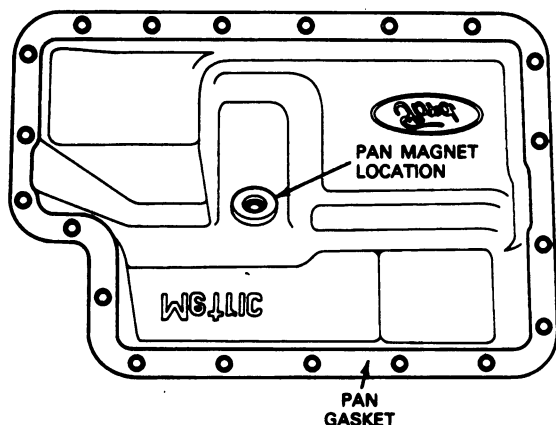
IN-VEHICLE SERVICE (Continued)

8. Install new pump inlet filter and seal assembly by lubricating seal with transmission fluid and pressing filter into place. Do not reuse old filter or seal.



D9215-C

9. Using a light coat of petroleum jelly to hold the new pan gasket, position gasket onto pan. Clean and check condition of pan magnet and replace as required. Position pan magnet over dimple in pan.



D8232-1A

10. Install pan and bolts using a 10mm socket. Tighten bolts to 14-16 N·m (10-12 ft-lb).
11. Align MLP sensor for neutral gear position using MLP Sensor Alignment Tool T92P-70010-AH.
12. Using an 8mm socket, tighten bolts to 6-8 N·m (55-75 in-lb).
13. Install MLP sensor harness connector. Audible click indicates full connection.
NOTE: After connecting MLP sensor connector, verify connection by pulling on harness.
14. Install the manual lever assembly onto the manual lever shaft. The lever should be up and the pin away from the transmission.
NOTE: The manual lever assembly must be seated on the flats of the shaft.
CAUTION: A new manual lever assembly nut must be used to properly secure lever to shaft.
15. Install a new manual lever nut using a 15mm socket while holding the lever with a crescent wrench. Tighten the nut to 27-39 N·m (20-29 ft-lb).
16. Install shift cable onto manual lever assembly. Use a screwdriver to press cable end fitting over transmission lever ball stud.
17. Remove safety stands and lower vehicle.
18. Fill the transmission to proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid E4AZ-19582-B (ESP-M2C 166-H) or equivalent.
19. Check shift cable adjustment. Refer to Section 07-05.

DISASSEMBLY AND ASSEMBLY

Transmission

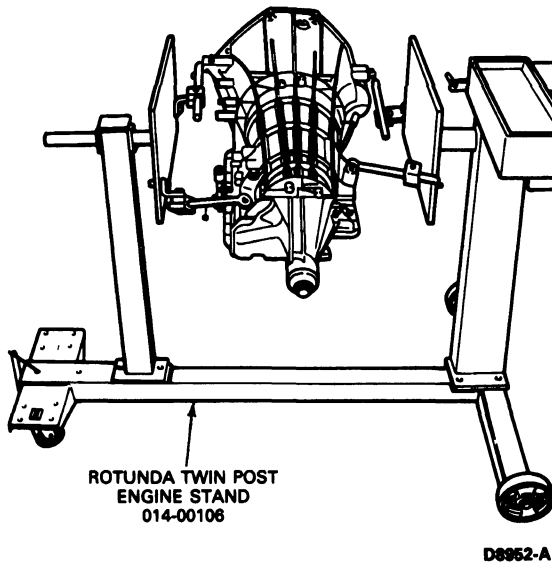
Refer to the transmission disassembled view at the beginning of this section.

NOTE: During disassembly and assembly of the transmission, the "clock" numbers shown in the following illustrations will be referred to in order to reference the position in the transmission.

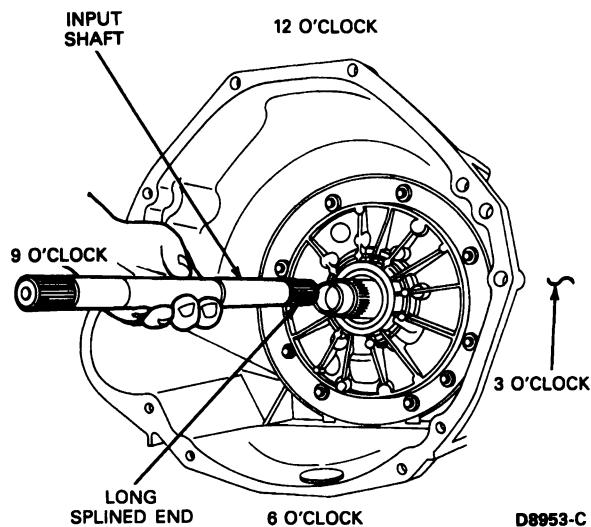
DISASSEMBLY AND ASSEMBLY (Continued)

Disassembly

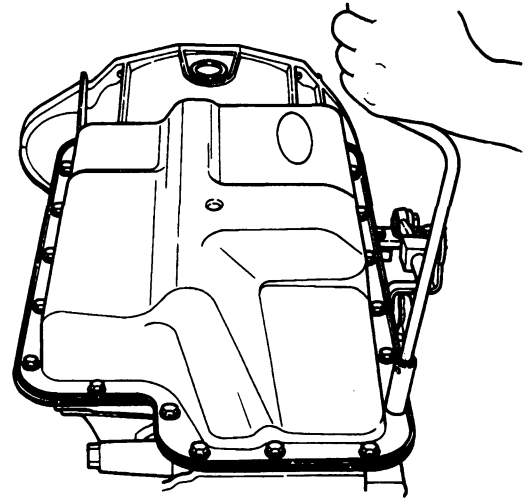
1. Mount transmission on Rotunda Twin Post Engine Stand 014-00106 or equivalent with the converter assembly removed.



2. Remove input shaft from transmission.



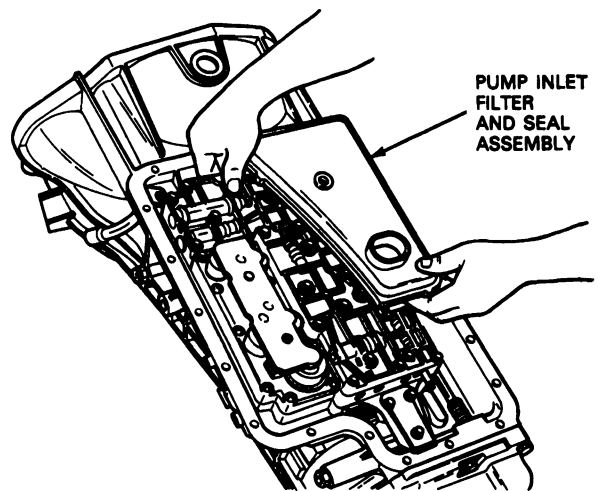
3. Rotate transmission so that pan is facing up. Remove 20 pan attaching bolts (10mm socket). Remove the pan and gasket, discard gasket.



4. Remove pump inlet filter and seal assembly by carefully pulling and rotating filter as necessary. If seal remains in bore, carefully remove using O-Ring Tool T71P-19703-C.

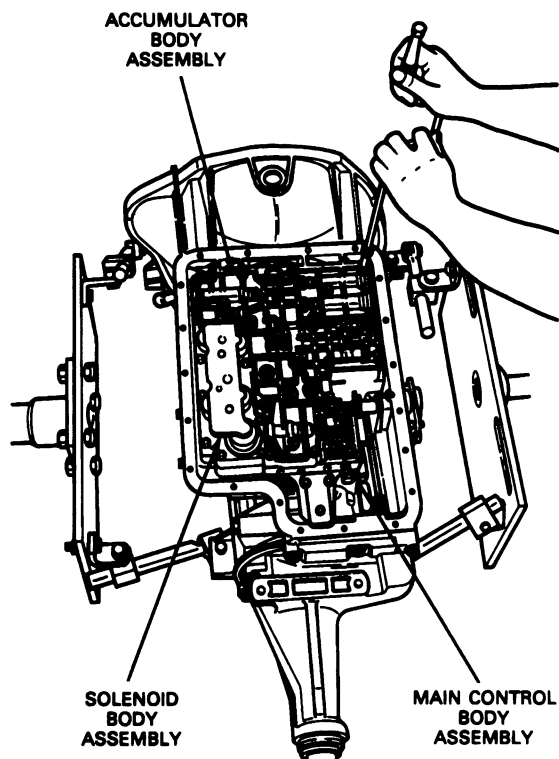
NOTE: Discard filter and seal.

CAUTION: Use care not to scratch or damage aluminum pump bore.



DISASSEMBLY AND ASSEMBLY (Continued)

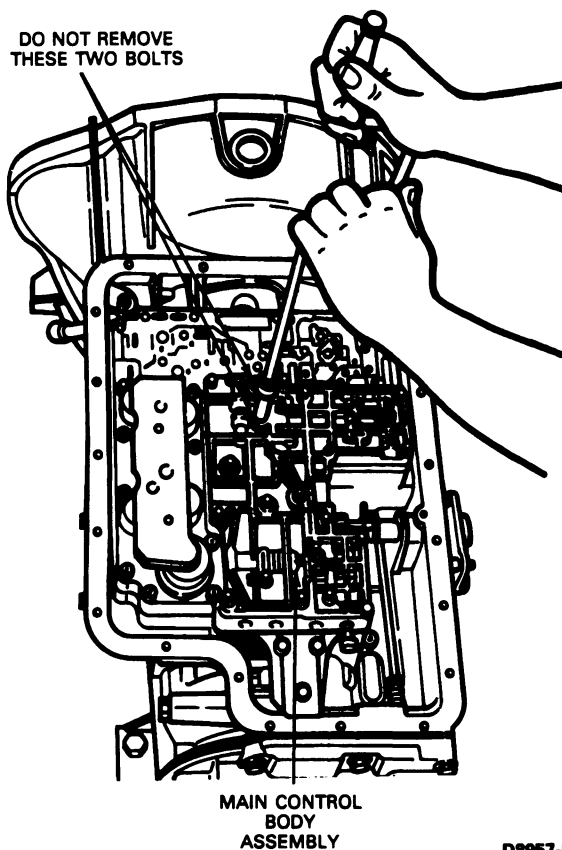
5. Remove accumulator body assembly, 11 bolts (8mm socket) and two nuts (10mm socket).



D8956-C

6. Remove main control body assembly 14 bolts (8mm socket) two nuts (10mm socket).

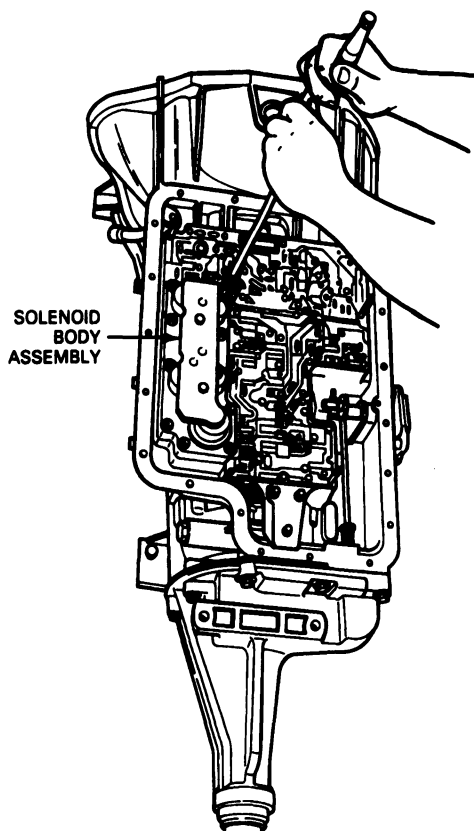
NOTE: Do not remove the two bolts as shown. These two bolts hold the upper and lower main control bodies together as an assembly.



D8957-D

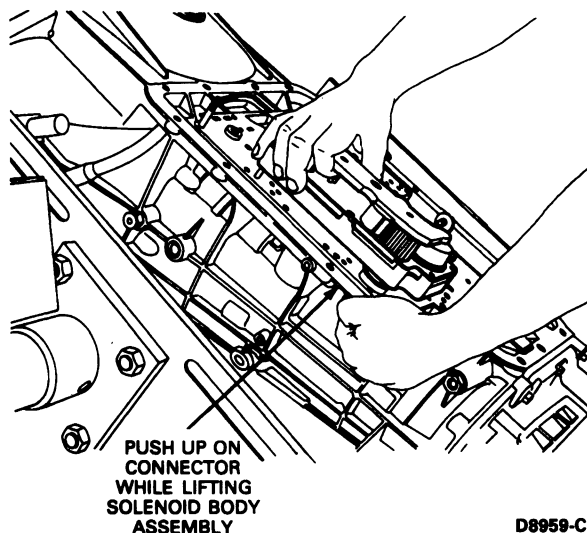
DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove nine solenoid body assembly bolts (T30 Torx® bit) and one nut (10mm socket).



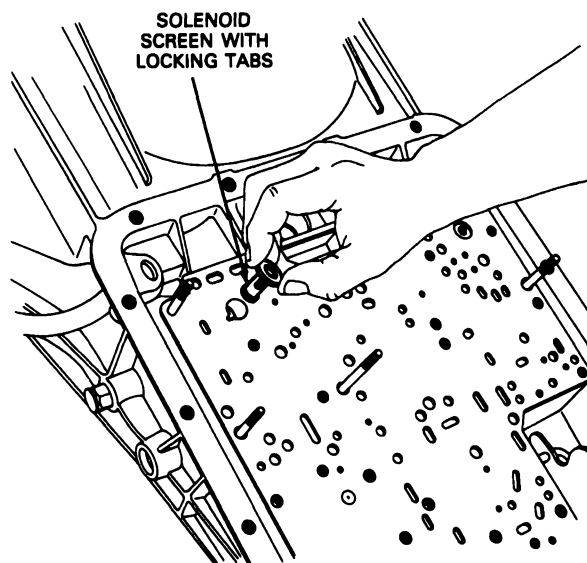
D8958-C

8. Push up on solenoid body connector while removing solenoid body assembly.



D8959-C

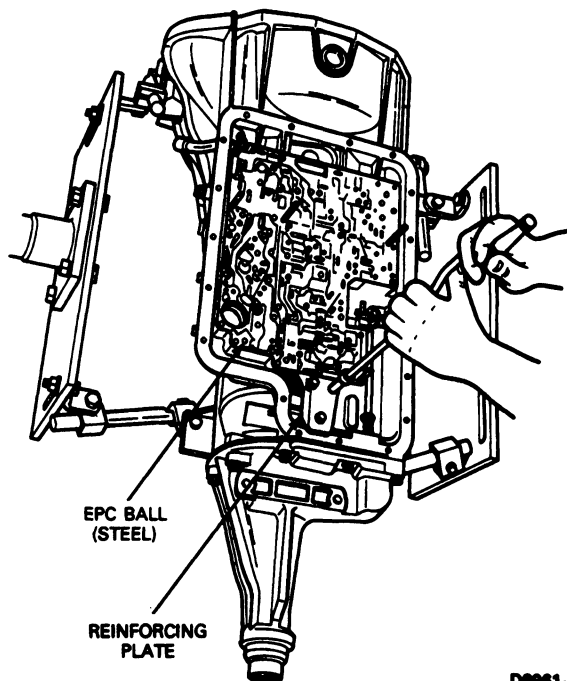
9. Remove solenoid screen by rotating and pulling out.



D8960-C

10. Remove three reinforcing plate bolts (8mm socket). Remove plate.

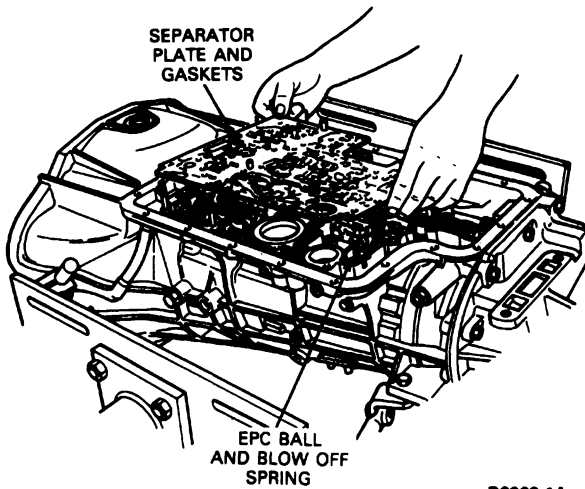
NOTE: EPC ball (steel) is spring loaded under separator plate.



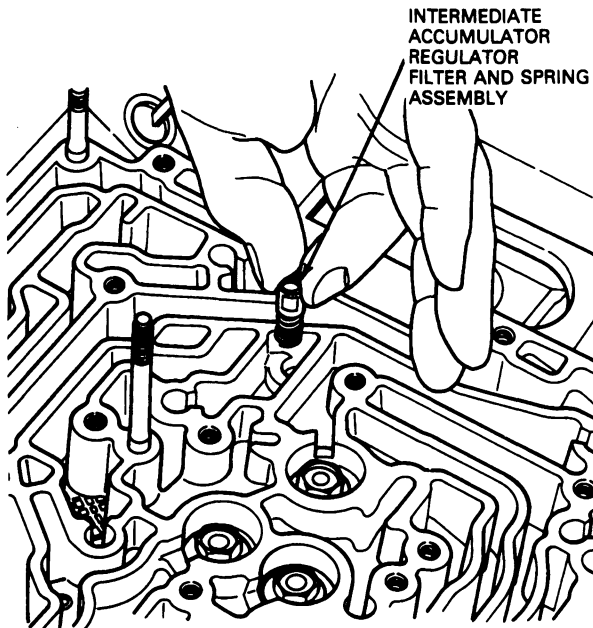
D8961-B

DISASSEMBLY AND ASSEMBLY (Continued)

11. Remove separator plate and two gaskets. Discard gaskets.



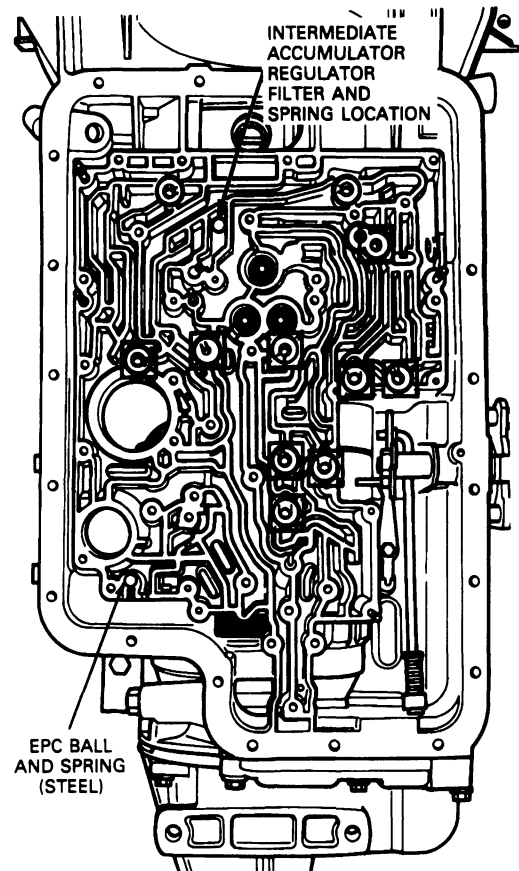
12. Remove and clean or replace intermediate accumulator regulator filter and spring assembly.



13. Remove EPC ball (steel) and spring and nine rubber check balls from transmission, using a small screwdriver.

CAUTION: Use care not to damage rubber check balls.

NOTE: The EPC ball is a 0.25-inch diameter steel ball and is smaller than the rest.



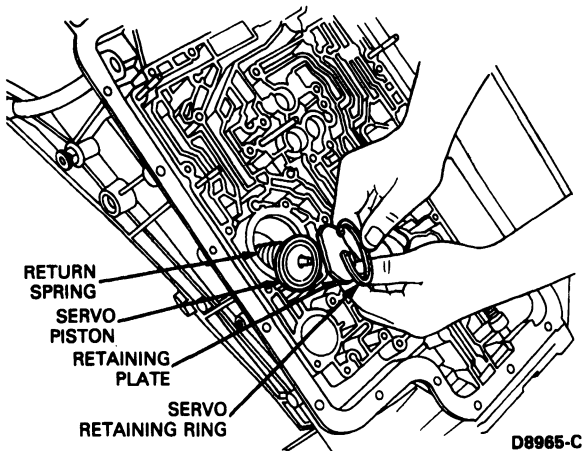
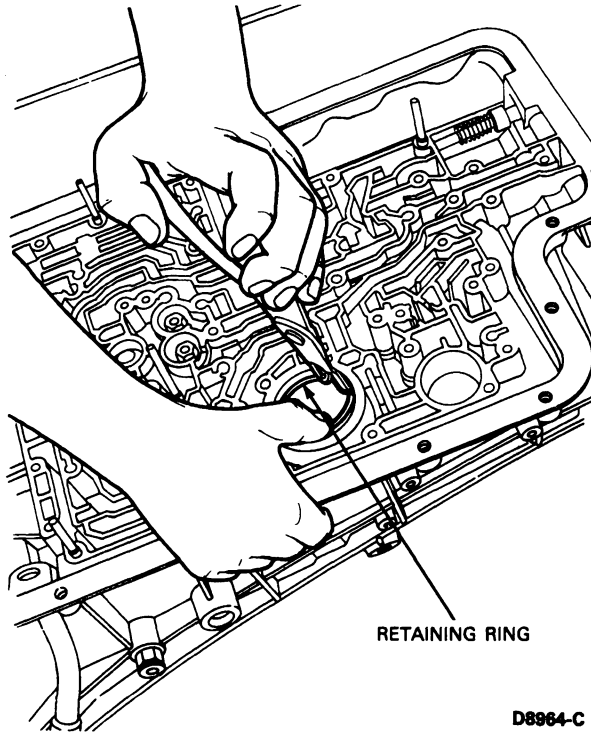
□ — RUBBER (9)

CHECKBALL LEGEND

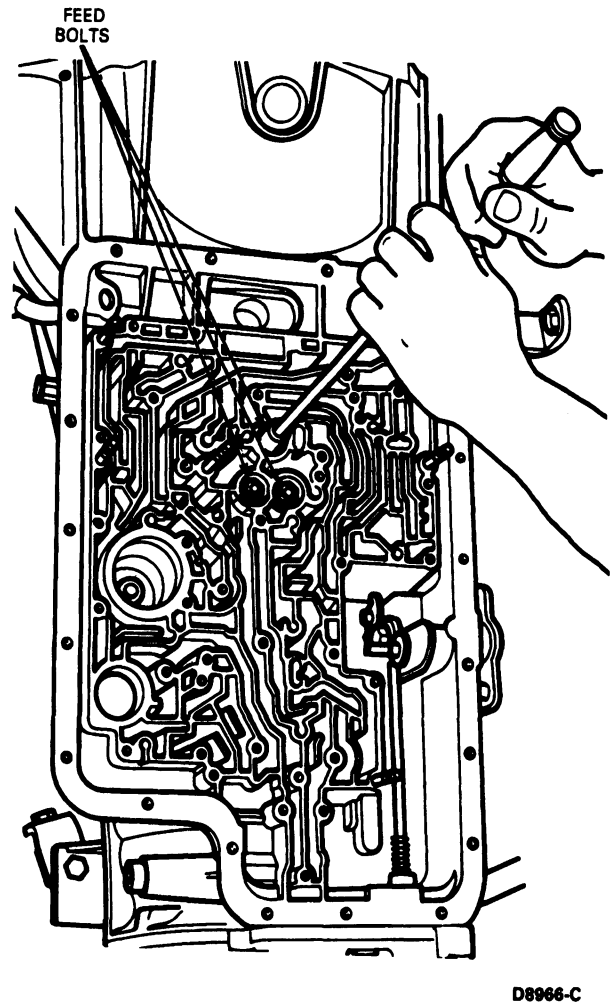
D9040-E

DISASSEMBLY AND ASSEMBLY (Continued)

14. Remove servo retaining ring, retaining plate, piston and rod assembly and servo spring.
NOTE: Apply slight downward pressure to plate while removing retaining ring.



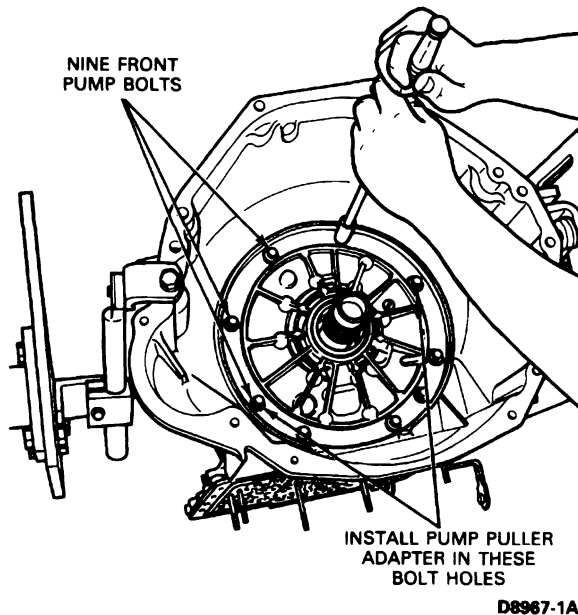
15. Remove three feed bolts (13mm socket).
CAUTION: Discard feed bolts.



DISASSEMBLY AND ASSEMBLY (Continued)

16. Rotate transmission so that converter housing is facing up. Remove nine pump bolts (10mm socket).

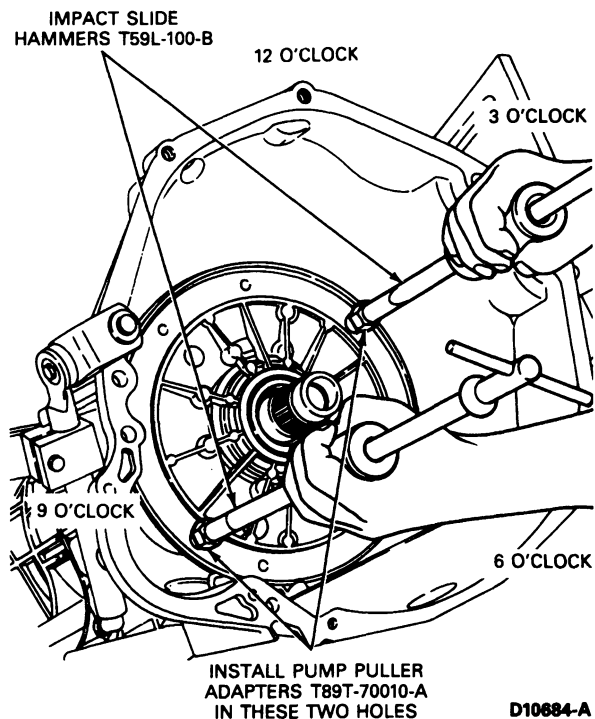
CAUTION: Discard pump bolt washers.



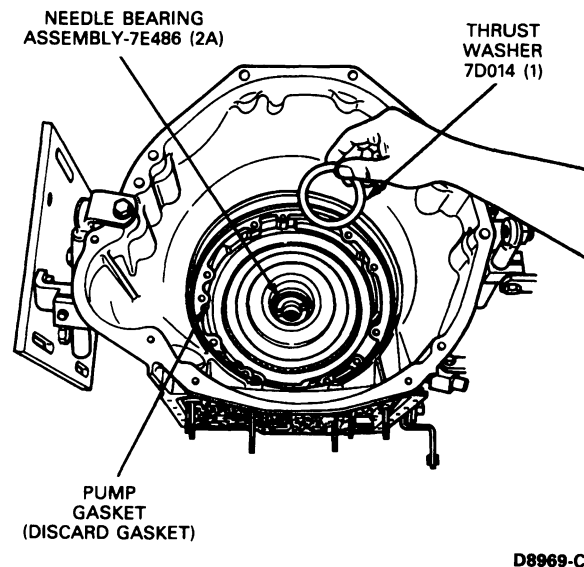
17. Use two threaded holes in pump and install Pump Puller Adapter T89T-70010-A. Install Slide Hammer T59L-100-B into adapter and remove pump. Use slide hammer type puller only.

NOTE: The impact slide hammers should be at approximately the 2 and 8 o'clock positions.

NOTE: Thrust washer 7D014 (1) and needle bearing 7E486 (2A) may stay with pump.

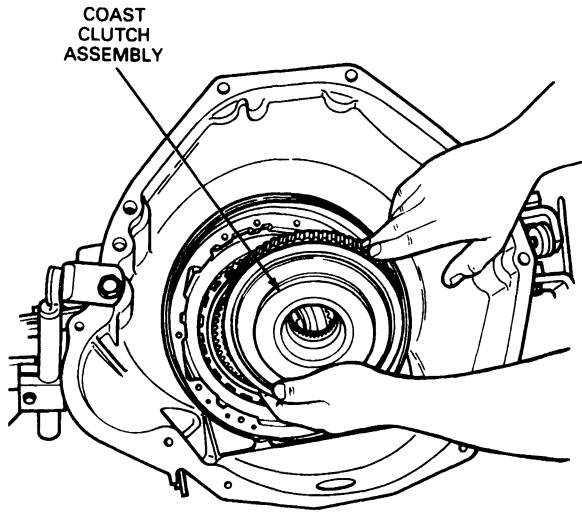


18. Remove pump gasket and 7D014 (1) thrust washer. Discard gasket.
19. Remove needle bearing assembly 7E486 (2A) between pump and sun gear.



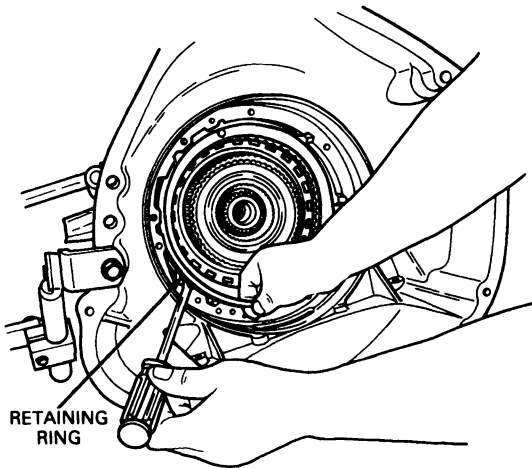
DISASSEMBLY AND ASSEMBLY (Continued)

20. Lift out the coast clutch assembly.



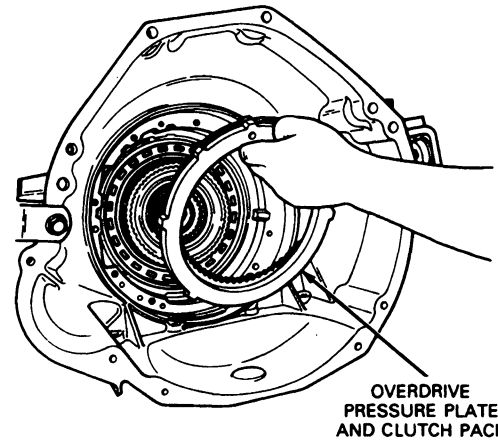
D8970-B

21. Remove large overdrive clutch retaining ring using large screwdriver.



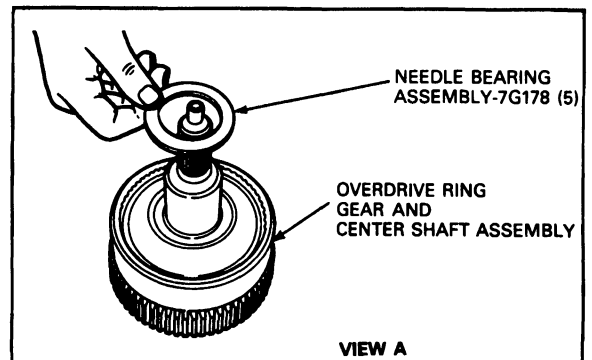
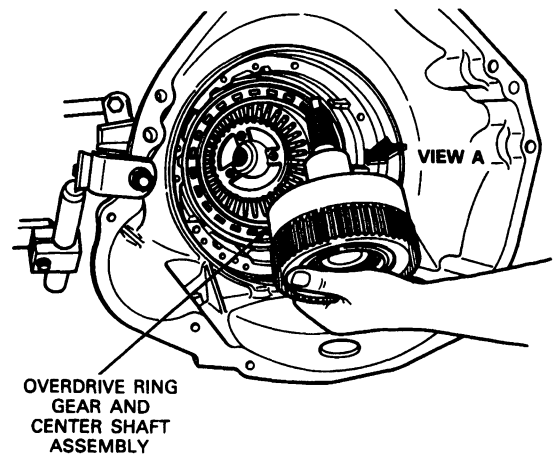
D8972-B

22. Remove overdrive pressure plate and clutch pack and tag for re-assembly.



D8973-1A

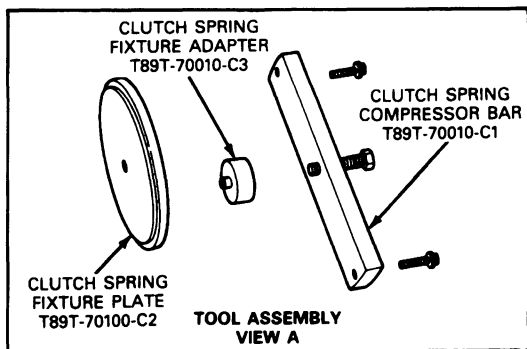
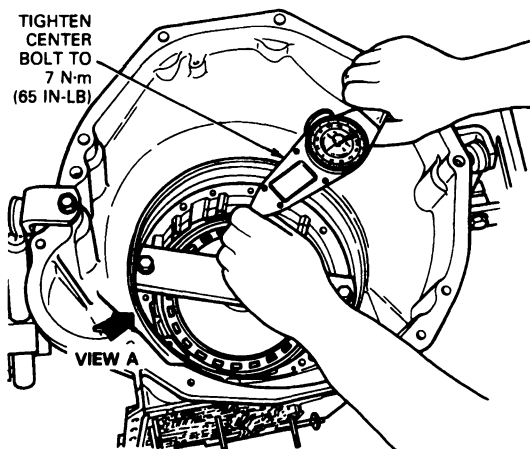
23. Remove overdrive ring gear and center shaft assembly and needle bearing assembly 7G178 (5).



D8974-B

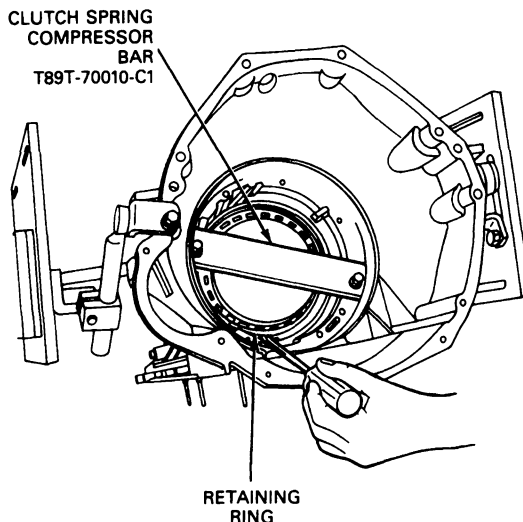
DISASSEMBLY AND ASSEMBLY (Continued)

24. Install Clutch Spring Fixture T89T-70010-C onto intermediate / overdrive cylinder assembly. Tighten center bolt to 7 N·m (65 in-lb).



D8975-B

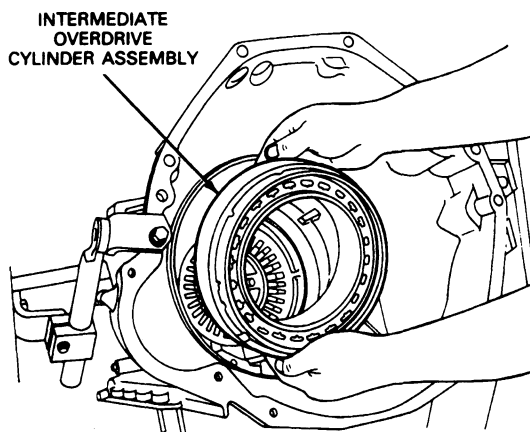
25. Remove large intermediate cylinder retaining ring with large screwdriver. Loosen spring compressor center bolt and remove compressor tools.



D8976-B

26. Remove intermediate / overdrive cylinder assembly.

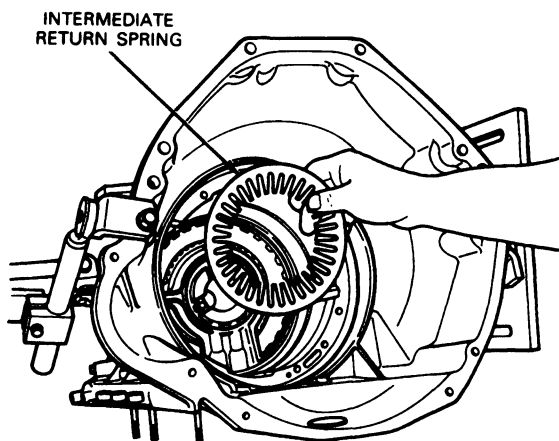
CAUTION: Do not “cock” the cylinder assembly in the case bore. Damage could result.



D8977-1A

DISASSEMBLY AND ASSEMBLY (Continued)

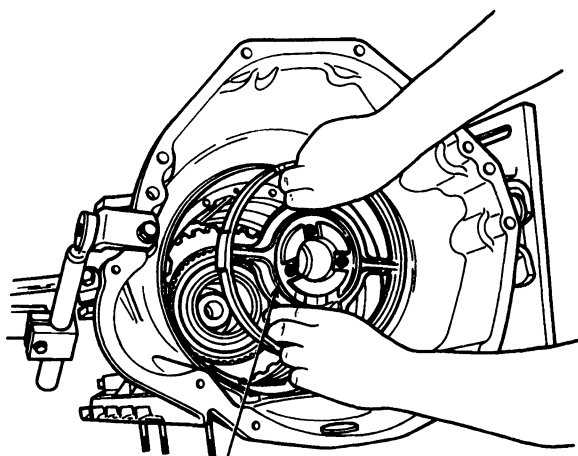
27. Remove intermediate return spring.



D8978-1A

28. Carefully remove center support assembly.

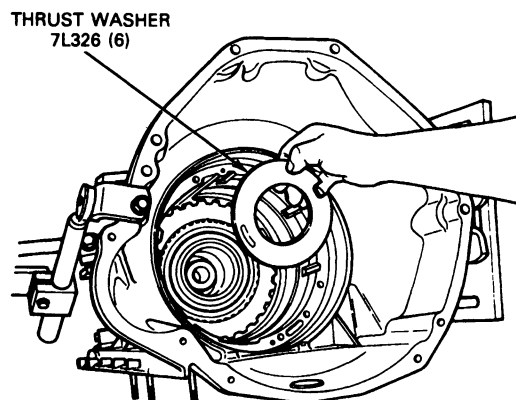
CAUTION: Do not "cock" the center support assembly in the case bore. Damage could result.



CENTER
SUPPORT
ASSEMBLY

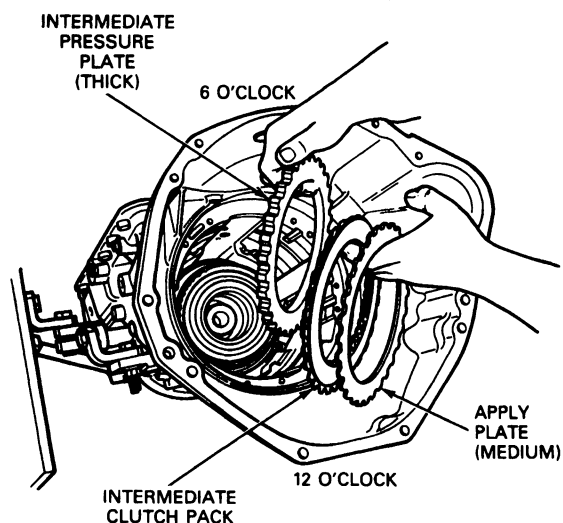
D8979-B

29. Remove thrust washer 7L326 (6).



D8980-B

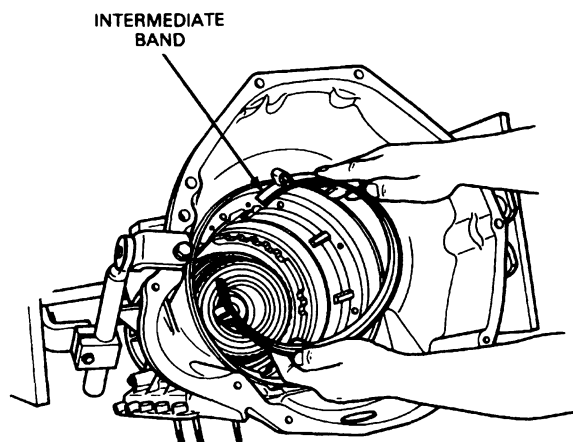
30. Remove apply plate, intermediate clutch pack and intermediate pressure plate. Tag clutch pack for proper re-assembly.



D8981-B

DISASSEMBLY AND ASSEMBLY (Continued)

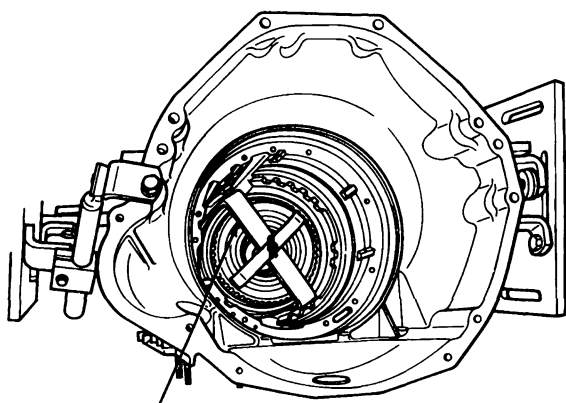
31. Remove intermediate band.



D8982-1A

32. Using Clutch Remover / Replacer T89T-70010-E, lifting upward, remove direct clutch forward clutch and shell.

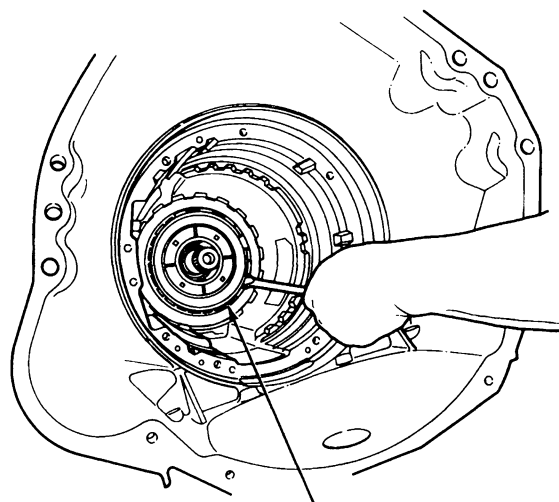
NOTE: Hooks on crossbar must be rotated to engage notches on input shell. Refer to illustration.



CLUTCH REMOVER/REPLACER
T89T-70010-E

D8983-B

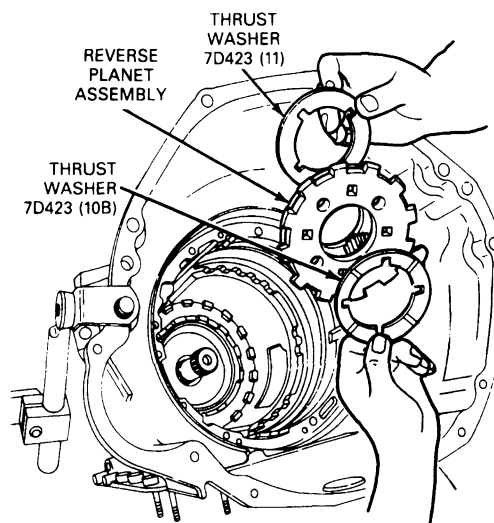
33. Using large screwdriver, remove reverse planet assembly retaining ring.



REVERSE PLANET
ASSEMBLY RETAINING RING

D8984-B

34. Remove reverse planet assembly and two thrust washers 7D423 (10B and 11).



THRUST
WASHER
7D423 (11)
REVERSE
PLANET
ASSEMBLY

THRUST
WASHER
7D423 (10B)

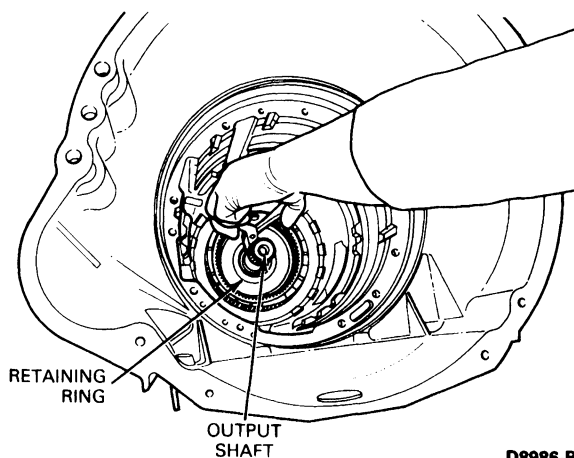
D8985-E

35. Using Retaining Ring Pliers, remove the output shaft retaining ring.

CAUTION: Use care when removing the retaining ring. The output shaft could fall out.

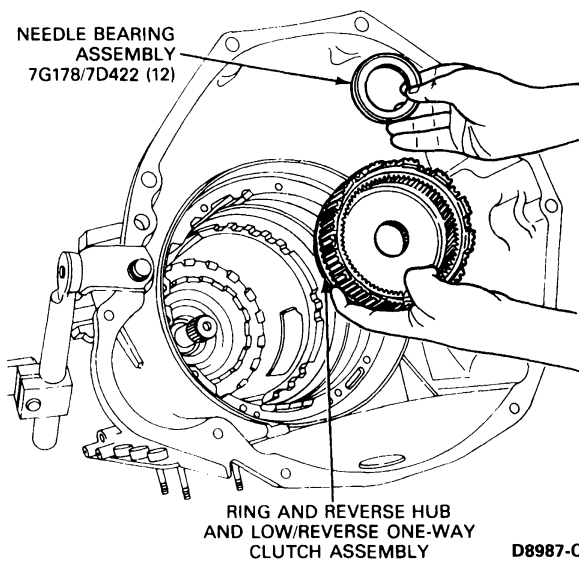
DISASSEMBLY AND ASSEMBLY (Continued)

CAUTION: Discard retaining ring.



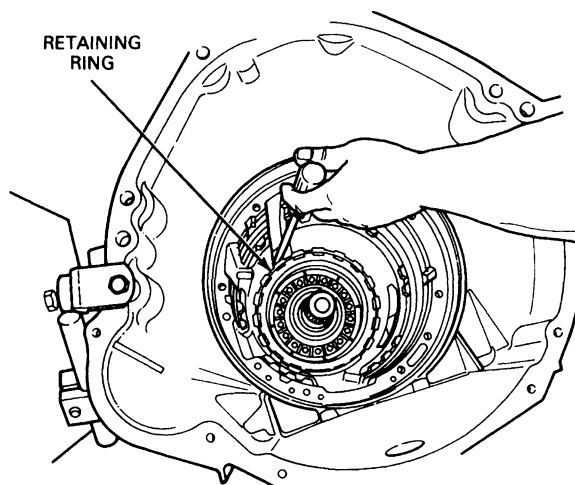
D8986-B

36. Remove ring gear and hub assembly, needle bearing assembly 7G178 (12) and reverse hub and one-way clutch as an assembly.



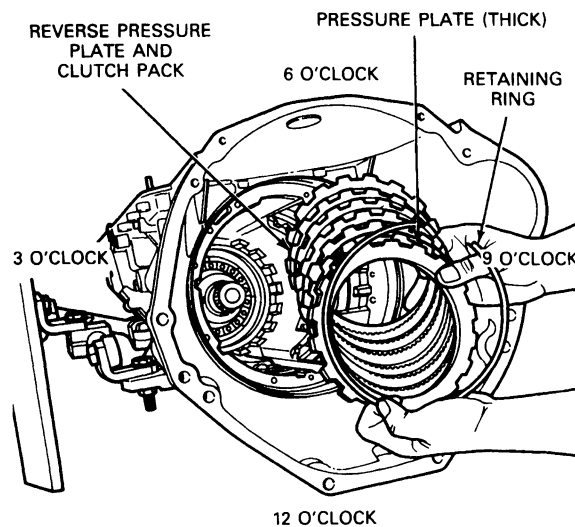
D8987-C

37. Using a large screwdriver remove reverse clutch retaining ring.



D8989-C

38. Rotate transmission so that pan surface is facing up.
39. Remove reverse pressure plate and clutch pack. Tag for re-assembly.



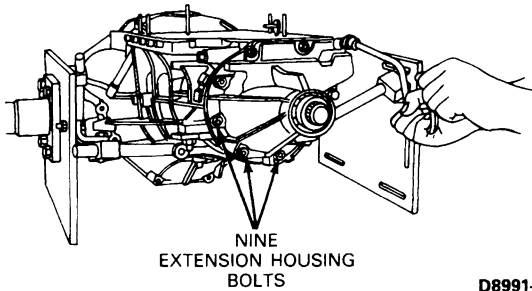
D8990-C

CAUTION: Use care not to drop output shaft while rotating transmission.

DISASSEMBLY AND ASSEMBLY (Continued)

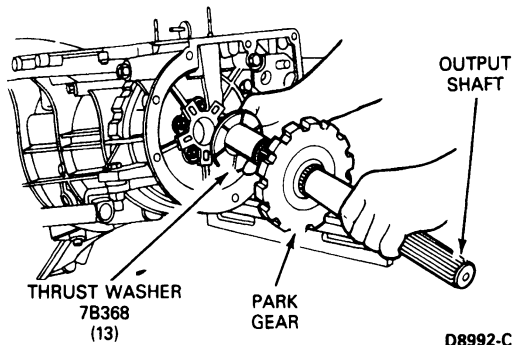
40. Remove nine extension housing bolts (13mm socket). Remove wiring bracket, extension housing and gasket.

CAUTION: Discard gasket.



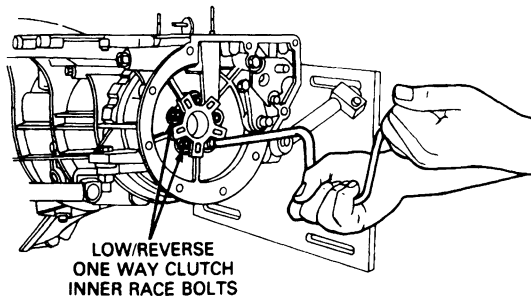
D8991-B

41. Remove output shaft, park gear and thrust washer 7B368 (13).



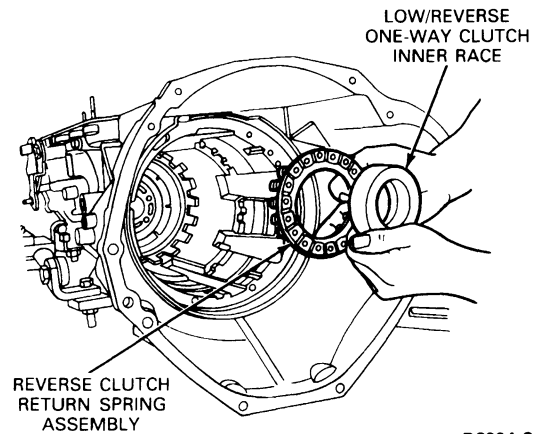
D8992-C

42. Remove five bolts (7 / 16-inch socket) from the low / reverse one-way clutch inner race.



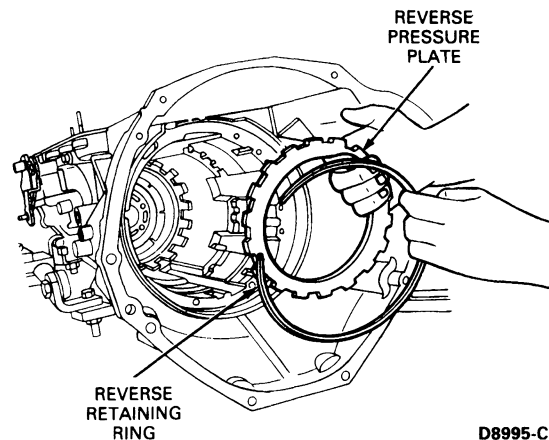
D8993-B

43. Remove reverse clutch return spring assembly and inner race.



D8994-C

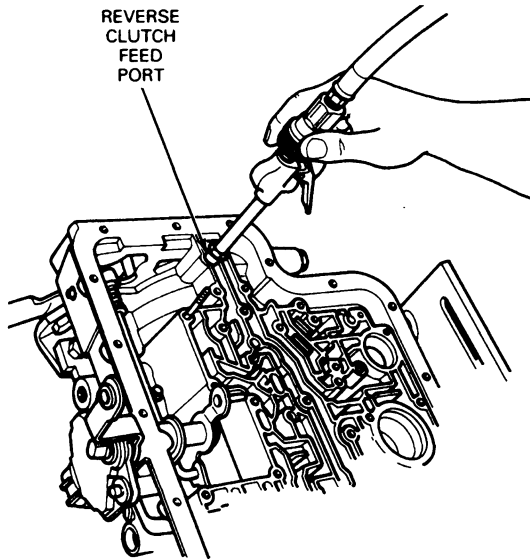
44. Reinstall reverse clutch pressure plate and retaining ring to restrain the reverse clutch piston during removal.



D8995-C

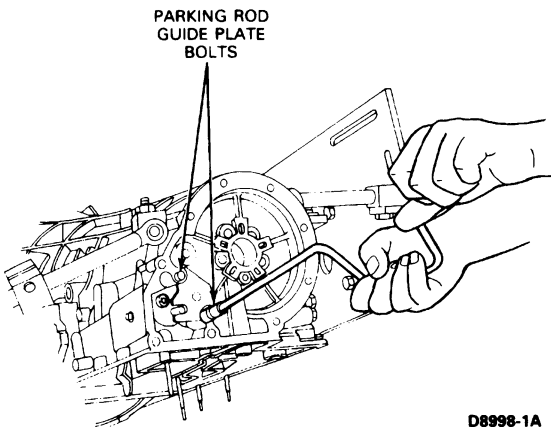
DISASSEMBLY AND ASSEMBLY (Continued)

45. Blow into reverse clutch feed port using compressed air. This will blow out the reverse clutch piston against the pressure plate.



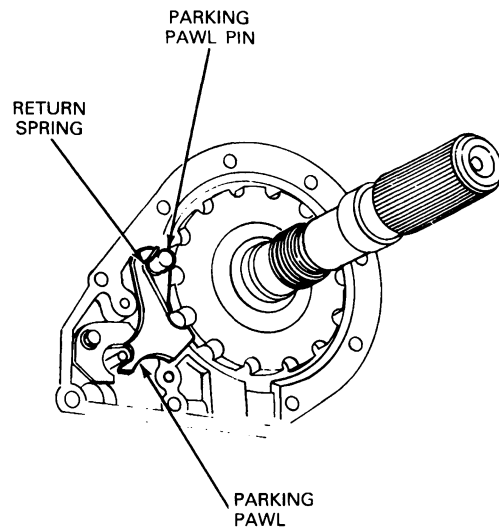
D8996-1A

46. Remove retaining ring, reverse clutch pressure plate and piston from case.
47. Remove two bolts (13mm socket) from parking rod guide plate.



D8998-1A

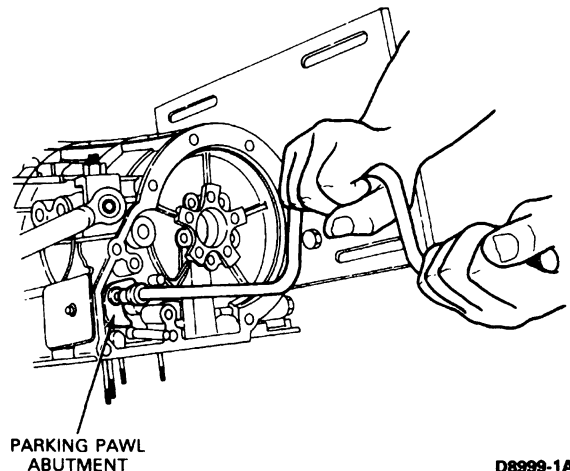
48. Remove park pawl return spring, pin and parking pawl from case.



D8997-C

49. If required, remove the Torx® head screw (T40 bit) and parking pawl abutment.

CAUTION: The Torx® head bolt has a thread-locking compound and should be removed only if the case is being replaced. If bolt is removed, it must be discarded and a new one installed.

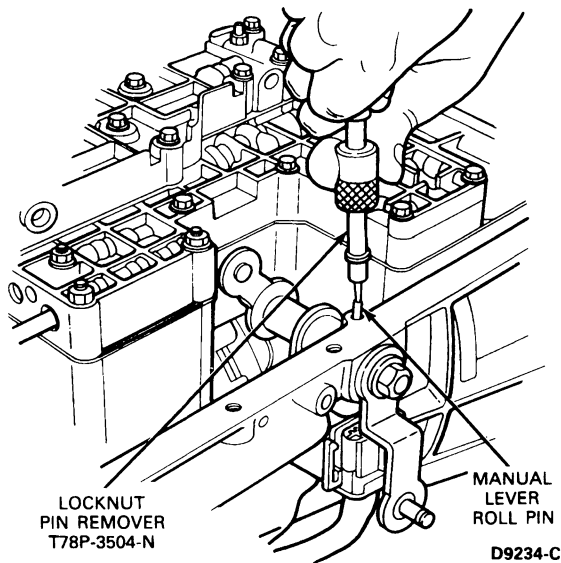


D8999-1A

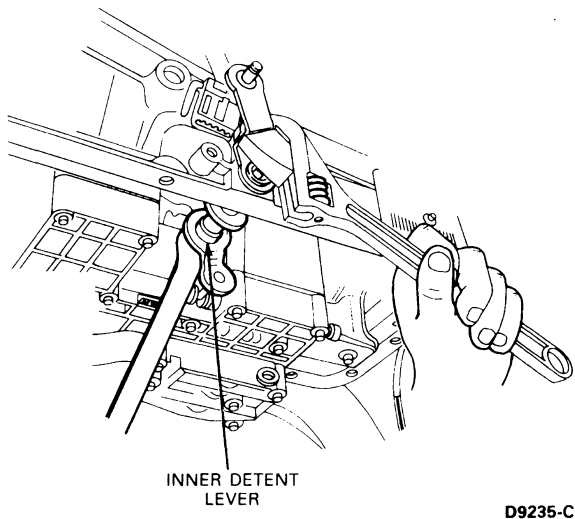
DISASSEMBLY AND ASSEMBLY (Continued)

50. Removal manual lever roll pin using Locknut Pin Remover T78P-3504-N.

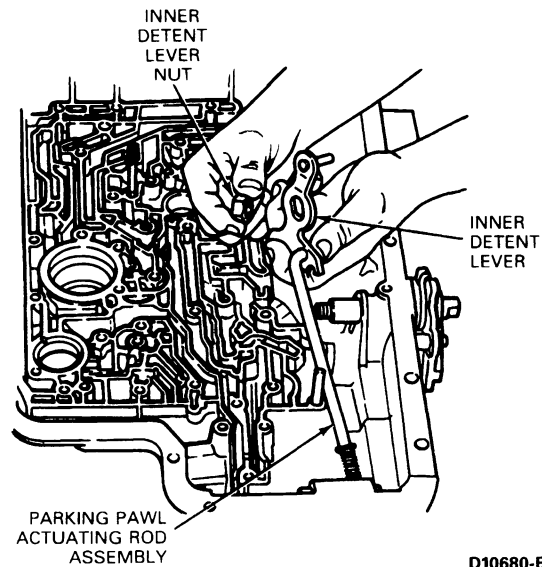
NOTE: A number 53 drill bit (1 / 16-inch) may be used as an alternate method to remove the manual lever pin.



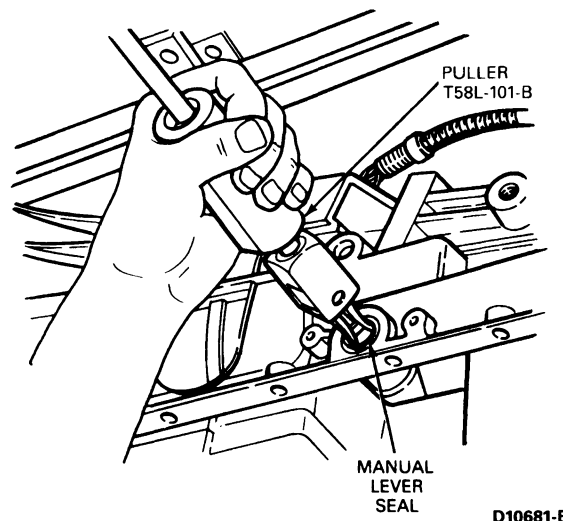
51. Remove manual valve inner detent lever nut using a 21mm box wrench while holding manual lever assembly with a crescent wrench.



52. Remove manual valve inner detent lever and park actuating rod assembly from manual lever shaft.



53. Remove the manual lever assembly outer nut using a 15mm socket while holding lever with crescent wrench.
54. Remove manual lever assembly.
CAUTION: Discard manual lever assembly nut. Do not reuse.
55. Remove two MLP sensor bolts and washer using an 8mm socket and remove sensor.
56. Remove manual lever shaft.
CAUTION: Use care not to damage the manual lever bore.
57. Remove bolt and manual valve detent spring.
58. Remove manual lever seal using Puller T58L-101-B.

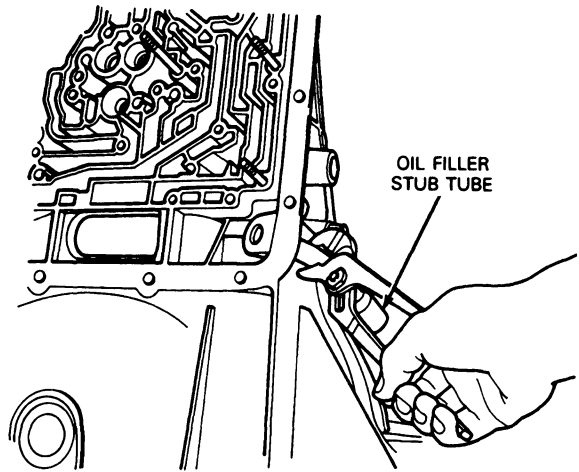


DISASSEMBLY AND ASSEMBLY (Continued)

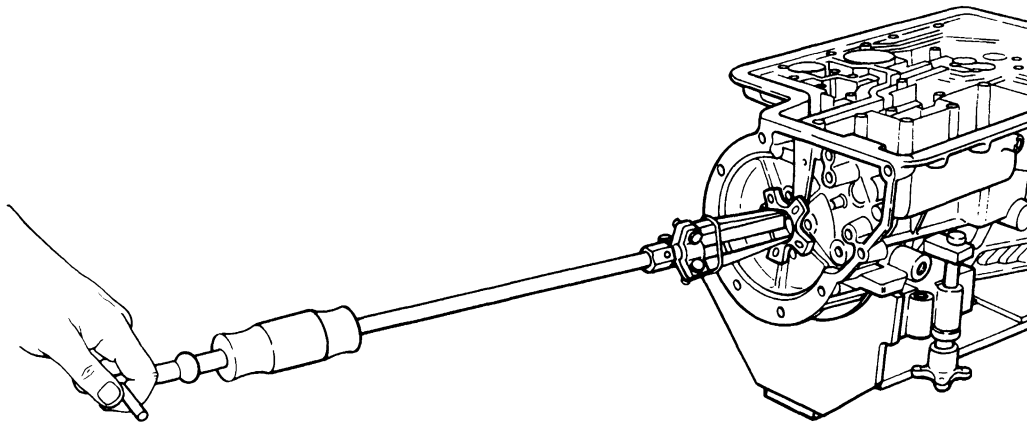
NOTE: Remove case bushings only if they show signs of excessive wear or scoring.

NOTE: The stub tube should be removed only if it is loose or damaged.

59. Inspect case bushing bores for nicks or burrs. Remove any nicks or burrs using a fine oil stone.
60. If required, remove stub tube, using channel lock pliers.

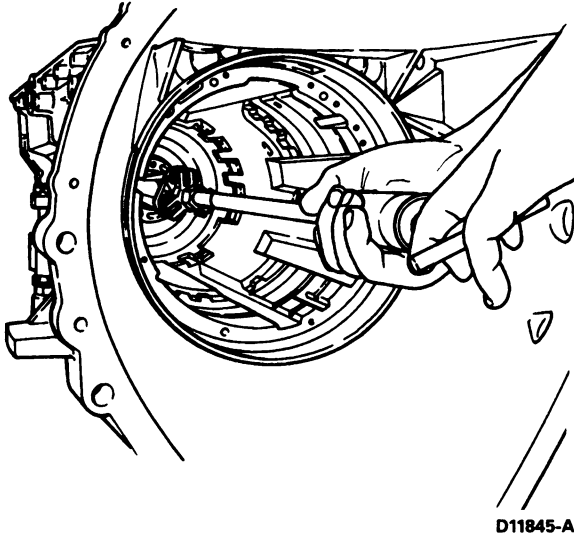
**D9006-B**

61. Remove front and rear bushing using Seal Remover TOOL-1175-AC and Slide Hammer T50T-100-A.

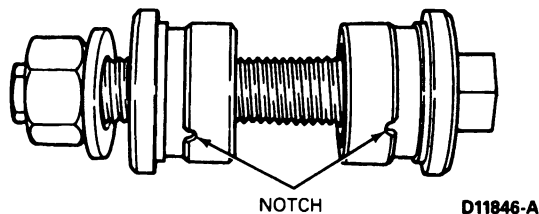
**D11844-A**

DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: Remove the rear bushing from the rear of the case, and remove the front bushing from the front of the case.

**Assembly**

1. Using Rear Case Bushing Replacer T92T-77110-AH install front and rear case bushings as follows.
2. Place bushings on front and rear portions of replacer tool with the notches positioned as shown.

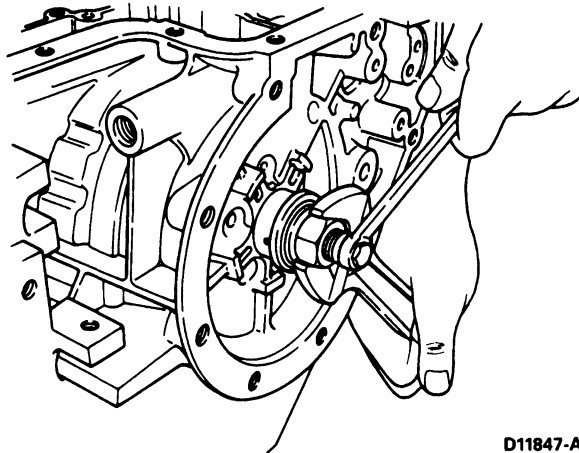


NOTE: The front bushing notches face toward the front of the case, and the bushing joint should be positioned at the 12 o'clock position. This will place one of the oil grooves at the very bottom (6 o'clock) position.

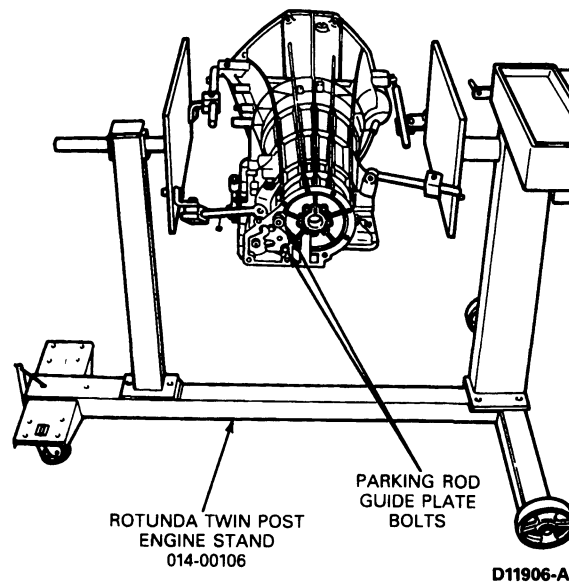
The rear bushing is to be installed with the notches facing the rear of the case.

3. Set front portion of tool with the bushing into case.
4. Holding the front portion in position, place the rear portion (with bushing) over the threaded rod. Install the nut and snug by hand, making sure bushings remain properly positioned.

5. Hold the nut using an adjustment wrench while turning the threaded bar counterclockwise until bushings are fully seated. The tool shoulders will butt up against the case when bushings are fully seated. Unscrew the nut and remove tool.



6. Soak all friction clutch plates in clean Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid E4AZ-19582-B (ESP-M2C166-H) or equivalent for 15 minutes.
7. Lightly lubricate all O-ring seals before installing using Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid E4AZ-19582-B (ESP-M2C166-H) or equivalent.
8. Lightly grease all thrust washers with petroleum jelly to hold in place during assembly.
9. Mount transmission case in Twin Post Engine Stand Rotunda 014-00106 or equivalent.

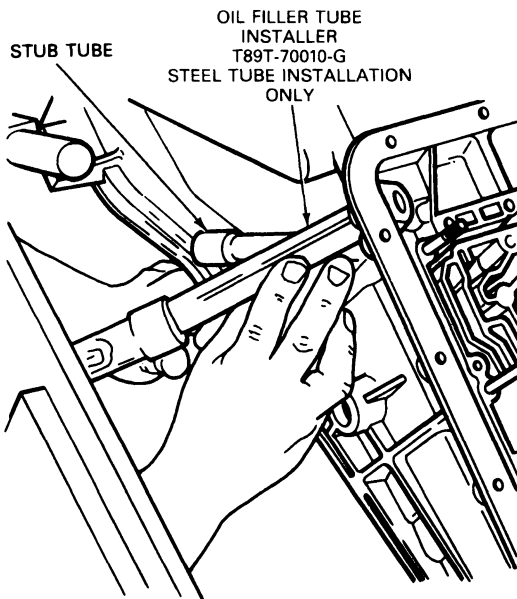


10. Rotate transmission so that converter housing is facing up.

DISASSEMBLY AND ASSEMBLY (Continued)

11. If removed, install new stub tube using Oil Filler Tube Installer T89T-70010-G for steel tube (7N463). If installing plastic tube (7H003) no special tools are required.

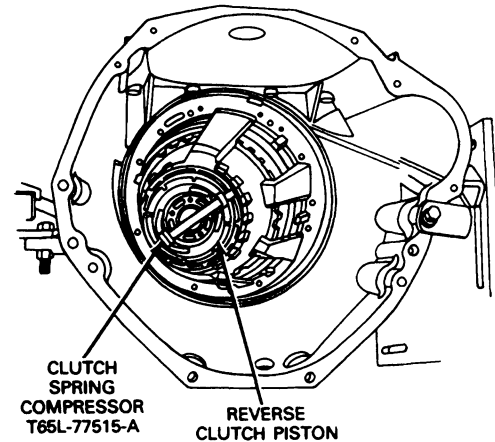
NOTE: When installing stub tube (steel or plastic) use stripe or rib on tube for alignment. Stripe should be farthest outboard when installed. Rib should be toward the front.



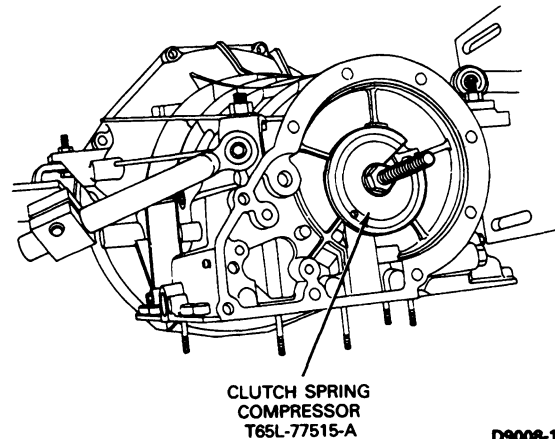
D10685-B

CAUTION: While performing the following step, use care not to over-tighten compressor tool or "cock" the piston in its bore.

12. Install reverse clutch piston using Clutch Spring Compressor T65L-77515-A. Remove tool after installing piston.

Front View

D9007-1A

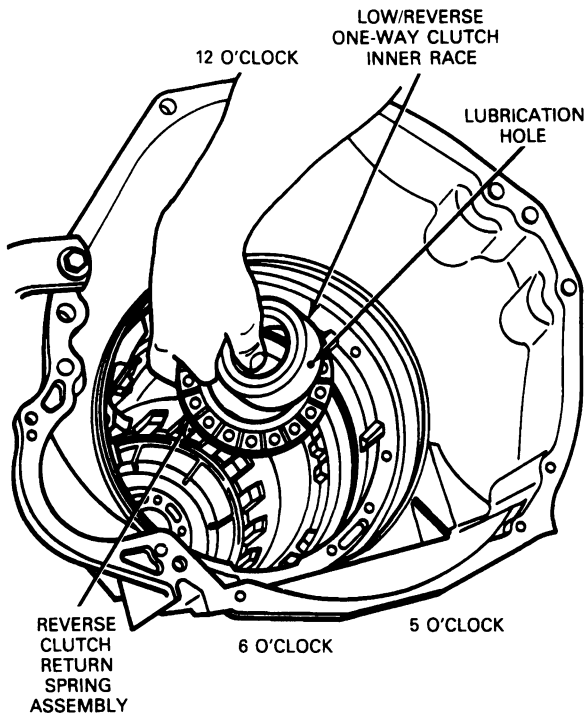
Rear View

D9008-1A

DISASSEMBLY AND ASSEMBLY (Continued)

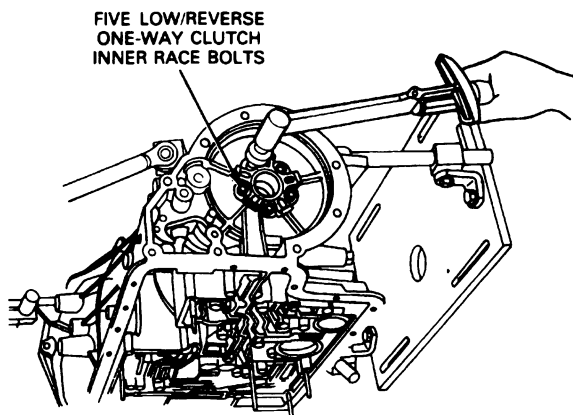
13. Install reverse piston return spring assembly and one-way clutch inner race. Inner race must be installed with lubrication hole in the 5 o'clock position.

NOTE: The use of two 5 / 16-24 x 3-1/2-inch bolts with the heads removed (for alignment pins) is helpful in aligning the inner race into the case.



D10686-A

14. Attach low / reverse one-way clutch inner race to case with five bolts (7 / 16-inch socket) and alternately tighten to 24-34 N·m (18-25 ft·lb).

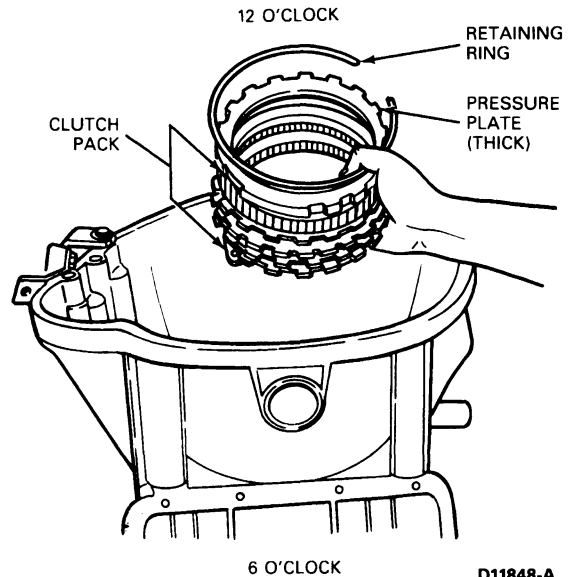


D9009-1A

15. Install reverse clutch pack (six or five plate depending on transmission model) starting with an external spline plate. Alternate external spline plates with internal spline plates. Install reverse clutch pressure plate (thick) and retaining ring.

NOTE: Install retaining ring with opening between the 12 and 3 o'clock positions.

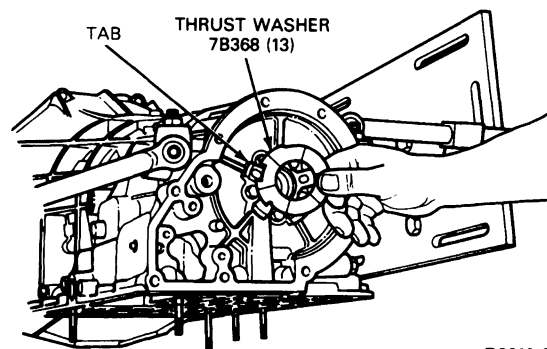
NOTE: No stack-up clearance measurement required.



D11848-A

16. Rotate transmission to horizontal position.
17. Lubricate steel side of the thrust washer 7B368 (13) with petroleum jelly and place on rear of case so that bronze side is facing outward.

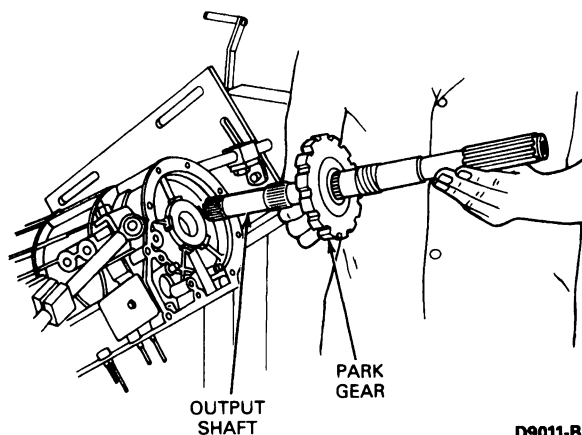
NOTE: Be sure thrust washer is properly seated against tab on case.



D9010-C

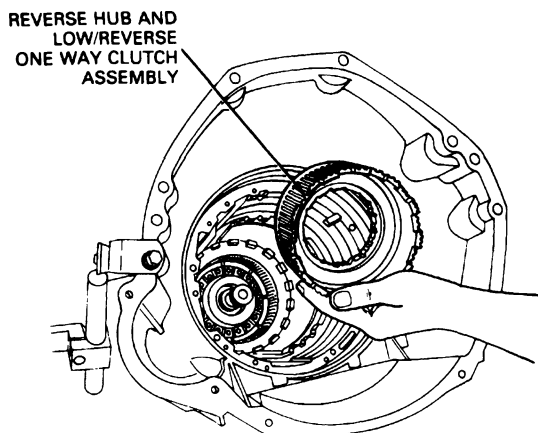
DISASSEMBLY AND ASSEMBLY (Continued)

18. Slide park gear onto shaft with thrust surface forward. Install output shaft.



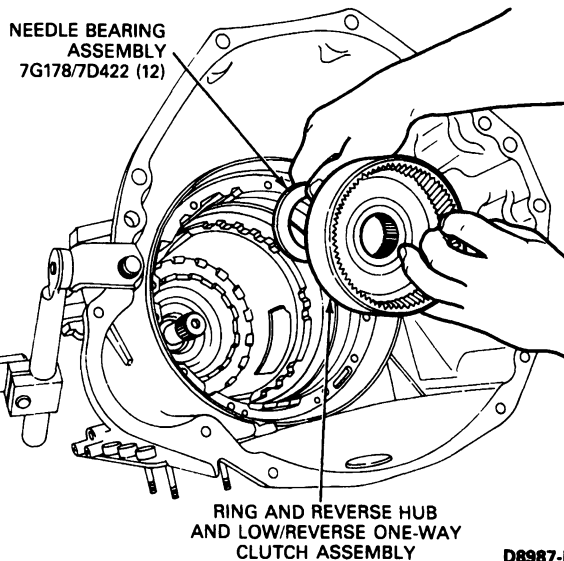
D9011-B

19. Install reverse hub and low /reverse one-way clutch assembly by rotating to fully seat.



D8988-1A

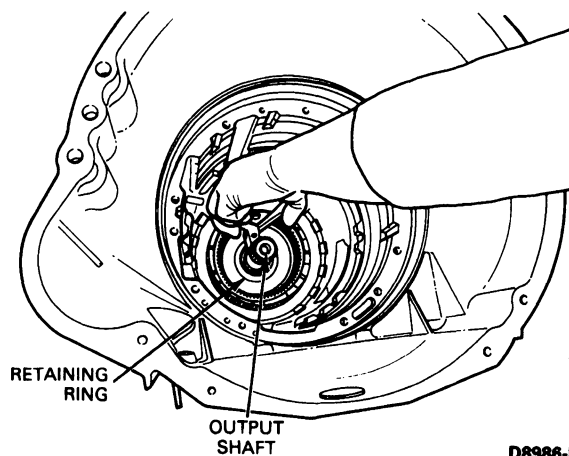
20. Using petroleum jelly, place the needle bearing assembly 7G178 (12) on the rear surface of the hub assembly. Place the output shaft hub and reverse ring gear into the case.



D8987-B

21. Install **new** retaining ring onto output shaft.

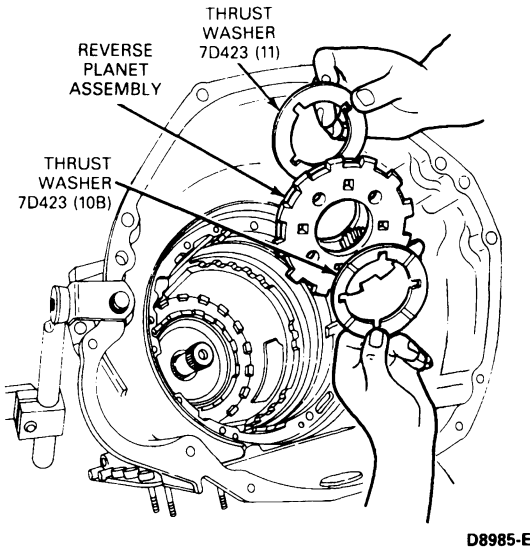
WARNING: DO NOT OVEREXTEND RETAINING RING WHEN INSTALLING. MAKE SURE RETAINING RING IS SECURELY SEATED IN GROOVE.



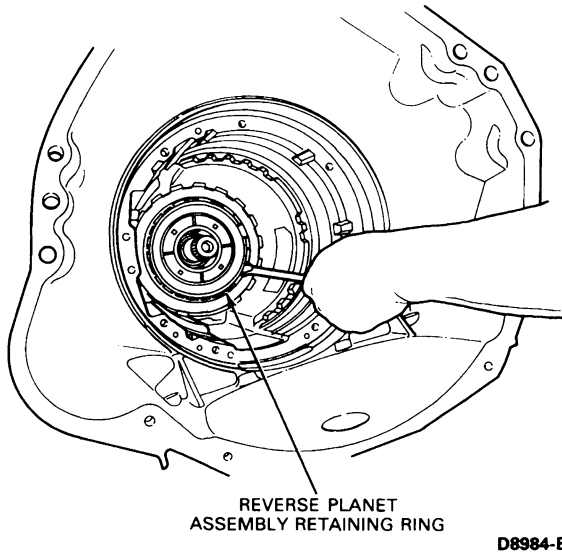
D8986-B

DISASSEMBLY AND ASSEMBLY (Continued)

22. Rotate transmission so that converter housing is facing up. Install reverse planet assembly into hub with thrust washer 7D423 (10B and 11).

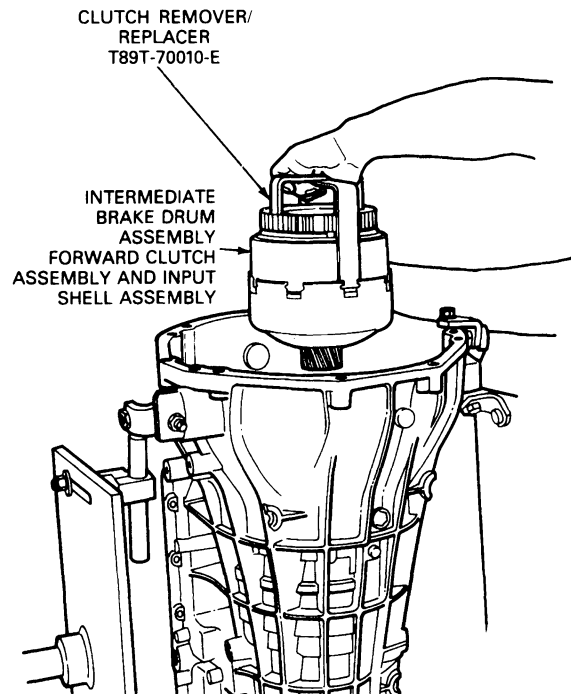


23. Install retaining ring into low reverse hub. Verify retaining ring is fully seated.



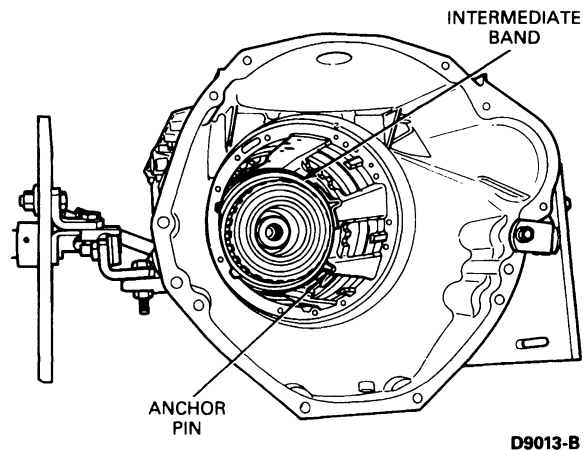
24. With Clutch Remover / Replacer T89T-70010-E attached, lower entire assembly (intermediate brake drum assembly, forward clutch assembly and input shell assembly) into case.

NOTE: It may be necessary to rotate output shaft to fully seat reverse sun gear.



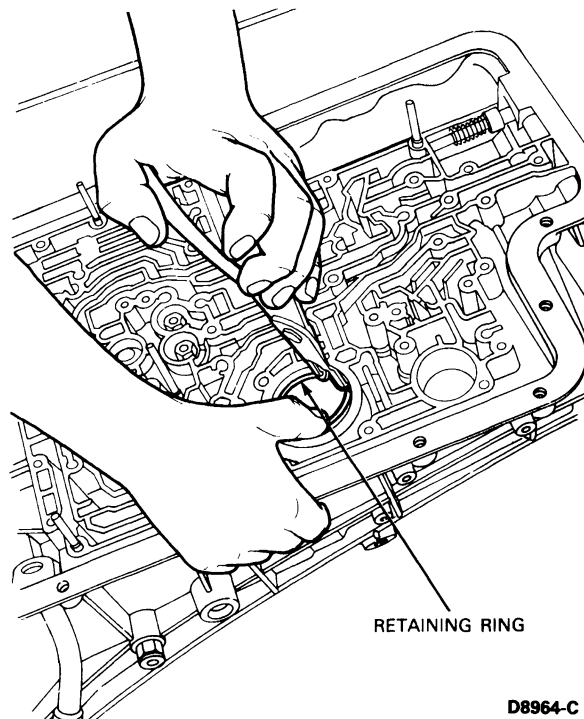
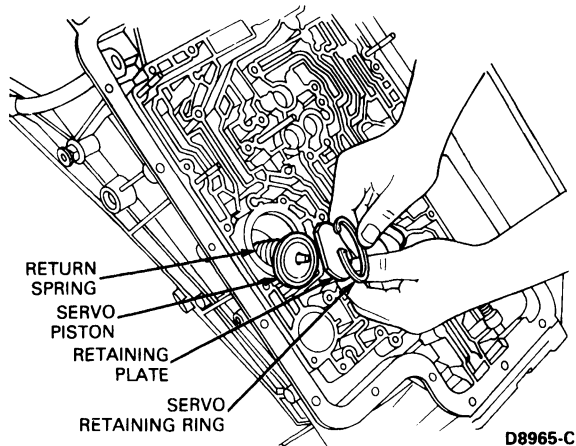
25. Remove service tool.

26. Install intermediate band so that one ear is resting on the anchor pin.

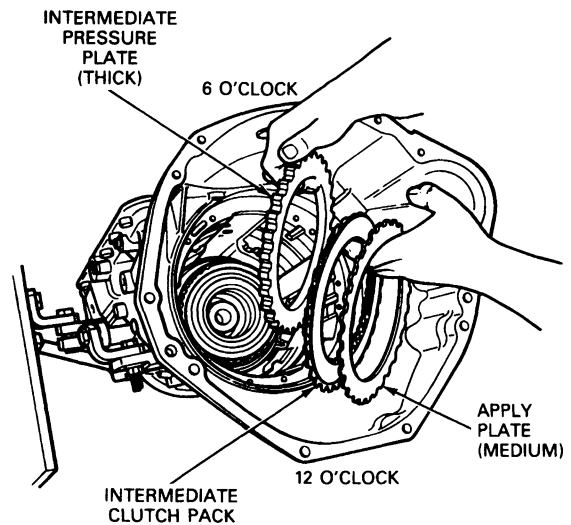


DISASSEMBLY AND ASSEMBLY (Continued)

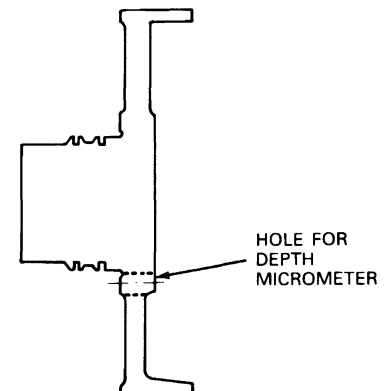
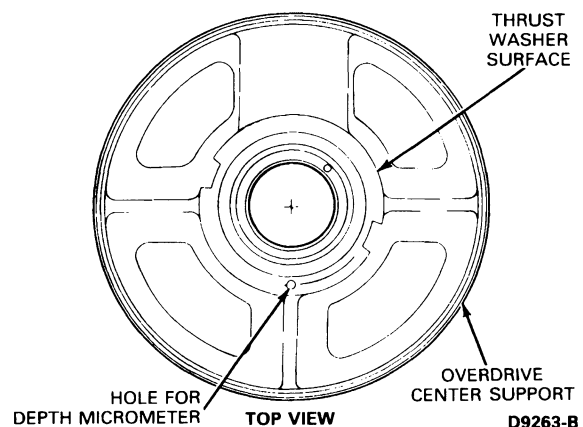
27. Install servo spring, piston and rod assembly, retaining plate and retaining ring.
- NOTE:** Apply slight downward pressure to plate while installing retaining ring.



28. Install intermediate pressure plate (thick) on bottom. Install clutch pack starting with internal spline plate and alternate with external spline plates. Install apply plate (medium) on top.
- NOTE:** Install apply plate with blank area (no teeth) at 6 and 12 o'clock positions.

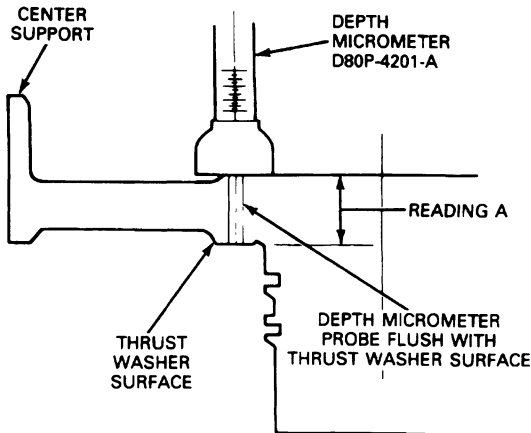


29. The transmission rear end clearance check determines the amount of space existing between the thrust washer surfaces of the center support and the intermediate brake drum. Determine end clearance with following procedure:

DEPTH GAUGE FIXTURE**SIDE VIEW**

DISASSEMBLY AND ASSEMBLY (Continued)

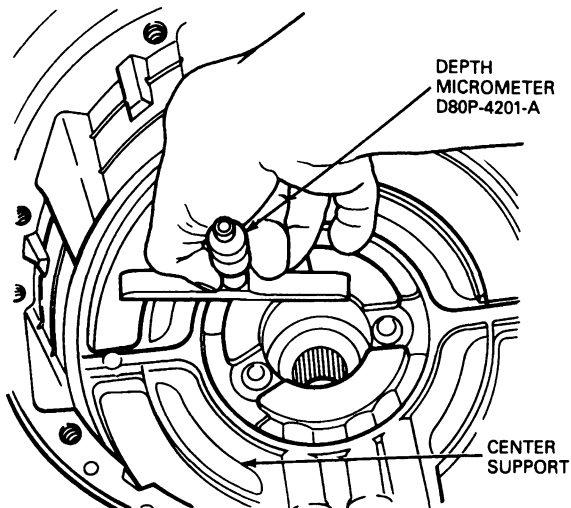
- a. Place Depth Micrometer D80P-4201-A or equivalent over drilled hole in center support fixture. Extend micrometer probe until it is flush with thrust washer surface. Record micrometer reading. This is Reading A.



D9264-1A

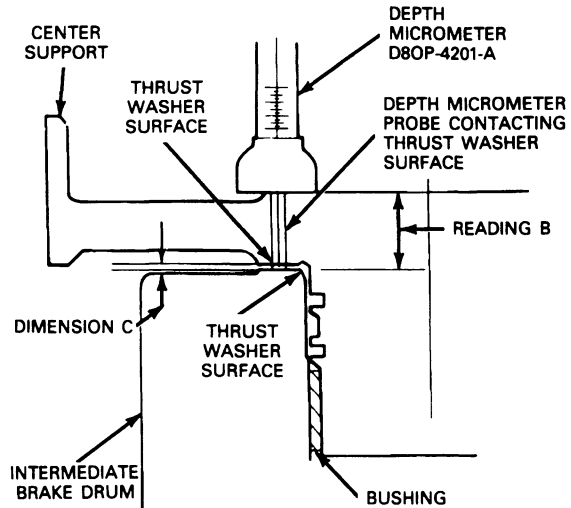
NOTE: Remove the cast iron seals from the center support to allow easy insertion into the intermediate brake drum.

- b. Install center support into intermediate brake drum. Make sure it is fully seated in transmission case.
- c. Place Depth Micrometer D80P-4201-A or equivalent over drilled hole in center support.



D10687-A

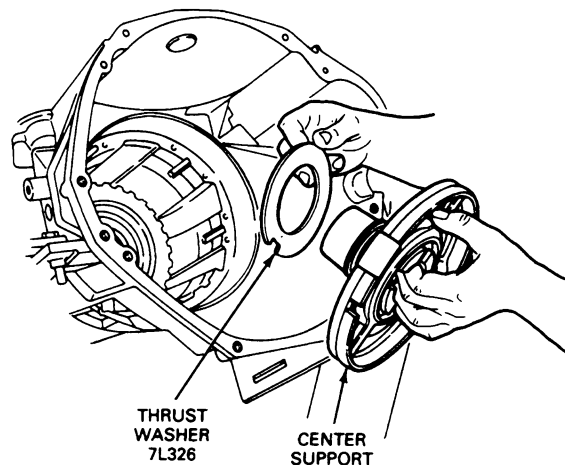
- d. Continue extending micrometer probe until it contacts thrust washer surface of intermediate brake drum. This is Reading B.



D9267-C

- e. Subtract Reading A from Reading B. The difference between these readings is Dimension C. This is the space between thrust surfaces. Subtract thrust washer thickness from Dimension C to determine final end clearance. Specification is 2.06-0.81mm (.081-.032 inch). If final dimension is outside specified limits, this indicates improper assembly, missing parts or parts out of specification. This requires rebuilding the unit.

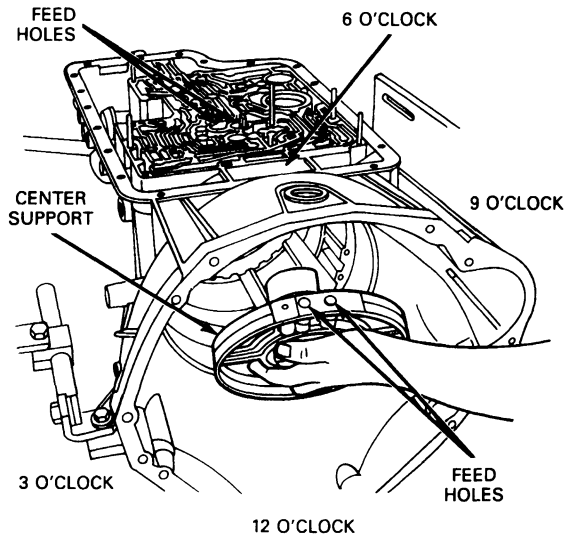
30. Remove center support from intermediate brake drum. Position thrust washer 7L326 (6) on rear of center support using light film of petroleum jelly.



D9014-1A

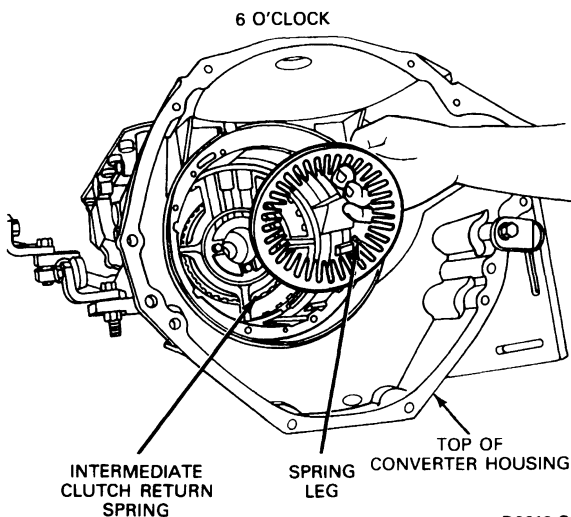
DISASSEMBLY AND ASSEMBLY (Continued)

31. Reinstall 2 cast iron seals to center support, removed earlier for clearance checks. Install center support with feed holes in 6 o'clock position. Install the two **new** feed bolts. **Do not** tighten at this time.



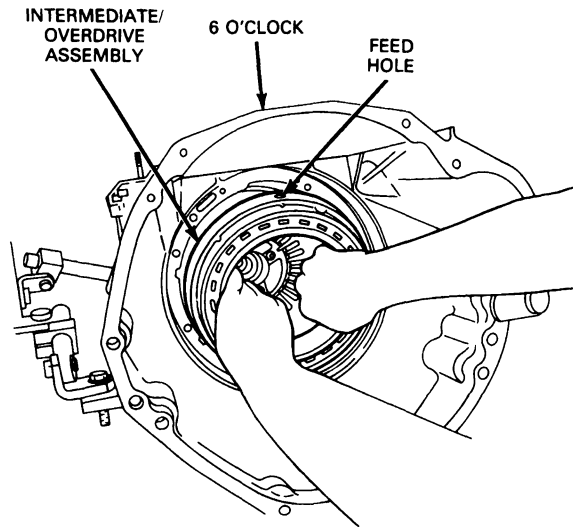
D9015-B

32. Install intermediate clutch return spring with dished surface inward.
NOTE: Locate one spring leg pointing toward the 6 o'clock position of the transmission.



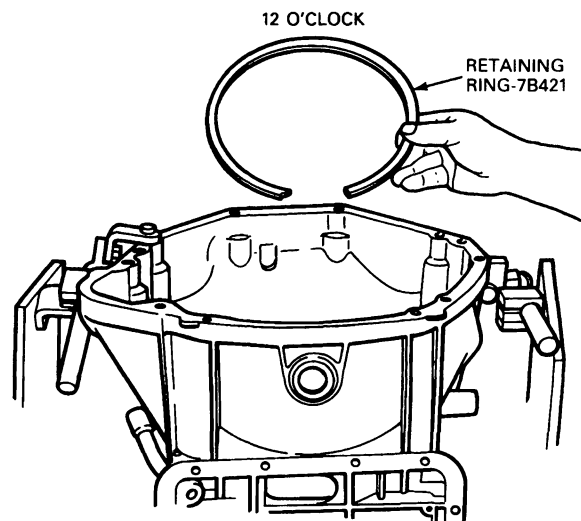
D9016-C

33. Install intermediate / overdrive cylinder assembly into case with feed hole in 6 o'clock position aligning with feed hole in case.
CAUTION: Do not "cock" cylinder assembly when installing.



D9017-B

34. Position retaining ring 7B421 over intermediate clutch cylinder assembly so that ring opening is at bottom (6 o'clock position) of case for proper fluid drainback.

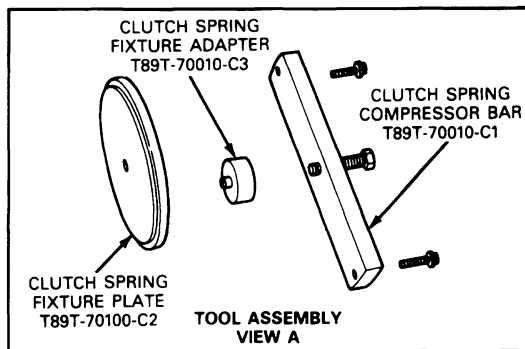
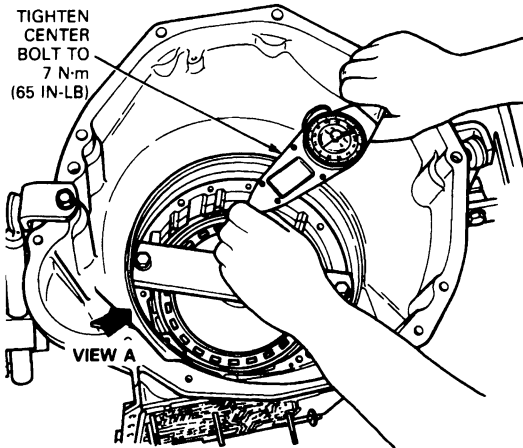


D10688-B

DISASSEMBLY AND ASSEMBLY (Continued)

35. Install Clutch Spring Fixture T89T-70010-C onto intermediate / overdrive cylinder assembly. Using two bolts, attach the tool to the pump face of case as illustrated. Tighten center bolt to 7 N·m (65 in-lb). Seat retaining ring 7B421 into case ring groove. Install one **new** intermediate clutch cylinder feed bolt. (**Do not** tighten at this time.)

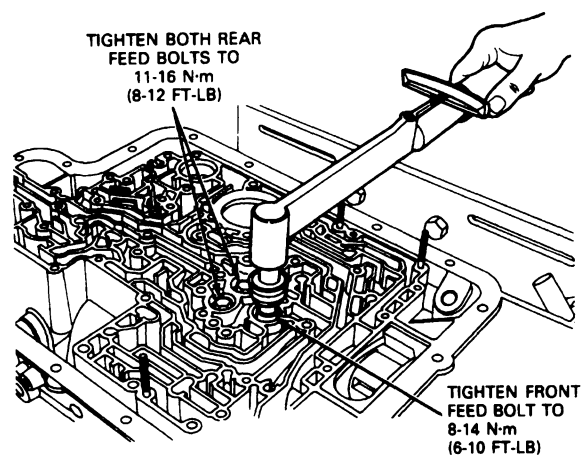
NOTE: No stack-up clearance measurement required.



D8975-B

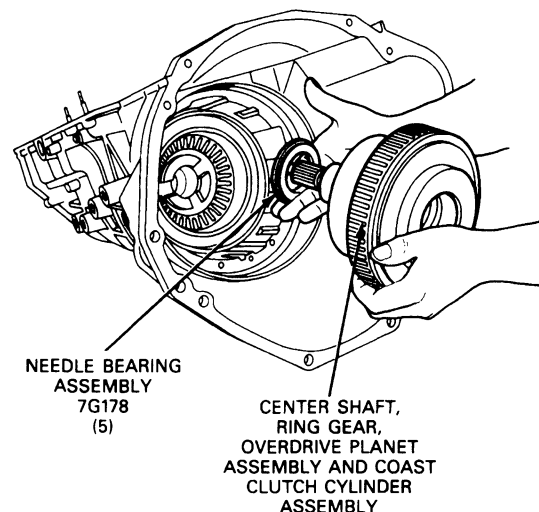
36. Remove Clutch Spring Fixture Assembly. Tighten three feed bolts (13mm socket) into intermediate / overdrive cylinder assembly and center support.

CAUTION: Tighten the front feed bolt to 8-14 N·m (6-10 ft-lb). Tighten both rear feed bolts to 11-16 N·m (8-12 ft-lb).



D9020-1A

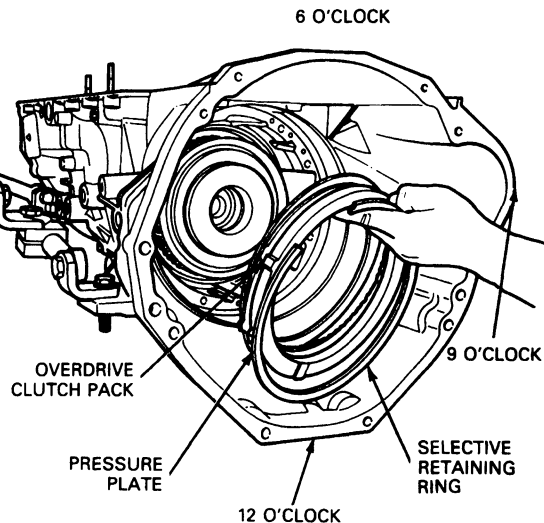
37. Verify that the needle bearing assembly 7G178 (5) is on rear face of center shaft. Install center shaft, overdrive ring gear, overdrive planet assembly and coast clutch cylinder as an assembly.



D9021-B

DISASSEMBLY AND ASSEMBLY (Continued)

38. Install overdrive clutch pack starting with steel plate alternating with friction plates. Install pressure plate with dot facing outward and at the 12 o'clock position. Install selective retaining ring with opening at bottom of case (6 o'clock).



D9022-B

39. Check stack-up clearance in three positions 120° apart using a feeler gauge. If not within specification, install correct selective retaining ring and recheck.

Specification:

1.20 - 0.55mm (0.047 - 0.022 inch)

Selective Retaining Rings

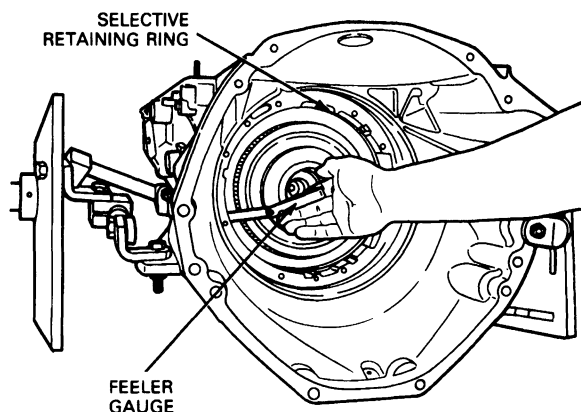
1.55 - 1.45mm (0.061 - 0.057 inch)

2.05 - 1.95mm (0.081 - 0.077 inch)

2.60 - 2.50mm (0.102 - 0.098 inch)

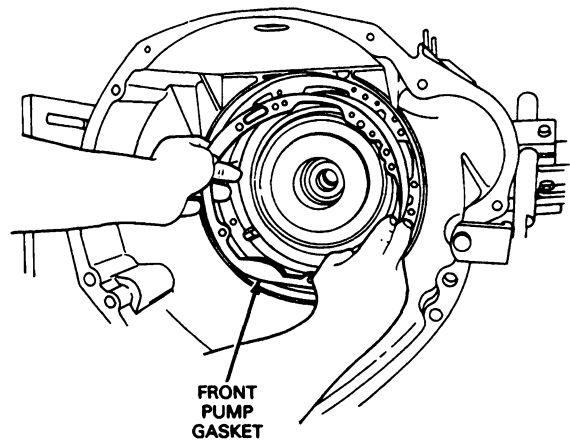
3.10 - 3.00mm (0.122 - 0.118 inch)

3.60 - 3.50mm (0.142 - 0.138 inch)



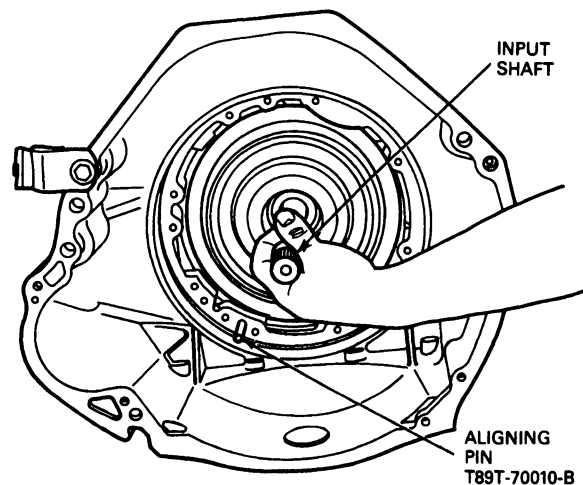
D9023-B

40. Align holes and install new pump gasket into case.



D9024-1A

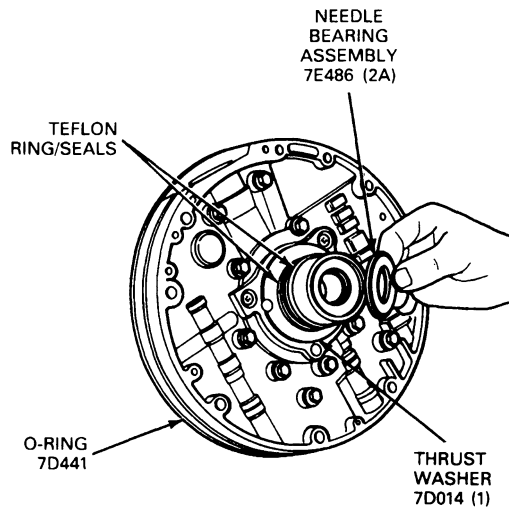
41. Install input shaft (long splined end first) and thread Aligning Pin T89T-70010-B into case.



D10689-A

DISASSEMBLY AND ASSEMBLY (Continued)

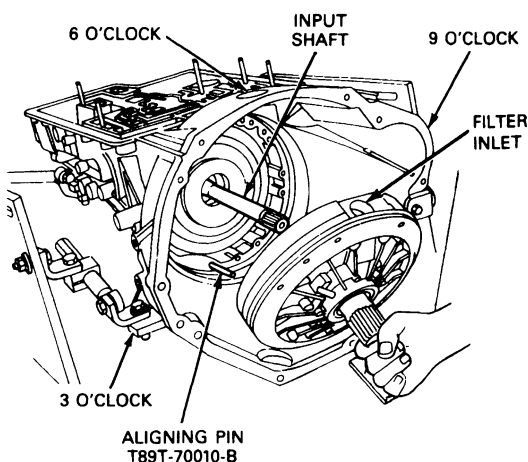
42. Using petroleum jelly to hold in place, make sure that thrust washer 7D014 (1) and needle bearing assembly 7E486 (2A) are in place before installing pump.



D9025-C

43. Install the pump into the case. Orient the filter inlet tube bore toward the 6 o'clock position. Fully seat the pump using hand pressure only.

CAUTION: Do not use bolts to draw pump into the case.

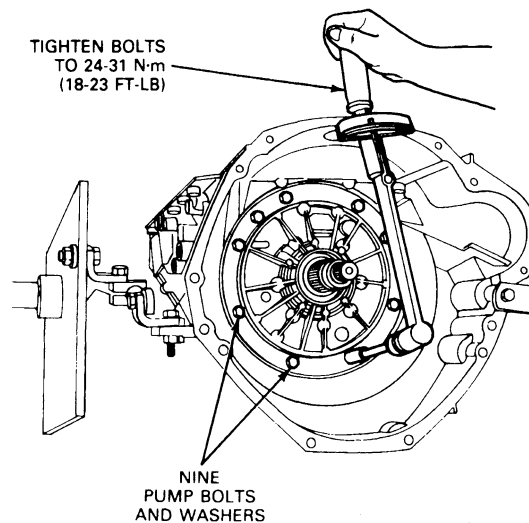


D9026-B

44. Remove old rubber coated washers from the nine pump-to-case bolts. Install nine **new** pump bolt washers (7G379). Remove Aligning Pin T89T-70010-B. Install nine pump bolts (10mm socket). Tighten to 24-31 N·m (18-23 ft-lb) alternating bolts. Remove input shaft.

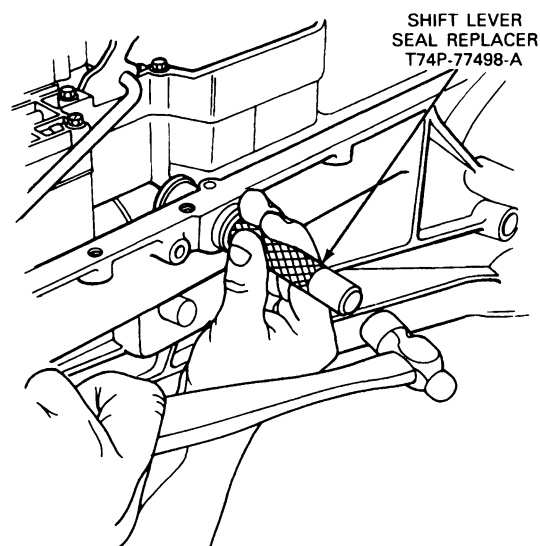
CAUTION: Remove input shaft prior to rotating transmission.

NOTE: Tighten pump bolts alternately to avoid possible damage.



D9027-1B

45. Clean bore opening with mineral spirits. Install seal using Shift Lever Seal Replacer T74P-77498-A.



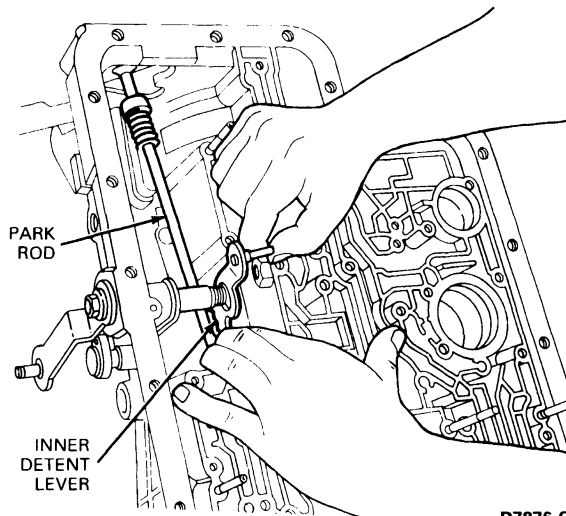
D11907-A

46. Install manual lever shaft.

DISASSEMBLY AND ASSEMBLY (Continued)

47. Install MLP sensor with two bolts and washers. **Do not** tighten bolts at this time.
48. Insert manual valve detent spring and 8mm bolt. Tighten to 9-11 N·m (80-100 in-lb).
49. Install manual valve detent lever, park actuating rod assembly and nut.

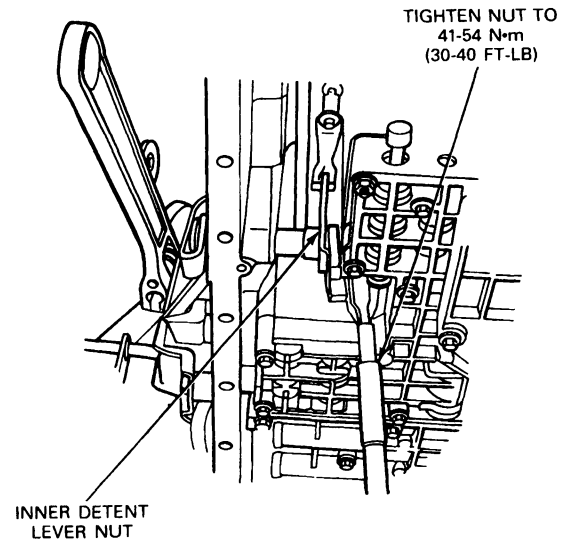
NOTE: Manual valve inner detent lever must be seated on flats of shaft, and rod assembly must be through guide plate.



D7876-C

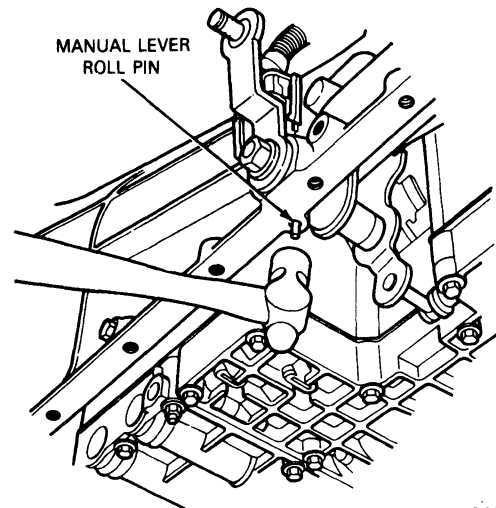
50. Tighten manual valve inner detent lever nut using a 21mm crowfoot while holding manual lever assembly flats with crescent wrench. Tighten nut to 41-54 N·m (30-40 ft-lb).

NOTE: Manual valve detent spring must be on detent lever and detent lever pin must align with manual valve.



D9238-B

51. Install manual lever roll pin past case surface.



D9239-D

52. Shift manual lever to all detent positions to check proper engagement of all positions and parking mechanism.
53. Align MLP sensor for neutral gear position using MLP Sensor Alignment Tool T92P-7010-AH.
54. Using an 8mm socket, tighten bolts to 6-8 N·m (55-75 in-lb).

NOTE: The manual lever assembly must be seated on the flats of the shaft.

DISASSEMBLY AND ASSEMBLY (Continued)

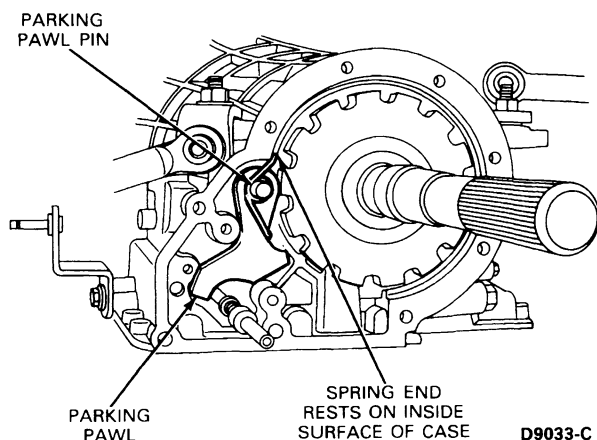
55. Install the manual lever assembly onto the manual lever shaft. The lever should be up and the pin away from the transmission (cable system only).

CAUTION: A new manual lever assembly nut must be used to properly secure lever to shaft.

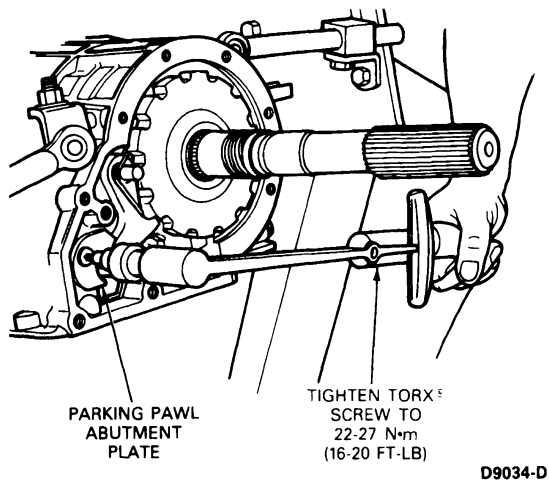
56. Install a new manual lever nut using a 15mm socket while holding the lever with a crescent wrench. Tighten the nut to 27-39 N·m (20-29 ft·lb) (cable system only).

57. Install parking pawl, pin and parking pawl return spring on rear face.

NOTE: Parking pawl return spring end rests on inside surface of case.

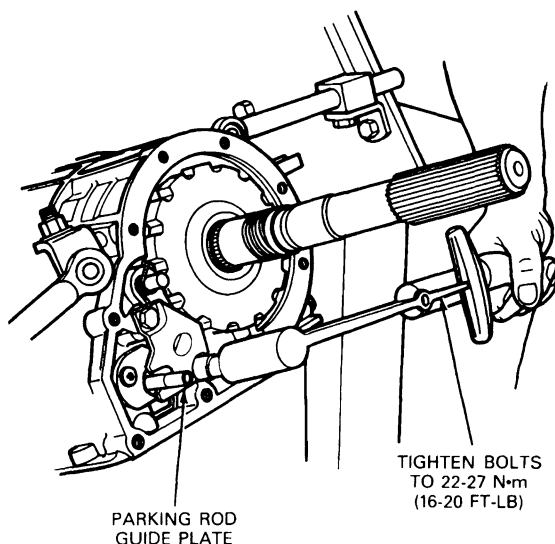


58. If removed, install parking pawl abutment with **new** Torx® head screw (T40 bit) and tighten to 22-27 N·m (16-20 ft·lb).

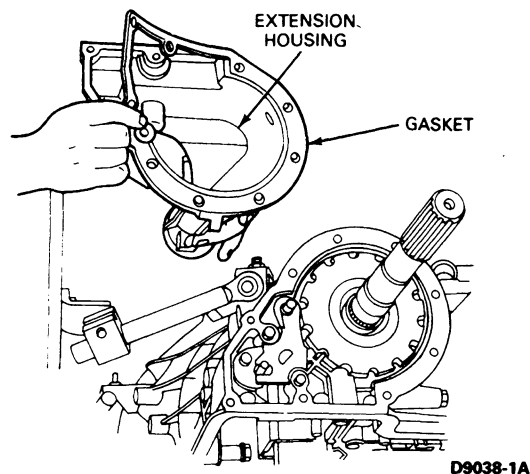


59. Attach parking rod guide plate with two bolts (13mm socket) and washers. Tighten to 22-27 N·m (16-20 ft·lb).

NOTE: Make sure plate dimple is facing inward and parking rod is in guide plate slot.



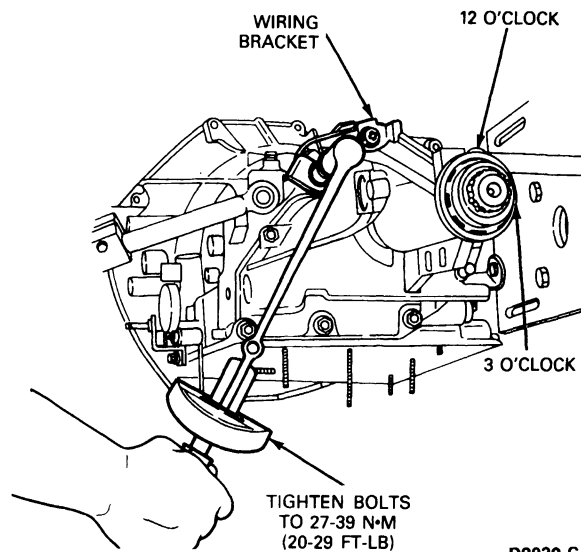
60. Place **new** gasket on extension housing.



DISASSEMBLY AND ASSEMBLY (Continued)

61. Install extension housing and wiring bracket on rear of case (at approximately the 10 and 11 o'clock positions) using nine bolts (13mm socket). Tighten bolts to 27-39 N·m (20-29 ft·lb).

NOTE: The two bottom extension housing bolts are slightly shorter on 4x2 vehicles and slightly longer on 4x4 models.

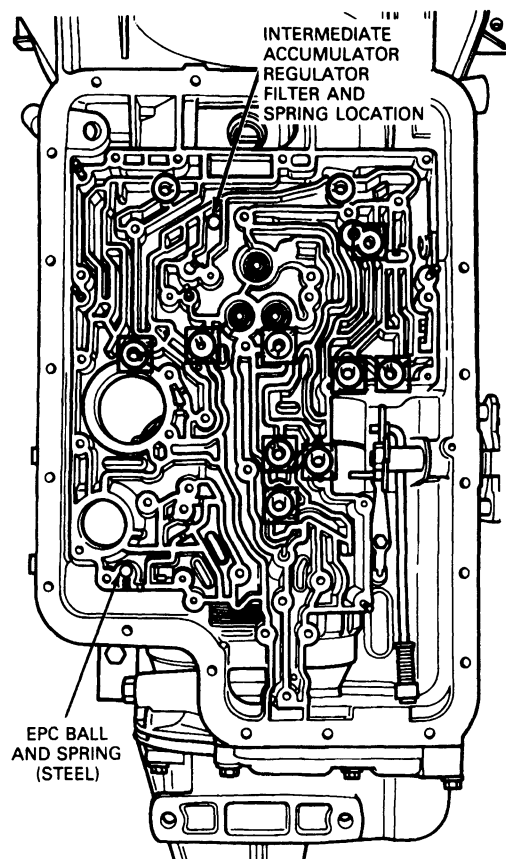


D9039-C

62. Rotate transmission so that pan surface is facing up. Install EPC ball (steel) and spring and nine rubber check balls. Install intermediate accumulator regulator filter assembly. Refer to the following illustration for checkball location.

CAUTION: Use care not to damage rubber check balls.

NOTE: The EPC ball is a .25-inch diameter steel ball that is smaller than the rest.



□ — RUBBER (9)

CHECKBALL LEGEND

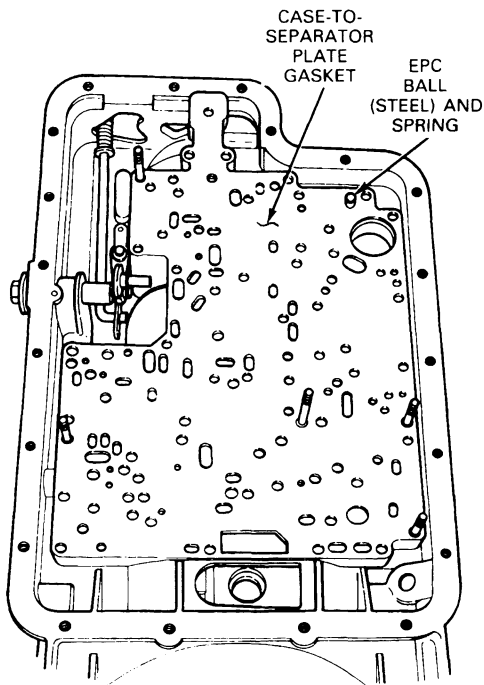
D9040-E

63. Install case-to-separator plate gasket.

NOTE: If the gasket and separator plate holes do not align, heat the gasket (if gasket is too large) or soak in transmission fluid (if gasket is too small) to obtain proper alignment before assembly.

DISASSEMBLY AND ASSEMBLY (Continued)

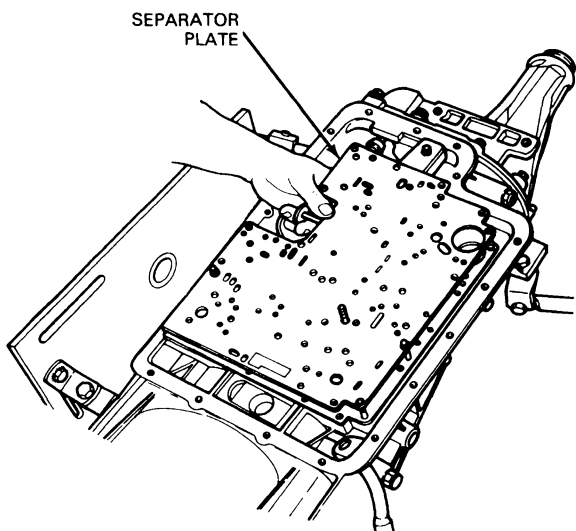
CAUTION: DO not overheat gasket. Damage could result.



D9041-C

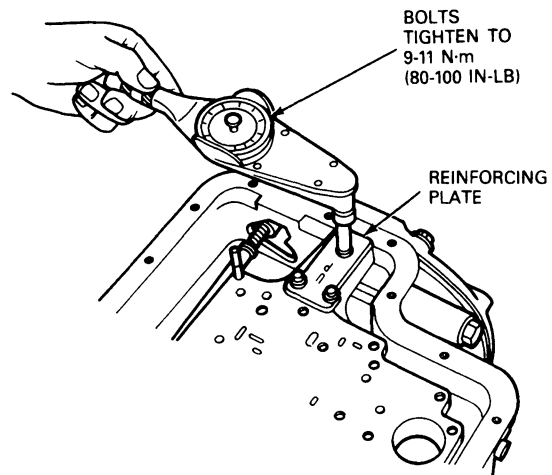
64. Install separator plate.

NOTE: Check placement of EPC ball (steel), and accumulator regulator filter spring assembly.



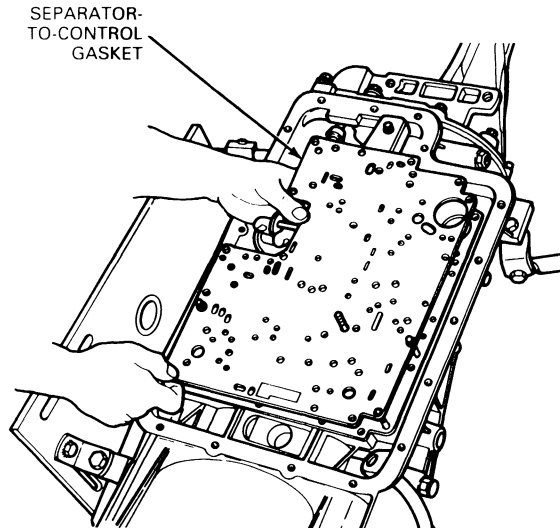
D9042-C

65. Attach reinforcing plate with three bolts (8mm socket) with the stamped word "UP" visible. Tighten to 9-11 N·m (80-100 in·lb).



D9043-B

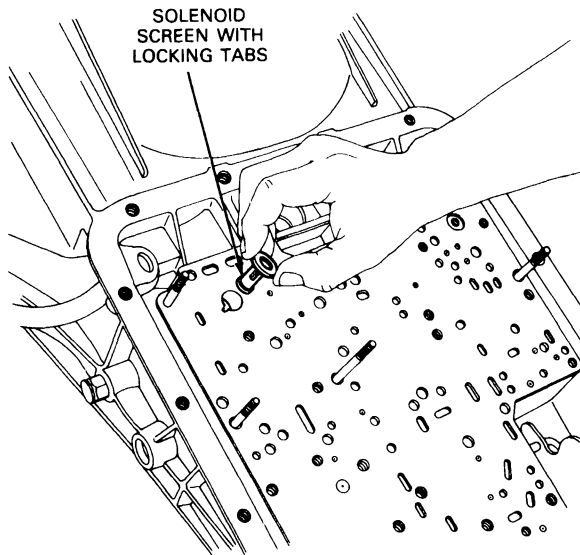
66. Install new separator-to-control gasket.



D9044-B

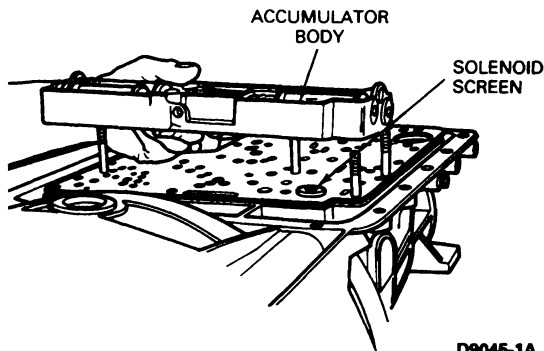
DISASSEMBLY AND ASSEMBLY (Continued)

67. Install solenoid screen into separator plate by pushing in and rotating to lock.



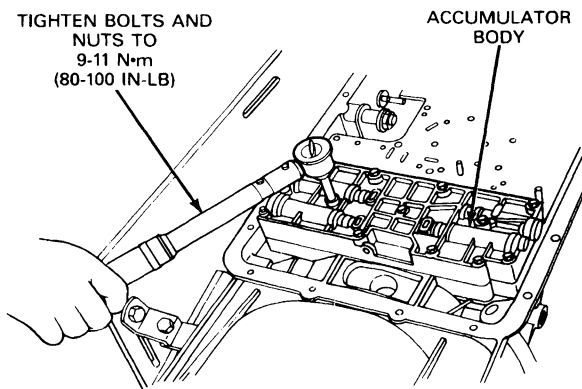
D8960-C

68. Install accumulator body assembly over studs and attach with two nuts (10mm socket) and 11 bolts (8mm socket). Tighten to 9-11 N·m (80-100 in-lb).



D9045-1A

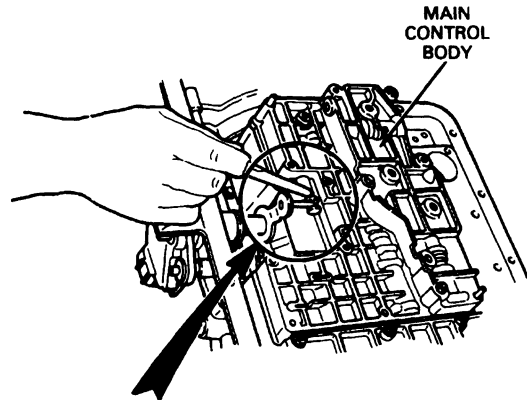
TIGHTEN BOLTS AND NUTS TO
9-11 N·m
(80-100 IN-LB)



D9046-B

69. Lower main control body assembly over studs. Align manual valve with manual lever pin.

NOTE: Detent spring roller must be centered on detent lever.

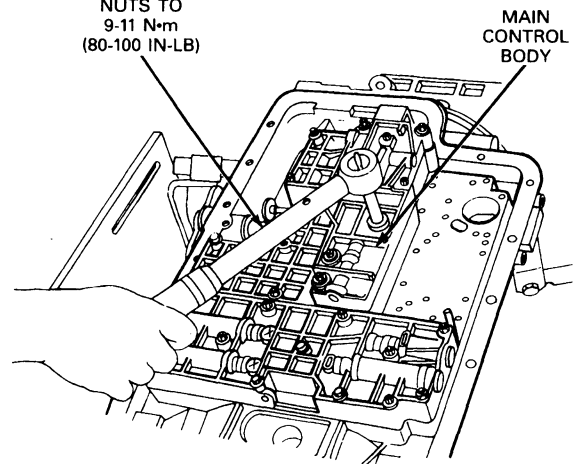


CHECK PLACEMENT OF
INNER DETENT LEVER
WITH MANUAL VALVE

D9047-1A

70. Attach main control body assembly with two nuts (10mm socket) and 14 bolts (8mm socket). Tighten to 9-11 N·m (80-100 in-lb).

TIGHTEN BOLTS AND NUTS TO
9-11 N·m
(80-100 IN-LB)

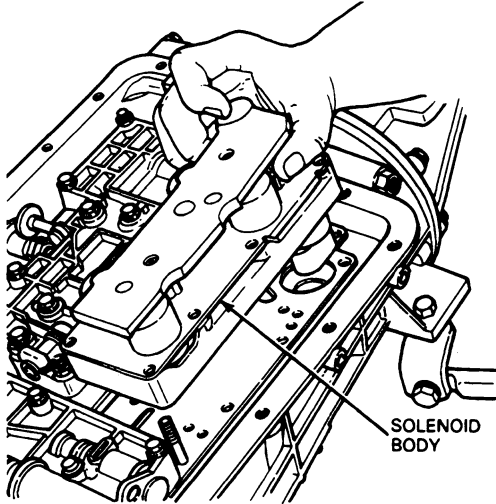


D9048-B

DISASSEMBLY AND ASSEMBLY (Continued)

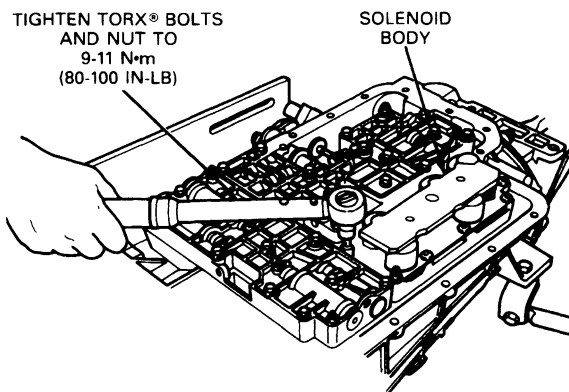
71. Install solenoid body over stud and attach with nine Torx® bolts (T30 bit) and one nut (10mm socket). Tighten to 9-11 N·m (80-100 in-lb).

NOTE: Prior to installing solenoid body assembly, coat the case connector bore with petroleum jelly or equivalent. Inspect seal in electrical connector for proper seating and condition.



D9049-1A

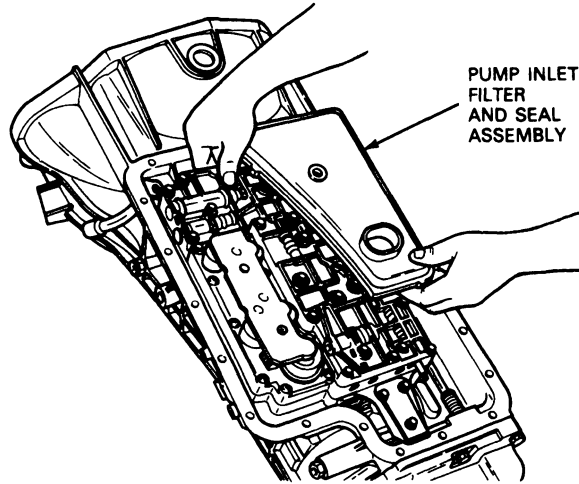
TIGHTEN TORX® BOLTS
AND NUT TO
9-11 N·m
(80-100 IN-LB)



D9050-B

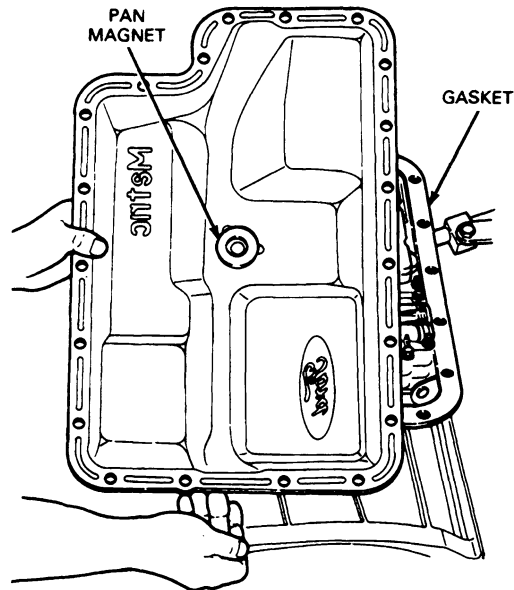
CAUTION: Do not reuse old pump inlet filter and seal assembly.

72. Install a **new** pump inlet filter and seal assembly by lubricating the seal with transmission fluid and pressing the filter into place.



D8955-B

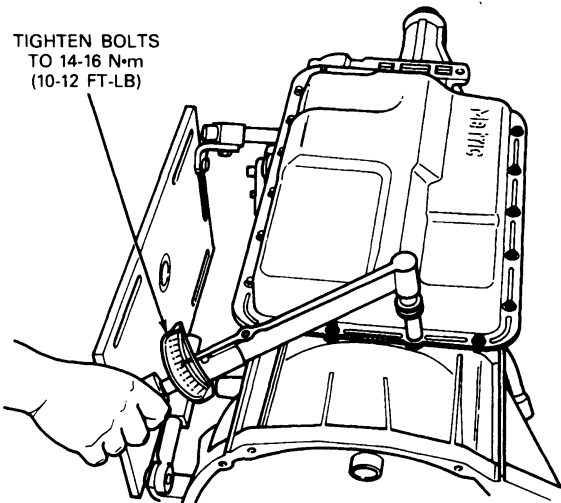
73. Clean and inspect pan magnet and replace if necessary. Place pan magnet on dimple in bottom of pan. Install new pan gasket on transmission.



D9051-1A

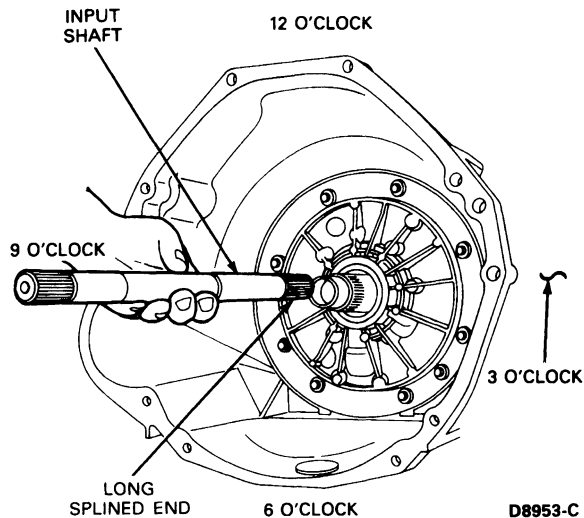
DISASSEMBLY AND ASSEMBLY (Continued)

74. Attach pan with bolts (10mm socket). Tighten bolts to 14-16 N·m (10-12 ft-lb).

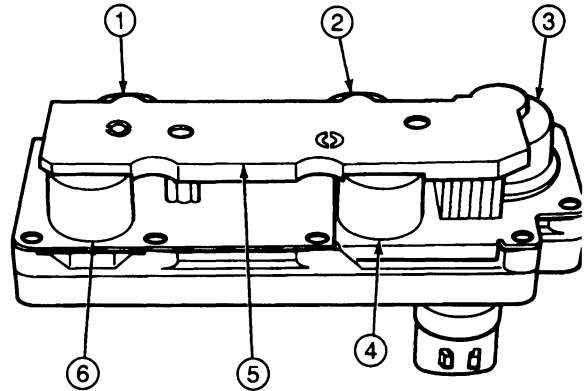


D9052-B

75. Rotate transmission so pan is facing down and install input shaft, long splined end first.



D8953-C



D5992-B

Item	Description
1	Shift Solenoid 1 (SS1)
2	Shift Solenoid 2 (SS2)
3	EPC Solenoid
4	Coast Clutch Solenoid (CCS)
5	TOT Sensor Location
6	Torque Converter Clutch (TCC) Solenoid

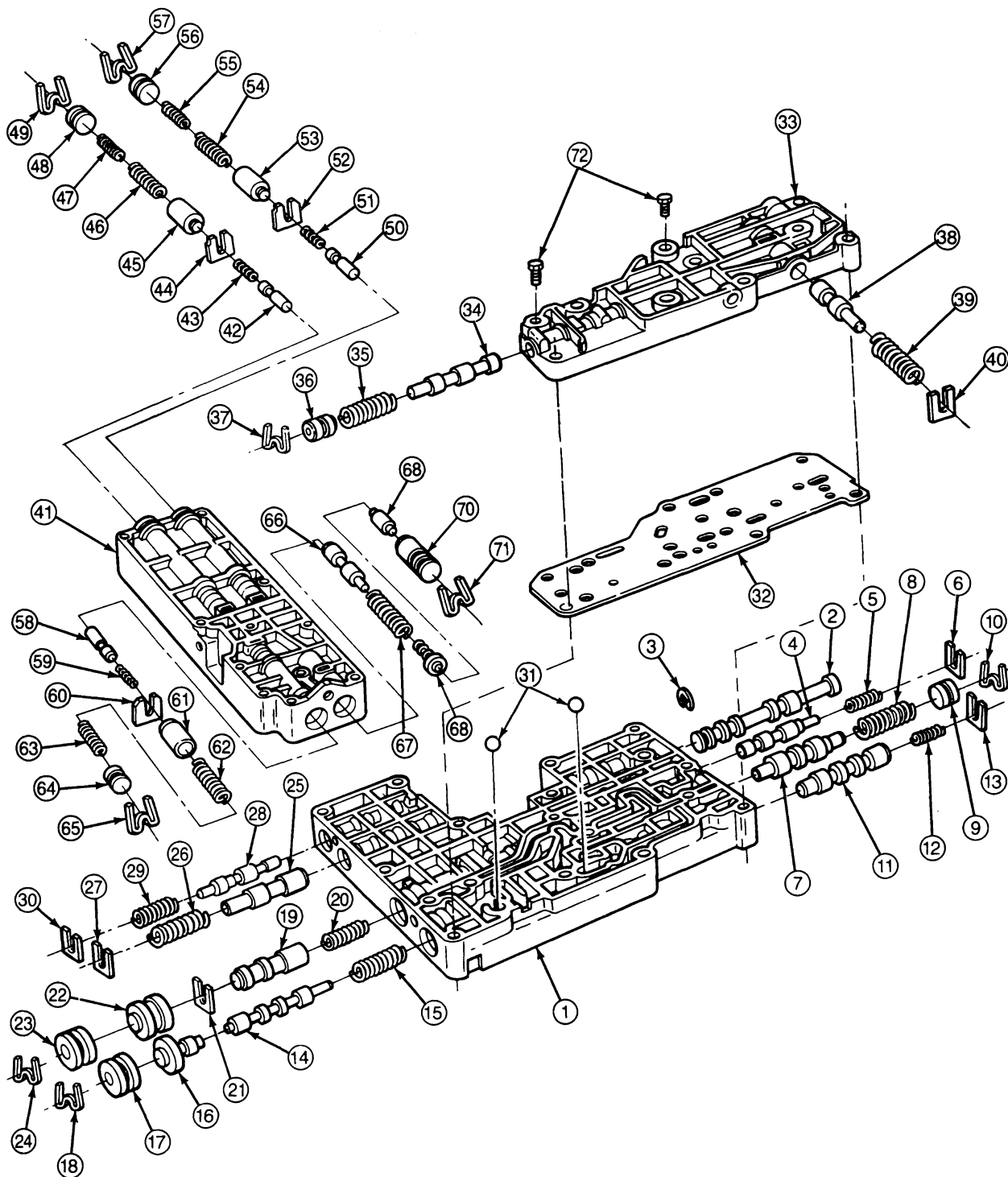
TD5992A

NOTE: Solenoid bodies may have either 9 or 12 pins in the electrical connector. These bodies are interchangeable.

NOTE: Check connector for terminal condition, corrosion and contamination. Clean, repair or replace as required.

DISASSEMBLY AND ASSEMBLY (Continued)

Main Control Valve Bodies and Accumulator Valve Body



D9256-D

DISASSEMBLY AND ASSEMBLY (Continued)

Item	Part Number	Description
1	7A092	Upper Control Body
2	7340	Manual Valve
3	97411-S	Retainer
4	7E238	Low/Reverse Modulator Valve
5	7E338	Spring
6	7F194	Retainer
7	7F259	3-4 Shift Valve
8	7K721	Spring
9	7F187	Plug
10	7E335	Clip
11	7D053	2-3 Shift Valve
12	7A320	Spring
13	7F194	Retainer
14	7D368	Drive 2 Shift Valve
15	7A288	Spring
16	7A334	1-2 Shift Valve
17	7F187	Plug
18	7E335	Clip
19	7G410	4-3-2 Manual Timing Valve
20	7G410	Spring
21	7G396	Retainer
22	7G399	4-3-2 Manual Timing Plunger
23	7F187	Plug
24	7E335	Clip
25	7G416	Coast Clutch Shift Valve
26	7K721	Spring
27	7F914	Retainer
28	7G392	Solenoid Regulator Valve
29	7G411	Spring
30	7F194	Retainer
31	7E195	Check Balls
32	7A008	Separator Plate
33	7A101	Lower Control Body
34	7G317	Engagement Control Valve
35	7G312	Spring
36	7F187	Plug
37	7G007	Clip
38	7G414	1-2 Manual Transition Valve
39	7K721	Spring
40	7F194	Retainer

(Continued)

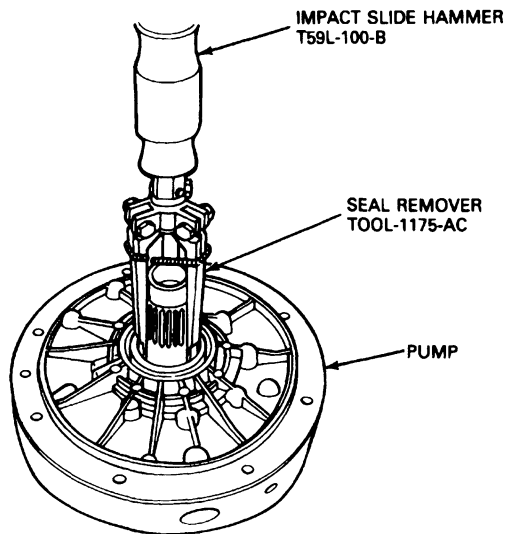
Item	Part Number	Description
41	7G393	Accumulator Control Body
42	7G321	Overdrive Clutch Accumulator Regulator Valve
43	7G310	Spring
44	7G409	Retainer
45	7G322	Overdrive Clutch Accumulator Plunger
46	7G394	Outer Spring
47	7G395	Inner Spring
48	7F187	Plug
49	7E335	Clip
50	7G321	Direct Clutch Accumulator Regulator Valve
51	7G310	Spring
52	7G409	Retainer
53	7G322	Direct Clutch Accumulator Plunger
54	7G394	Outer Spring
55	7G395	Inner Spring
56	7F187	Plug
57	7E335	Clip
58	7G321	Intermediate Clutch Accumulator Regulator Valve
59	7G310	Spring
60	7G409	Retainer
61	7G322	Intermediate Clutch Accumulator Plunger
62	7G394	Outer Spring
63	7G395	Inner Spring
64	7G187	Plug
65	7E335	Clip
66	7G408	Line Pressure Modulator Valve
67	7G314	Outer Spring
68	7H149	Spring and Retainer Assembly
69	7G415	Line Pressure Modulator Plunger Valve
70	7G407	Line Pressure Modulator Sleeve
71	7E335	Clip
72	N805325-S	Bolts

DISASSEMBLY AND ASSEMBLY (Continued)

Pump

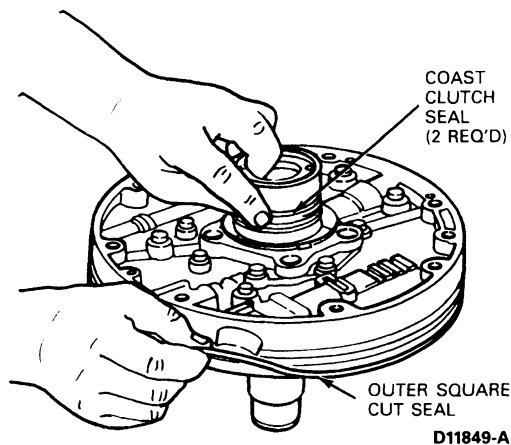
Disassembly

1. Inspect converter hub seal. If damaged, remove with Impact Slide Hammer Tool T59L-100-B and Seal Remover TOOL-1175-AC.



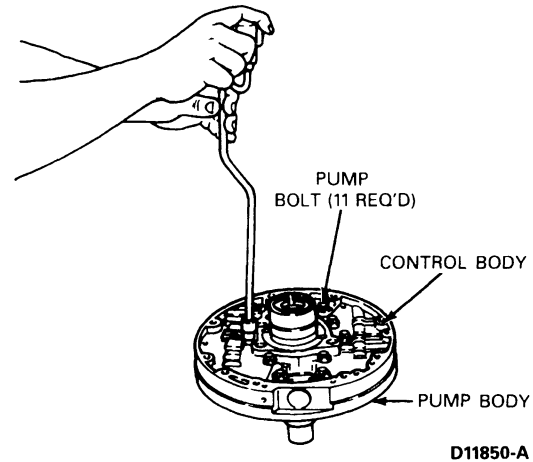
D9056-1A

2. Remove torque converter clutch seal from front of stator support.
3. Remove two Teflon® coast clutch seals from stator support. Remove pump outer diameter square cut seal.



D11849-A

4. Obtain Banding Tool D89L-7700-A and one 10mm bolt prior to removing pump body bolts. This tool is needed to align the pump with the control body assembly during re-assembly.
5. Remove eleven bolts and separate pump control body from pump body. Prior to removing last bolt, support pump body.



D11850-A

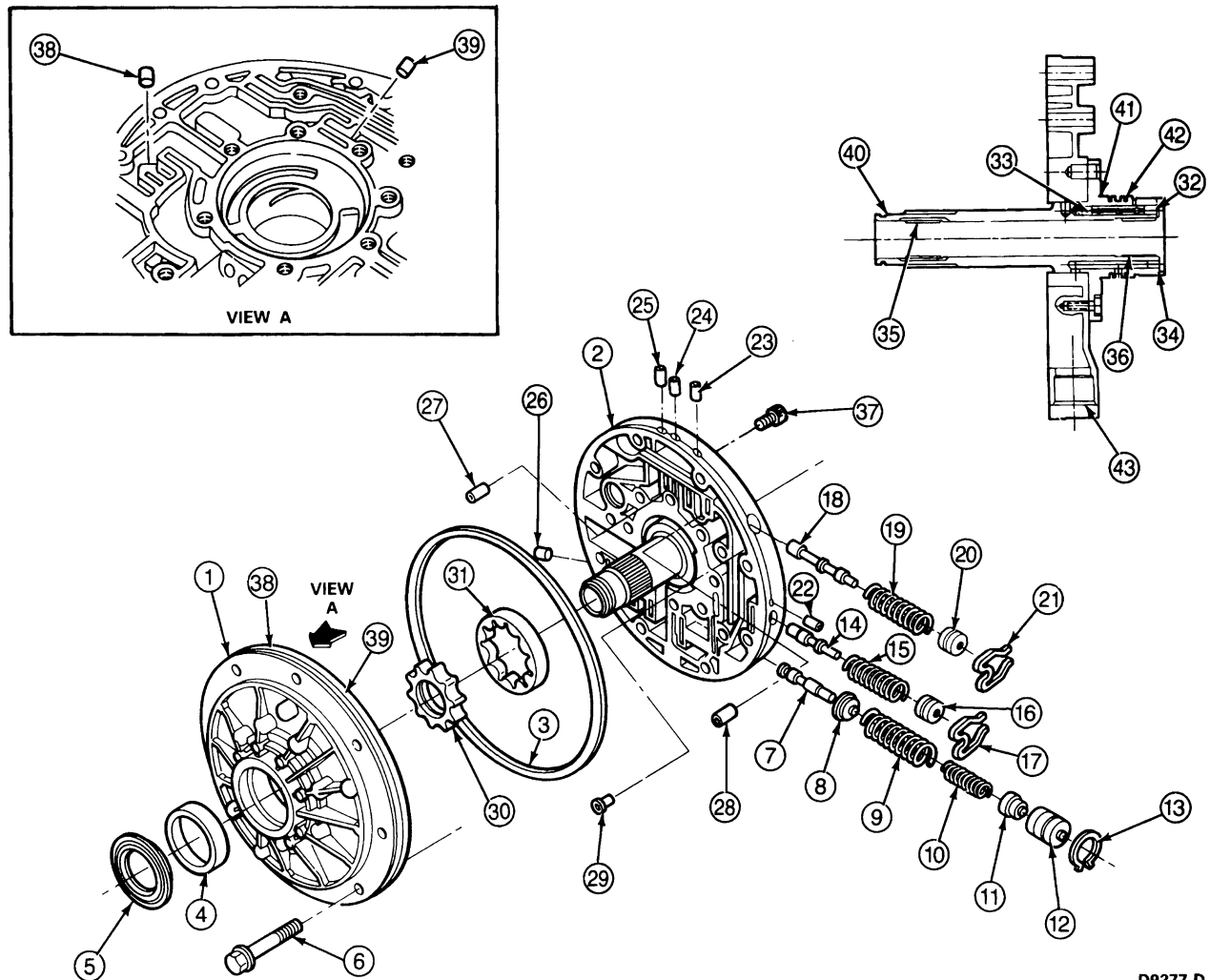
NOTE: For Steps 5 through 7 refer to pump assembly illustration.

CAUTION: DO NOT remove any of the cup plugs. DO NOT remove stator support from control body as this may distort the surface of the control body.

6. Apply pressure to main regulator booster sleeve and remove internal retaining ring. Remove main regulator valve train.
7. Remove converter regulator valve assembly by applying pressure to end plug and removing retainer clip with small screwdriver or tweezers.
8. Remove converter clutch shift valve assembly by applying pressure to end plug and removing retainer clip with small screwdriver or tweezers.

DISASSEMBLY AND ASSEMBLY (Continued)

Pump Assembly



D9277-D

Item	Part Number	Description
1	7A105	Pump Body
2	7G406	Control Body and Support Assembly
3	7D441	Square Cut O.D. Pump Seal
4	7B258	Converter Hub Bushing
5	7A248	Seal
6	N805260	Bolt and Washer Assembly (9 Req'd)
7	7C338	Main Regulator Valve
8	7E337	Spring Retainer
9	7A270	Outer Spring (Green)
10	7G498	Inner Spring (Green) to (Orange)
11	7D003	Main Regulator Booster Valve
12	7D002	Main Regulator Booster Sleeve

(Continued)

Item	Part Number	Description
13	N660225	Retainer
14	7G307	Converter Regulator Valve
15	7G316	Spring
16	7F187	Plug
17	7G007	Clip
18	7L318	Converter Clutch Control Valve
19	7L490	Spring (Yellow)
20	7F187	Plug
21	7G007	Clip
22	N805212	Solid Cup Plug
23	N805212	Solid Cup Plug
24	N805212	Solid Cup Plug
25	N805212	Solid Cup Plug
26	N805212	Solid Cup Plug
27	N806581	Orificed Cup Plug (.090-Inch Diameter Orifice)

(Continued)

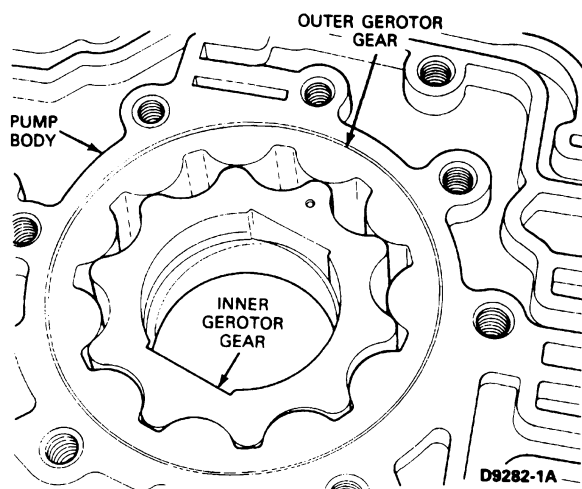
DISASSEMBLY AND ASSEMBLY (Continued)

Item	Part Number	Description
28	N805214	Orificed Cup Plug (.049-.055-Inch Diameter Orifice)
29	7H000	Air Bleed Check Valve Assembly
30	7C010	Inner Gerotor Gear
31	7C011	Outer Gerotor Gear
32	N807409	Orifice Cup Plug (.068-.074-Inch Diameter Orifice)

(Continued)

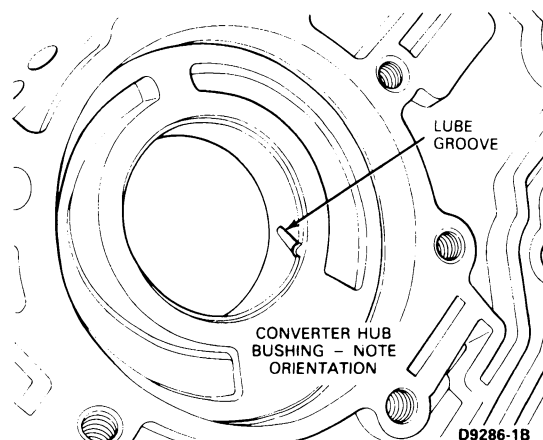
Item	Part Number	Description
33	7A250	Valve Assembly
34	N805175	Solid Cup Plug
35	7B261	Front Input Shaft Bushing
36	7D018	Rear Input Shaft Bushing
37	805208	Bolt M8 (11 Req'd)
38	N804896 ¹²	Orificed Cup Plug
39	N804986 ¹²	Orificed Cup Plug
40	7C323	Seal Conv. Clutch
41	7G402	Seal Coast Clutch
42	7G402	Seal Coast Clutch
43		Inlet Tube Bore

9. Remove gerotor gearset from pump body.

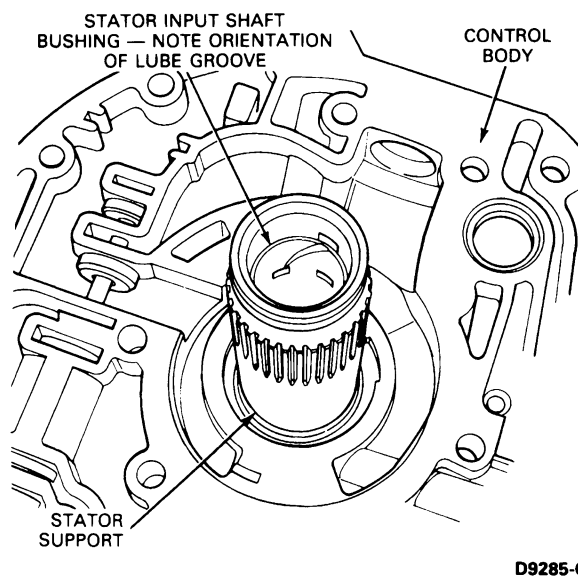


10. Clean all pump parts in solvent and dry with compressed air.
11. Inspect pump gears, faces, gear teeth, pump housing and mating surfaces for damage or scoring. Replace entire pump if any part is damaged or worn.
12. Inspect converter hub bushing. Replace entire pump if scored or excessively worn.

12 Orifice cup plugs not shown in illustration.

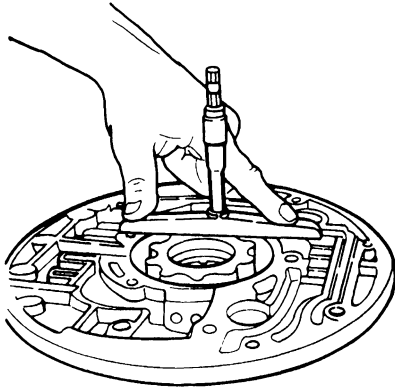


13. Inspect stator input shaft bushings. If bushings are worn or scored, or if lubrication groove is out of orientation, replace entire pump assembly.



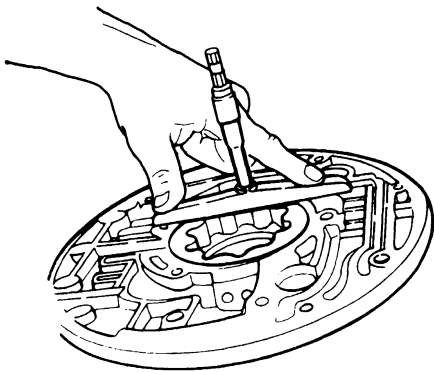
DISASSEMBLY AND ASSEMBLY (Continued)

14. Place inner pump gerotor gear in pump gear pocket, centered to pump bushing diameter.



D11851-A

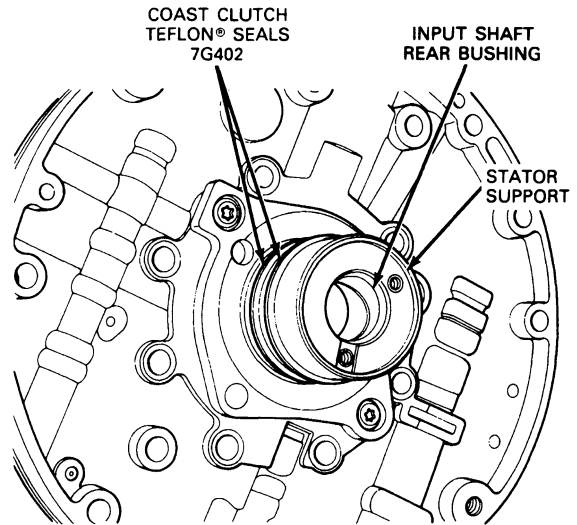
15. Using depth micrometer, measure and record the depth of inner gerotor gear face to the machined surface of the pump body.
16. Repeat measurement for a total of three readings in equally spaced locations on gear face.
17. Remove the inner gear and install the outer gear.



D11852-A

18. Using depth micrometer, measure and record the depth of the outer gerotor gear to the machined surface of the pump body.

19. All depth measurements must be within .0254-.0510mm (.001-0.002 inch). If either reading is out of specification, replace the pump assembly.



D9284-D

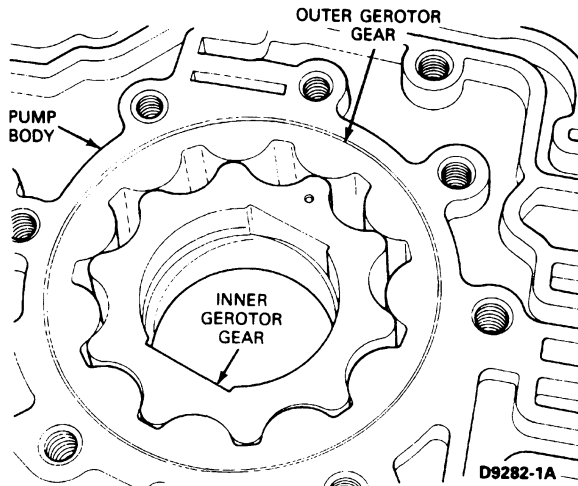
20. Inspect all valve and plug bores for scoring or damage. Check all passages for obstructions. Inspect mating surfaces for burrs and scoring. If necessary, use an oil stone to polish components. Use caution to avoid rounding sharp edges of valves and plugs.
21. Inspect all springs for distortion. Check that, when dry, all valves and plugs move freely within their bores.

Assembly

1. Install main regulator valve assembly as shown in control body assembly exploded view. Apply pressure to main regulator booster sleeve and install internal retaining ring. Make sure retaining ring is properly seated.
2. Install converter shift valve assembly.
3. Install converter regulator valve assembly.

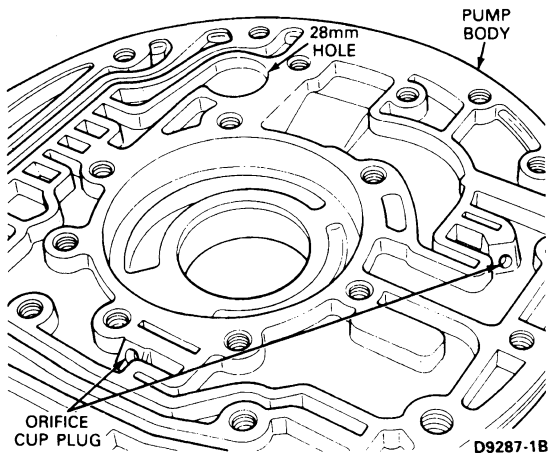
DISASSEMBLY AND ASSEMBLY (Continued)

4. Lightly coat the gerotor gears with transmission fluid and install in pump housing. The dot on the inner gerotor gear must face the control body assembly.

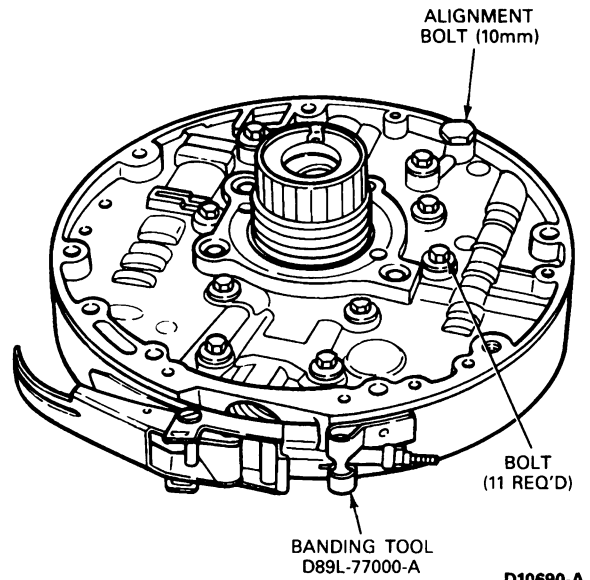


5. Inspect mating surfaces of pump body and control body to be sure they are clean and free of nicks and burrs. Lower the control body and stator assembly onto the pump body, aligning the 28mm round hole in the control body with the 28mm hole in the pump body.

CAUTION: Prior to pump assembly, make sure all cup plugs are installed.

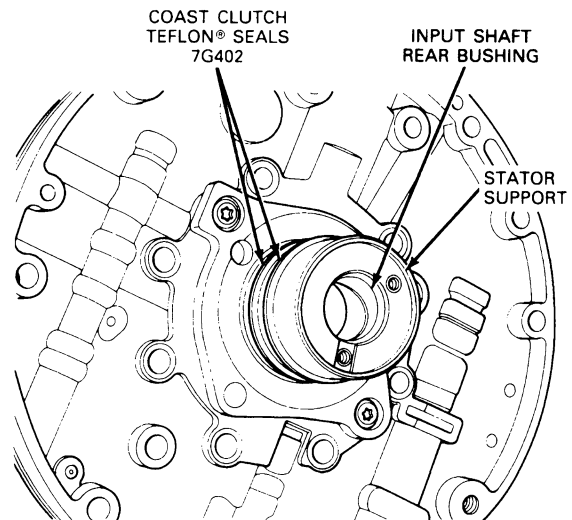


6. Loosely install eleven M8x50 bolts. Install one 10mm bolt in the position shown and install banding tool D89L-77000-A or equivalent with clamp by filter inlet. Align outer bolt holes and tighten banding tool.



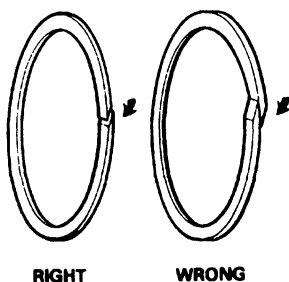
7. Tighten bolts to 24-31 N·m (18-23 ft·lb) and remove banding tool. Make sure the outer edges of the control body and the pump body are completely aligned.
8. Install coast clutch Teflon® seals. Install outer diameter seal.

NOTE: Be sure seal grooves are clean and free of burrs.



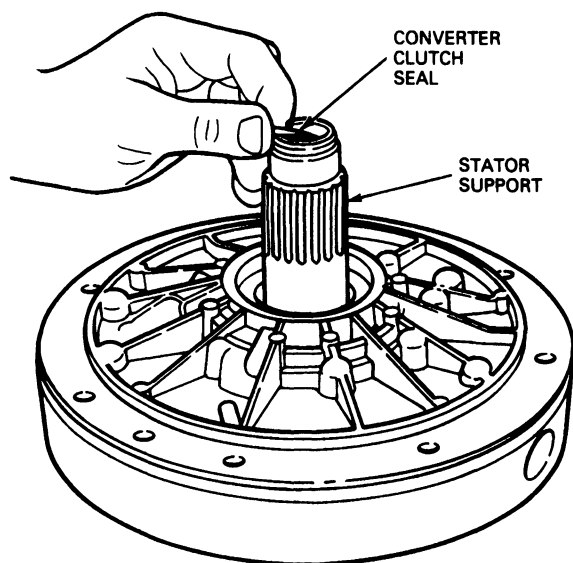
DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: Be sure Teflon® seals are fully seated in grooves and oriented 180° apart.



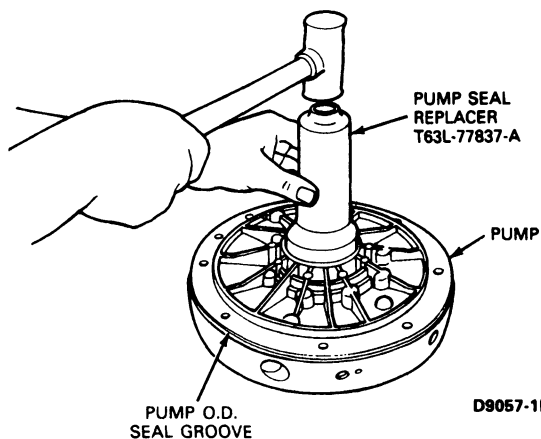
D9289-1A

9. Install torque converter clutch seal on front of stator support in same manner as coast clutch seals.



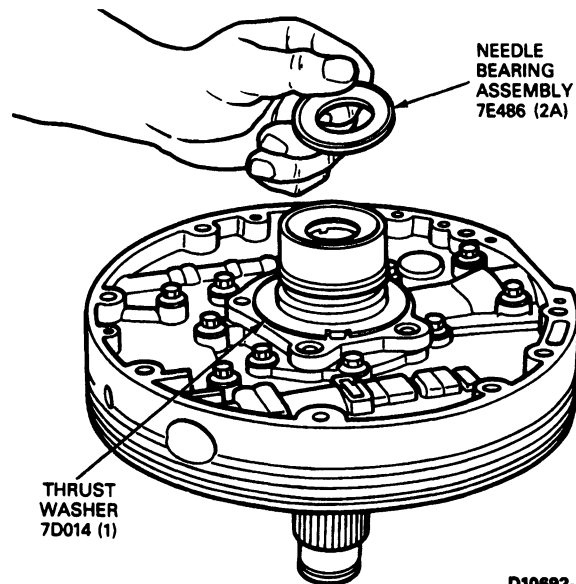
D10691-A

10. Using Pump Seal Replacer T63L-77837-A install converter hub seal if removed.

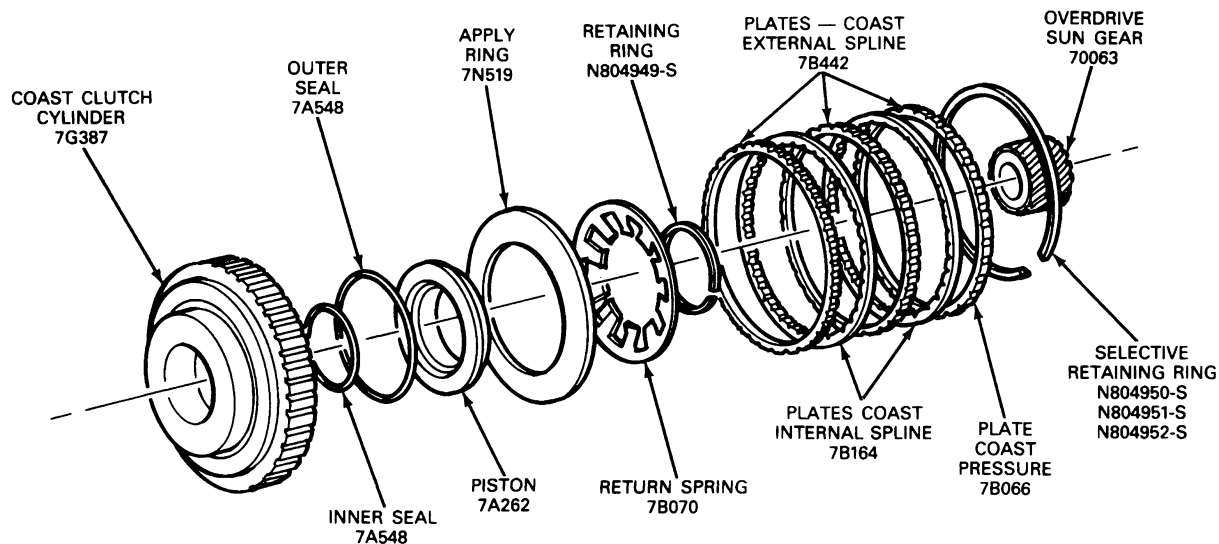


D9057-1B

11. Install thrust washer 7D014 (1) and needle bearing assembly 7E486 (2A) into pump. Use a light film of petroleum jelly to hold washer and bearing assembly in place.



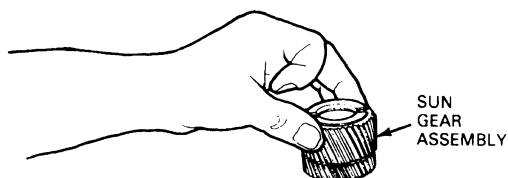
D10692-A

DISASSEMBLY AND ASSEMBLY (Continued)**Coast Clutch Cylinder Assembly**

D9257-C

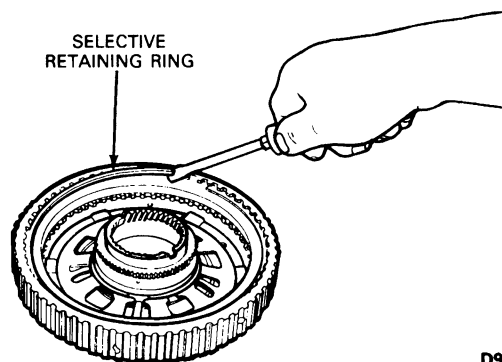
Disassembly

1. Remove sun gear assembly from coast clutch cylinder.



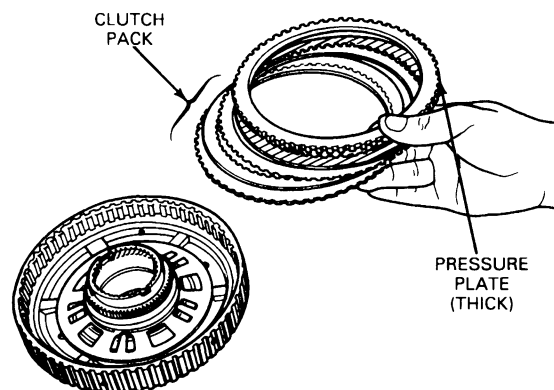
D9058-1B

2. Remove selective retaining ring.



D9059-B

3. Remove pressure and clutch plates from cylinder. Tag clutch pack for re-assembly.

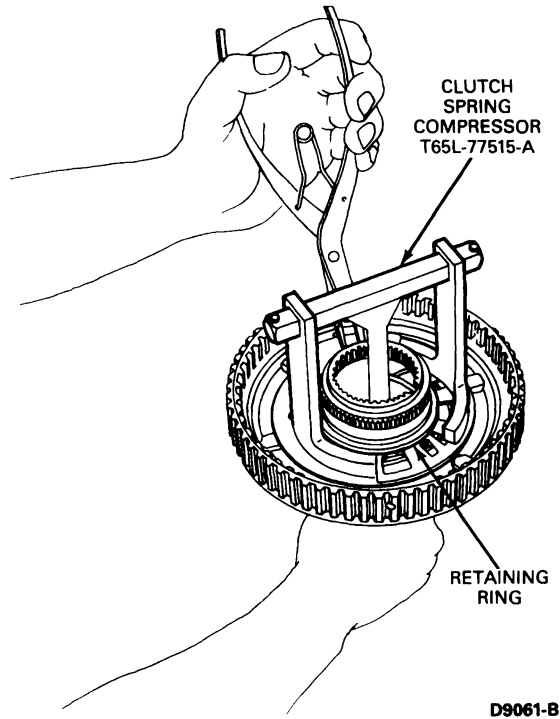


D9060-B

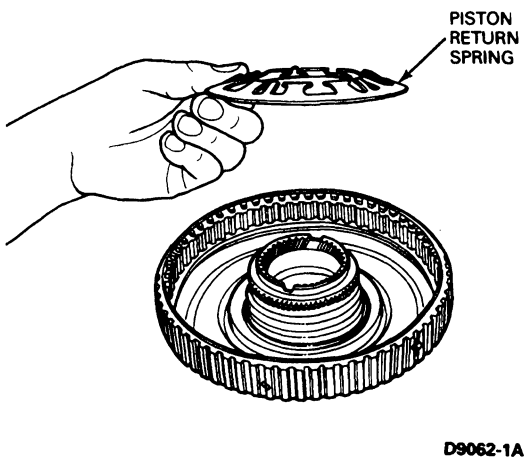
DISASSEMBLY AND ASSEMBLY (Continued)

4. Using Clutch Spring Compressor T65L-77515-A remove return spring retaining ring. Remove compressor tool.

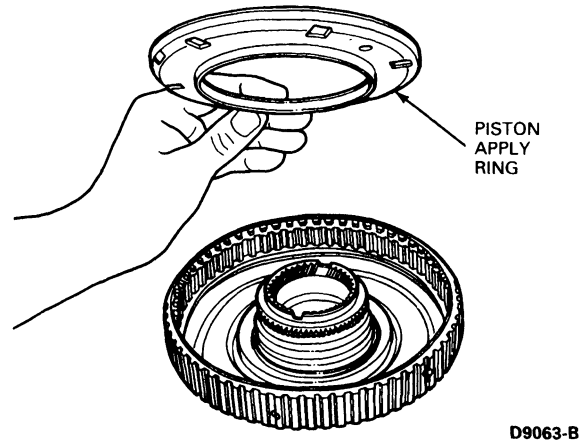
CAUTION: Discard return spring retainer ring.



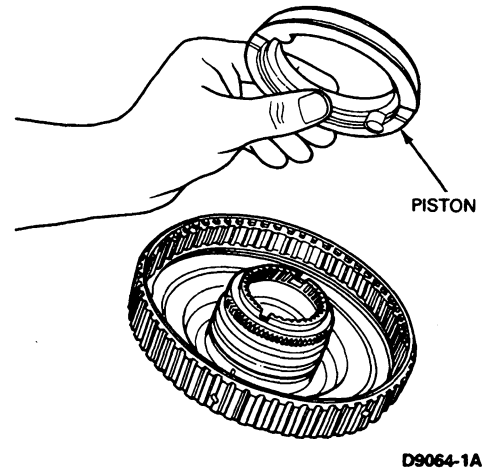
5. Remove piston return spring.



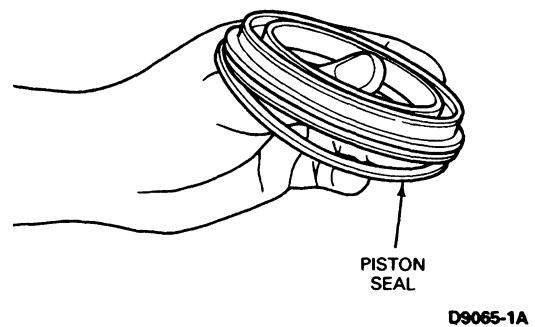
6. Remove piston apply ring.



7. Remove piston from cylinder.

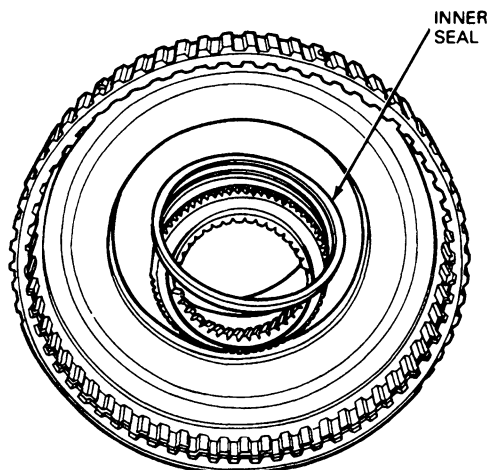


8. Remove outer seal from piston.



DISASSEMBLY AND ASSEMBLY (Continued)

9. Remove inner seal from cylinder.



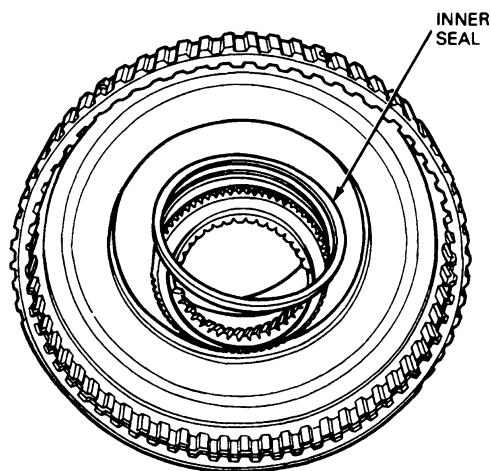
D9066-1A

Assembly

NOTE: Soak all friction plates in clean Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) or equivalent for 15 minutes.

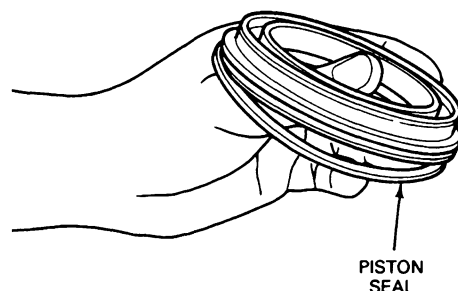
Lightly lube all O-ring seals before installing, using Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) or equivalent.

1. Install inner seal so that lip is facing toward bottom (down) into cylinder.



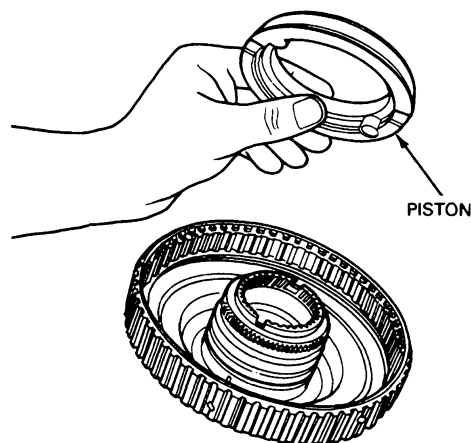
D9066-1A

2. Install outer seal so that lip is facing toward bottom (down) onto piston.



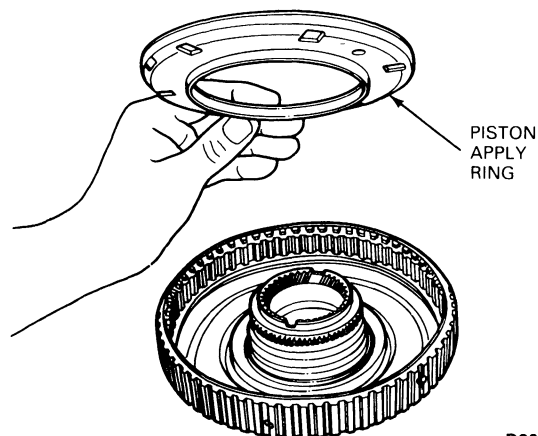
D9065-1A

3. Install piston into cylinder.



D9064-1A

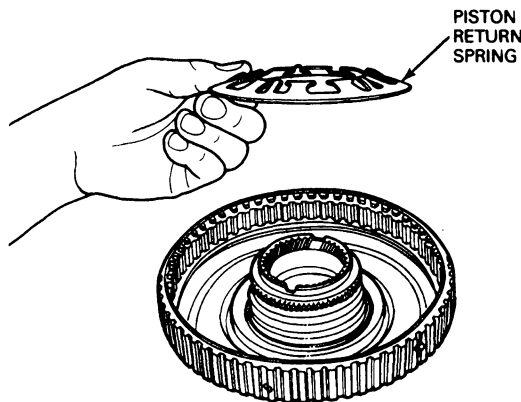
4. Install piston apply ring.



D9063-B

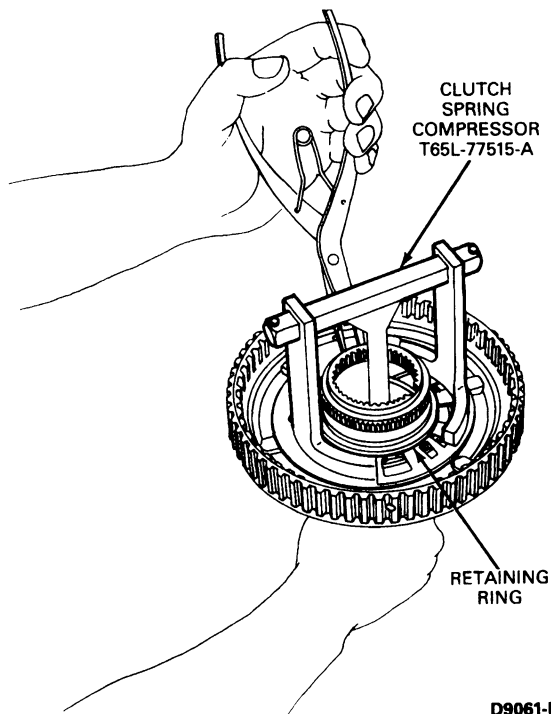
DISASSEMBLY AND ASSEMBLY (Continued)

5. Install piston return spring.



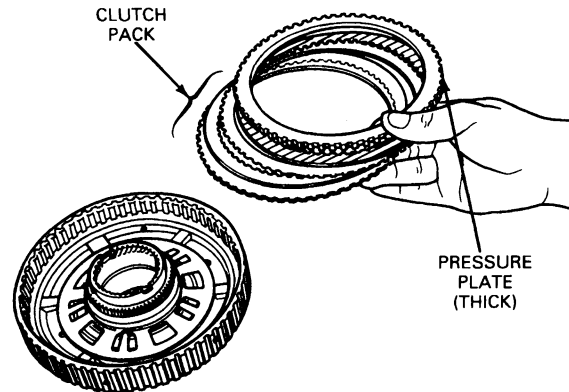
D9062-1A

6. Using Clutch Spring Compressor T65L-77515-A install **new** retaining ring.



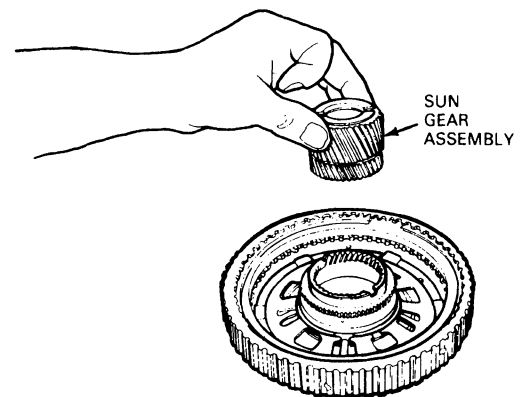
D9061-B

7. Install clutch pack plates alternately, starting with steel plate and ending with pressure plate (thick).



D9060-B

8. Install overdrive sun gear assembly with short end of gear down into coast clutch cylinder.



D9058-1B

9. Install selective retaining ring and check stack-up clearance (in three places 120° apart) using feeler gauge. If not within specification, install correct selective retaining ring and recheck.

Specification:

1.14-0.62mm (0.045-0.025 inch)

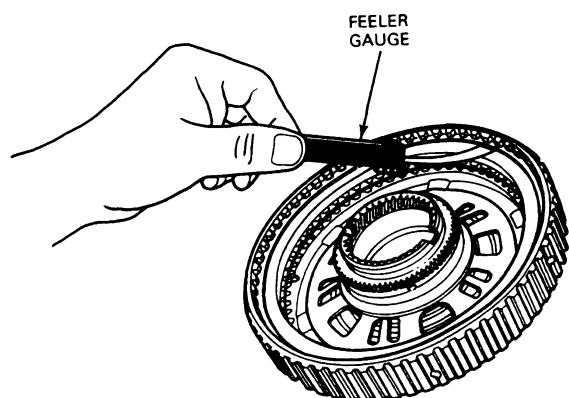
Selective Snap Rings

1.45-1.35mm (0.057-0.053 inch)

1.85-1.75mm (0.073-0.069 inch)

DISASSEMBLY AND ASSEMBLY (Continued)

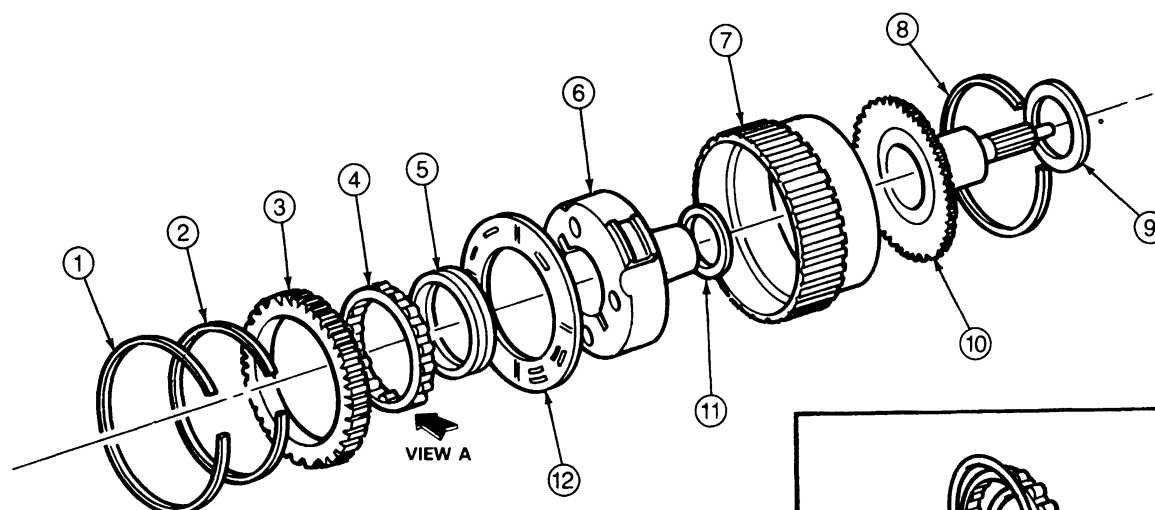
2.25-2.15mm (0.089-0.085 inch)



D9067-1A

11. Remove selective retaining ring and clutch plates. Performing this step is necessary to install the center shaft assembly. For further information, refer to Subassemblies in this section.

Overdrive Ring Gear And Center Shaft Assembly



D9258-D

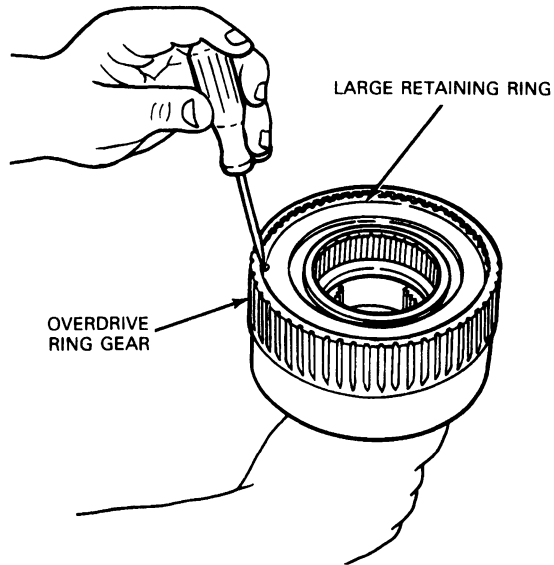
Item	Part Number	Description
1	377 155-S	Retaining Ring (Outer Race to Ring Gear)
2	377 135-S	Retaining Ring (OWC to Race)
3	7G389	Outer Race
4	7G381	One-Way Clutch Assembly
5	7G388	Inner Race

(Continued)

Item	Part Number	Description
6	7E031	Overdrive Planet Assembly
7	7A153	Ring Gear
8	7G375	Retaining Ring (Shaft to Ring Gear)
9	7G178	Needle Bearing Assembly
10	7A658	Center Shaft
11	7F240 (4)	Needle Bearing Assembly
12	7L339 (3)	Thrust Washer

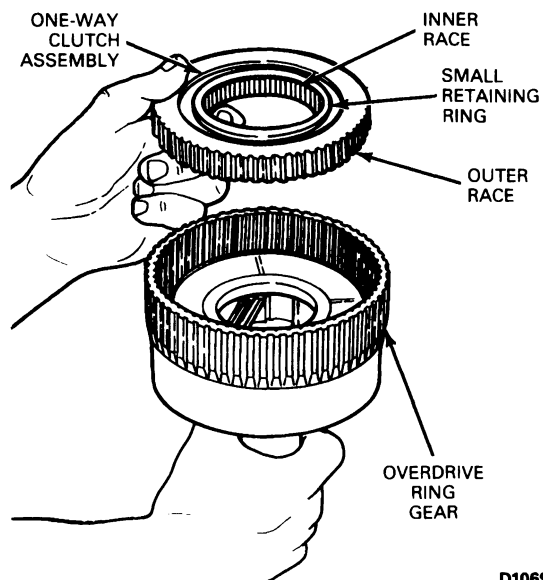
DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

1. Remove large outer race to ring gear retaining ring.



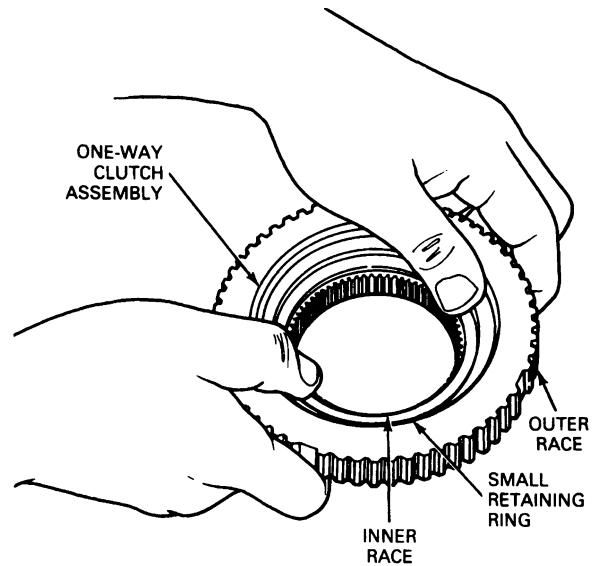
D10693-A

2. Remove one-way clutch assembly with inner and outer races.



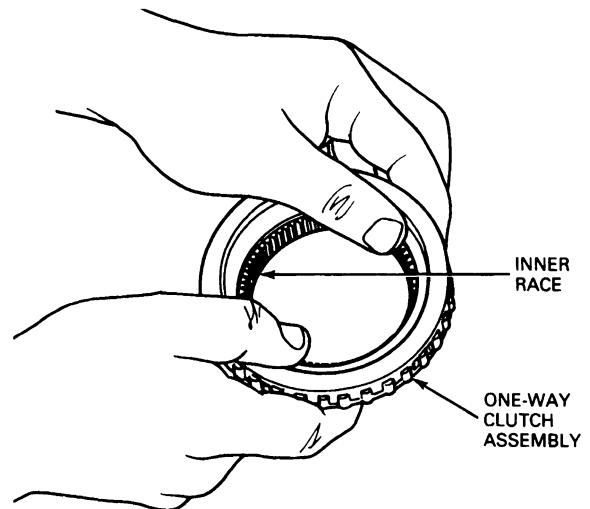
D10694-A

3. Push out one-way clutch assembly and inner race.



D10695-A

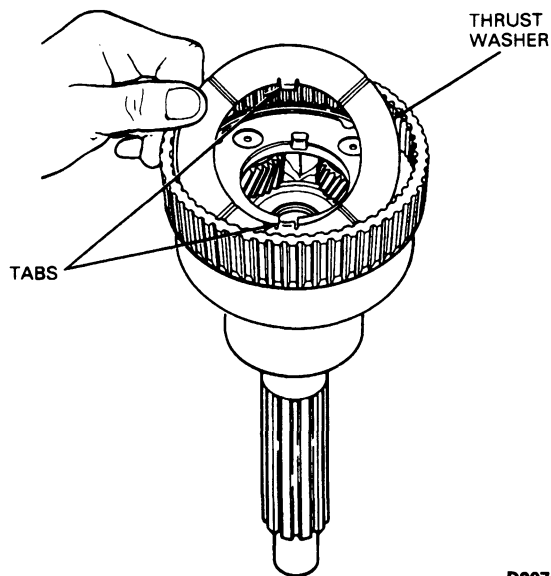
4. Remove inner race from one-way clutch assembly.



D10696-A

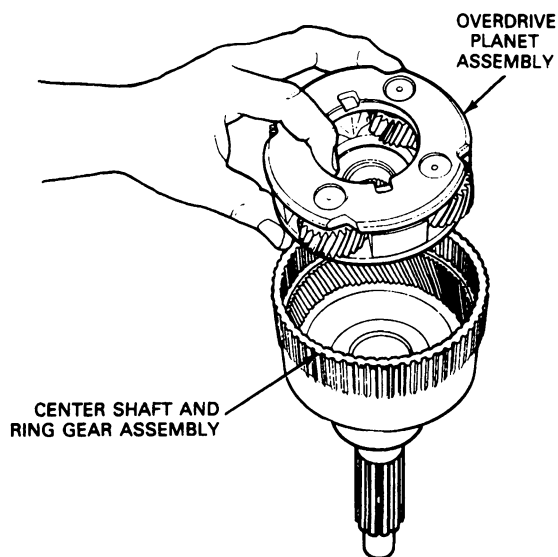
DISASSEMBLY AND ASSEMBLY (Continued)

5. Remove thrust washer 7L339 (3) from front of overdrive planet assembly.



D9072-B

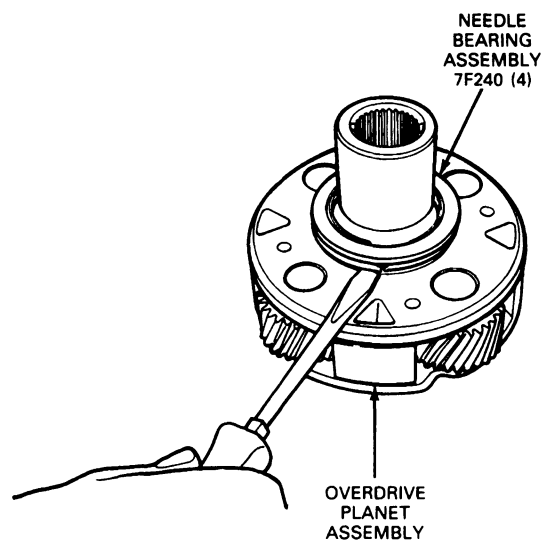
6. Remove overdrive planet assembly from center shaft and ring gear assembly.



D9073-D

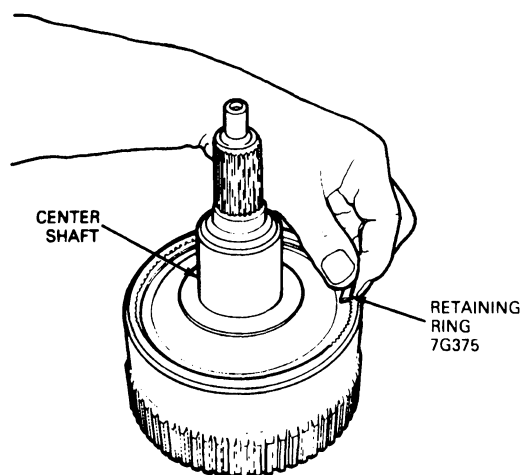
7. Remove needle bearing assembly 7F240 (4) from rear face of overdrive planet assembly, using screwdriver.

CAUTION: Use care not to damage bearing.



D9074-C

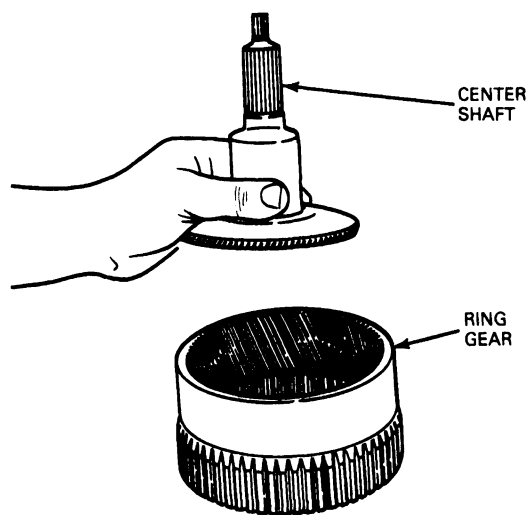
8. Remove center shaft to ring gear retaining ring 7G375.



D9075-1B

DISASSEMBLY AND ASSEMBLY (Continued)

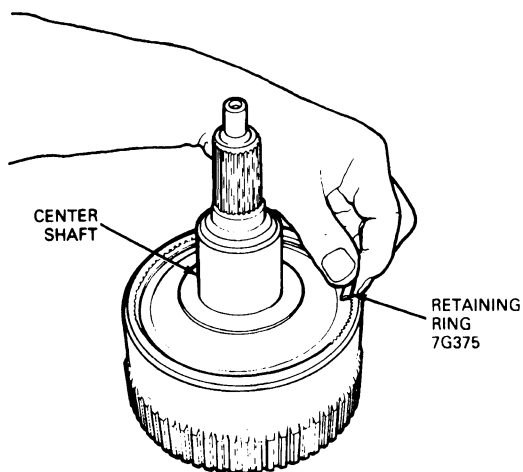
9. Remove center shaft from ring gear.



D10697-A

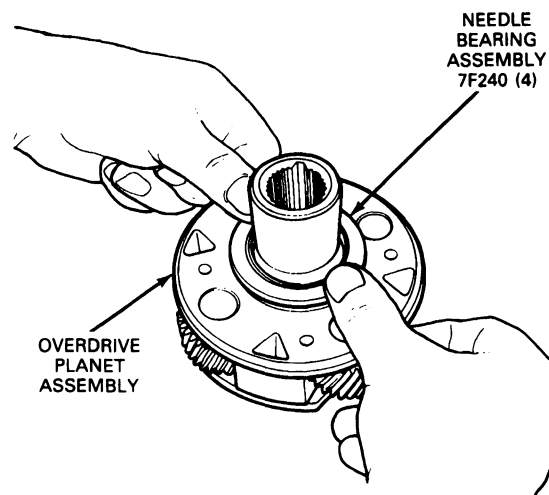
Assembly

1. Install center shaft into overdrive ring gear.
2. Install center shaft to ring gear with retaining ring 7G375.



D9075-1B

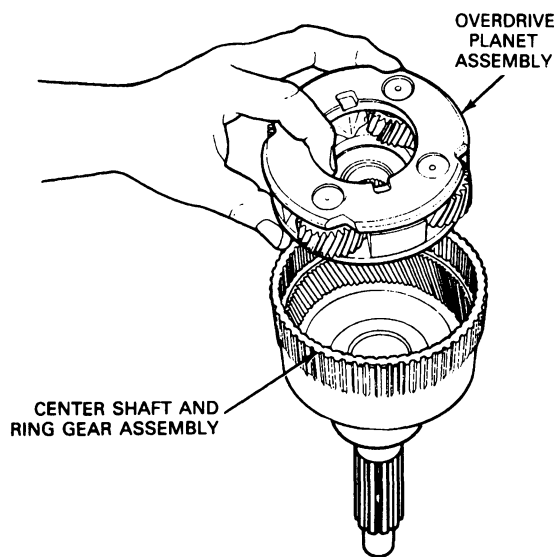
3. Install needle bearing assembly 7F240 (4) with outer lip down on rear face of overdrive planet assembly.



D9076-C

4. Install overdrive planet assembly into center shaft and ring gear assembly.

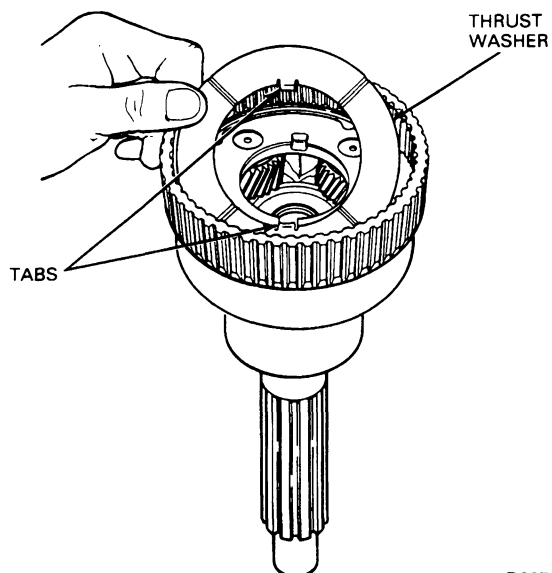
NOTE: Different vehicle applications will have different planet assemblies. Refer to Master Parts Catalog for correct usage.



D9073-D

DISASSEMBLY AND ASSEMBLY (Continued)

5. Install thrust washer 7L339 (3) on front of carrier.

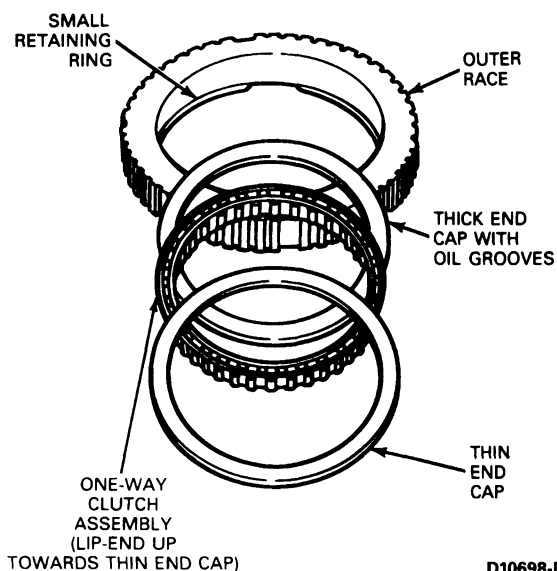


D9072-B

6. Place thick end cap into outer race against small retaining ring.
7. Install one-way clutch with lip toward thin end cap.
8. Install thin end cap onto one-way clutch.

NOTE: Inspect outer and inner races for scores or damaged surface areas where rollers or sprags contact races. Inspect rollers, sprags and springs for excessive wear or damage. Inspect spring and cage for bent or damaged spring retainers.

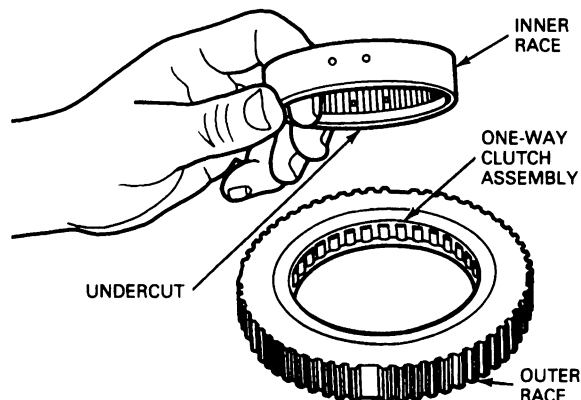
NOTE: E4OD overdrive one way clutch end caps must be installed as shown. The thick end cap has oil grooves (scallops) on the inner diameter and must be positioned toward the front of the transmission for proper lubrication.



D10698-B

9. Install inner race into one-way clutch assembly.

NOTE: Inner race undercut must face toward small retaining ring.

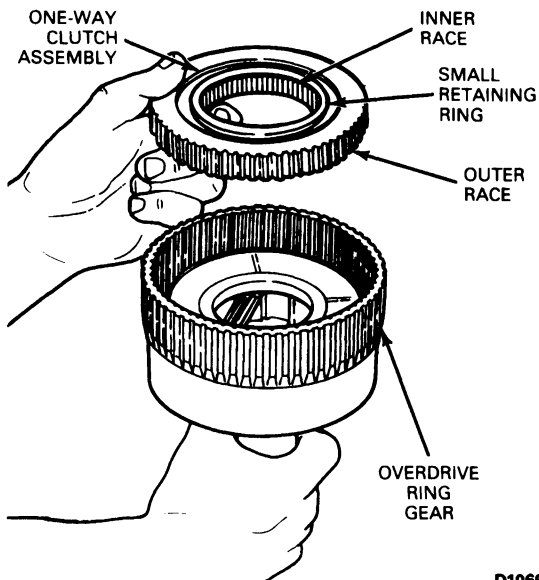


D10699-A

DISASSEMBLY AND ASSEMBLY (Continued)

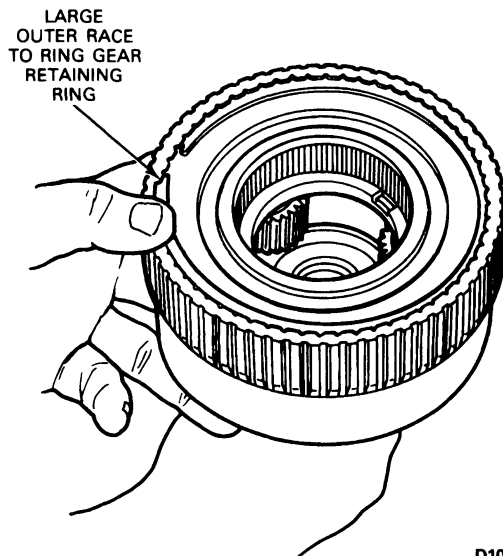
10. Install one-way clutch assembly into overdrive ring gear with small retaining ring facing upwards.

NOTE: Inner race **must** rotate counterclockwise.



D10694-A

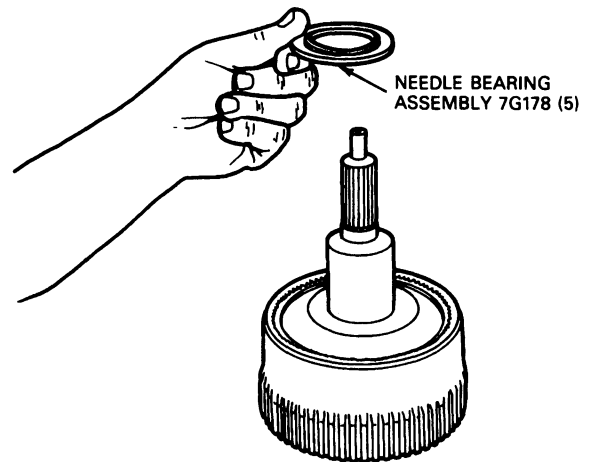
11. Install large outer race to ring gear retaining ring.



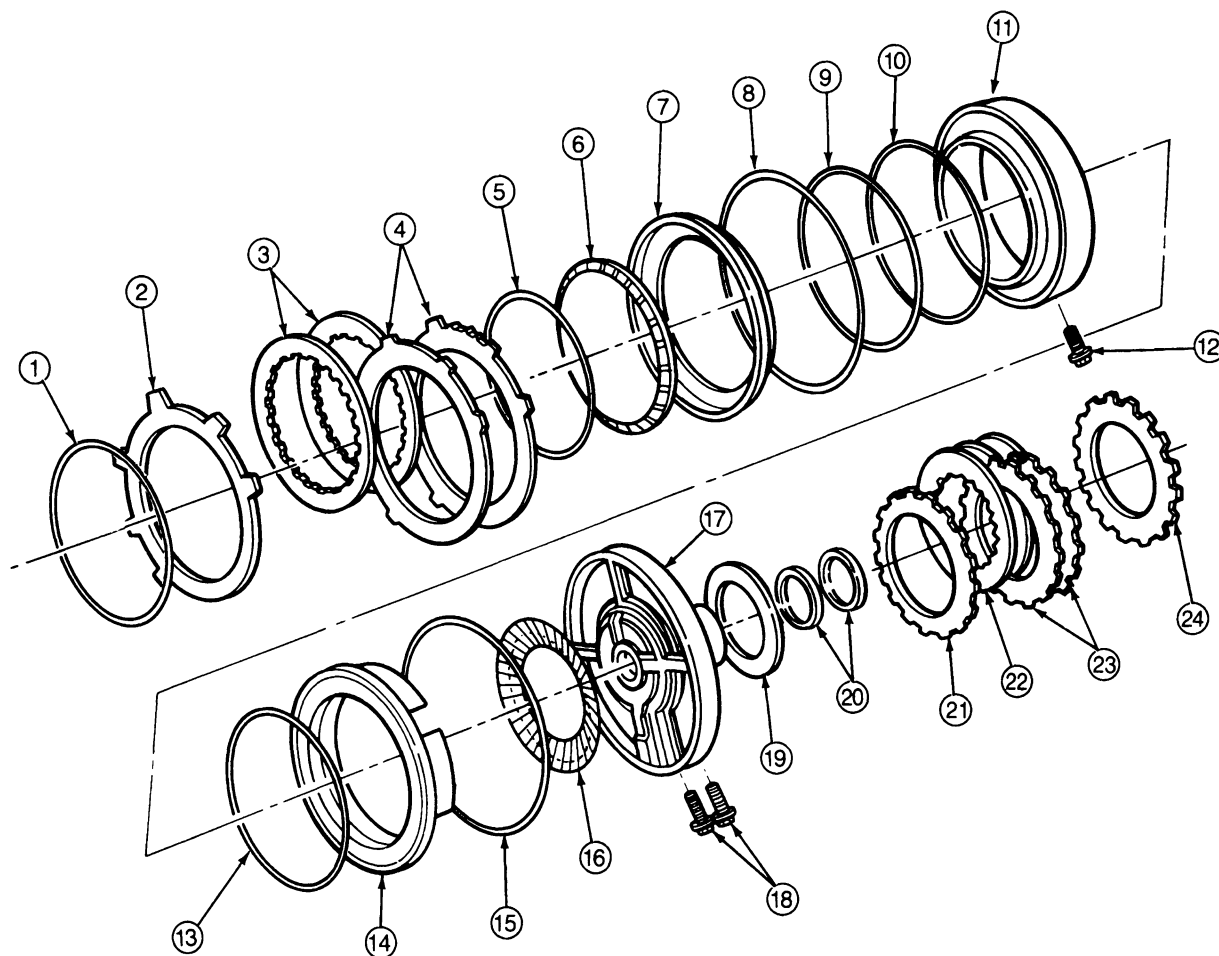
D10700-B

12. Install needle bearing assembly 7G178 (5) onto center shaft. Hold in place with a light film of petroleum jelly.

NOTE: Inner bearing race lip must face up.



D10701-A

DISASSEMBLY AND ASSEMBLY (Continued)**Intermediate / Overdrive Cylinder Assembly**

D9259-D

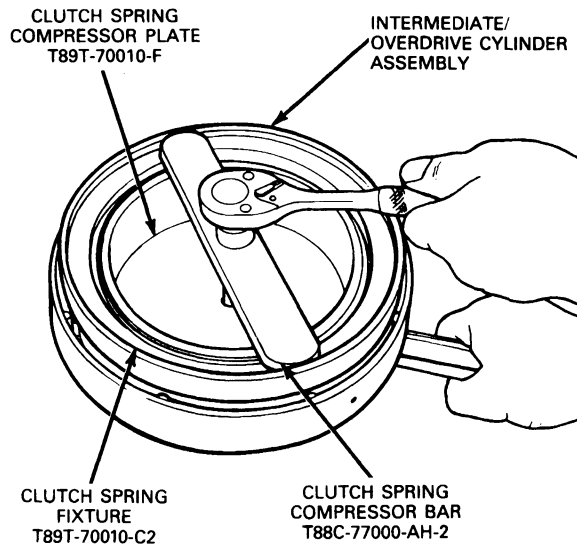
Item	Part Number	Description
1	7D483	Retaining Ring, Selective Fit
2	7B066	Pressure Plate
3	7B164	Plates, Internal Spline, O/D
4	7B442	Plates, External Spline, O/D
5	7A527	Retaining Ring, O/D Clutch Disc Spring
6	7B070	Spring, O/D Clutch Piston Disc
7	7A262	Piston, O/D Clutch
8	7A548	Seal, O/D Clutch Piston, Outer
9	7F225	Seal O/D Clutch Piston, Inner
10	7D483	Retaining Ring Int. Clutch, Selective Fit
11	7G384	Cylinder, O/D and Int. Clutch
12	7Z059	Bolt, M10-1.5 x 24mm O/D Cylinder Fluid Feed

Item	Part Number	Description
13	7F225	Seal, Int. Clutch Inner
14	7E005	Piston, Intermediate Clutch
15	7F224	Seal, Int. Clutch Outer
16	7B070	Spring, Int. Clutch Piston Disc
17	7A130	Center Support Assembly
18	7Z059	Bolt, M12-1.75 x 31mm, Center Support Fluid Feed
19	7L326	Washer, Center Support Thrust
20	7D025	Seal, Direct Clutch Cast Iron
21	7B066	Plate, Int. Clutch Pressure, Apply
22	7B164	Plate, Internal Spline, Int. Clutch, Friction
23	7B442	Plate, External Spline, Int. Clutch, Steel
24	7B066	Plate, Int. Clutch Pressure, Rear

(Continued)

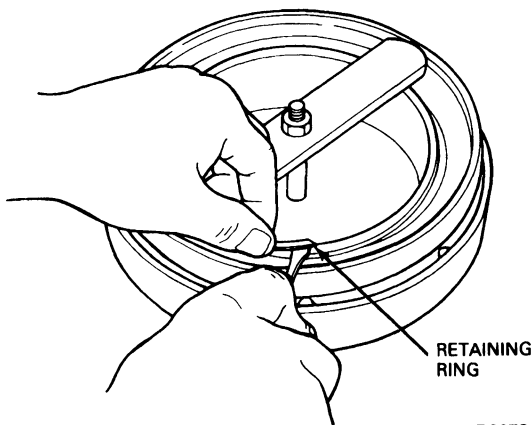
DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

1. Using Clutch Spring Compressor Plate T89T-70010-C2, Clutch Spring Compressor Bar T88C-77000-AH2 and Intermediate Clutch Spring Fixture T89T-70010-F, compress the overdrive return spring.



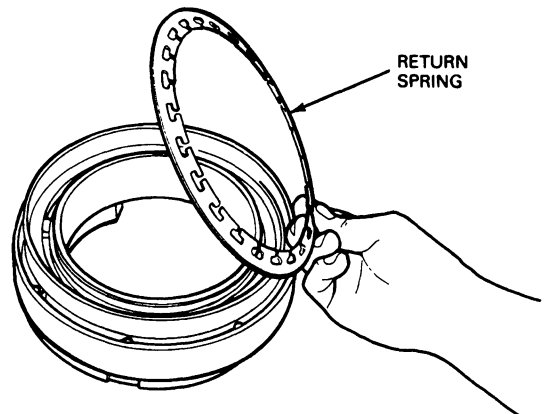
D9078-B

2. Remove overdrive return spring retaining ring.



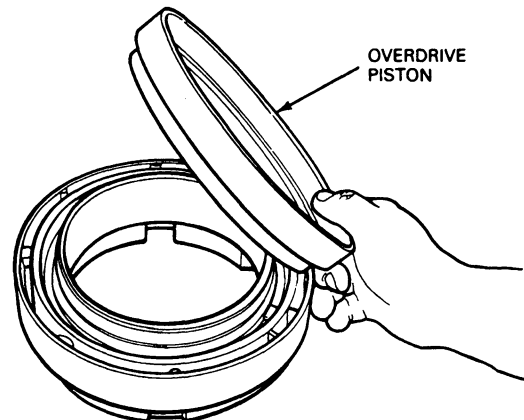
D9079-B

3. Remove compressor tool assembly.
4. Remove return spring.



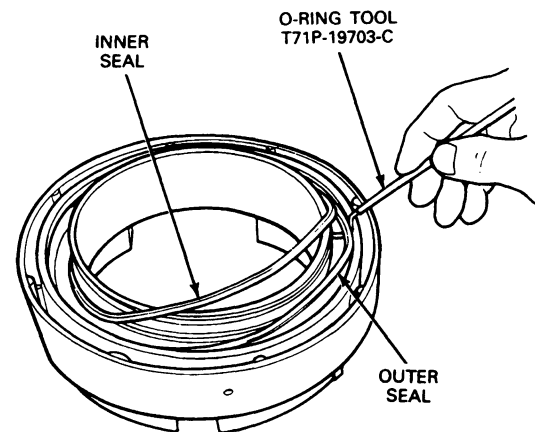
D9080-1A

5. Remove overdrive piston.



D9081-1A

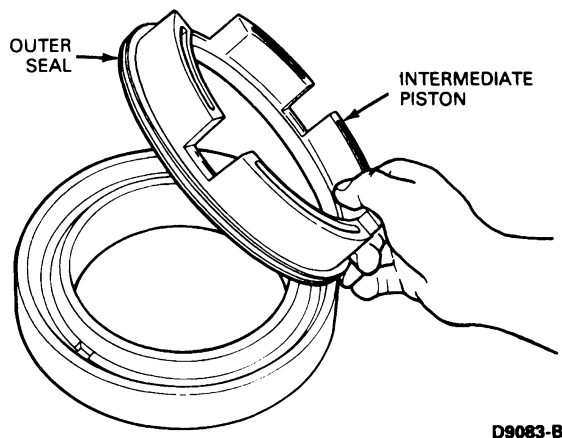
6. Remove outer and inner seals, using O-ring Tool T71P-19703-C.



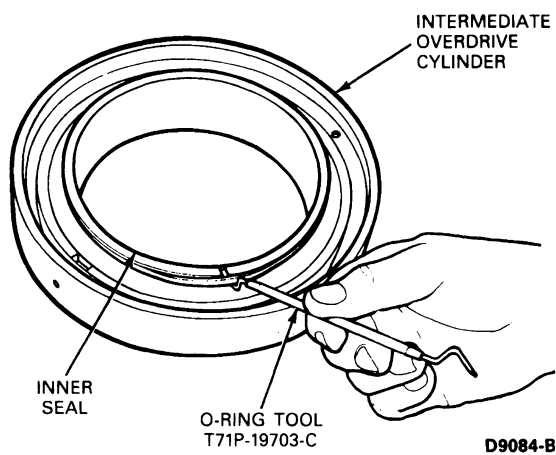
D9082-1A

DISASSEMBLY AND ASSEMBLY (Continued)

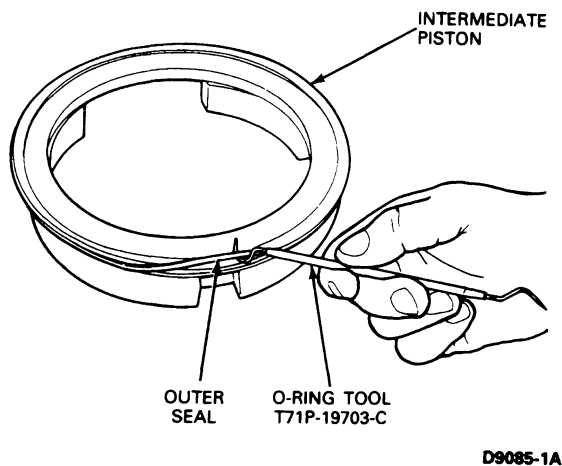
7. Remove intermediate piston.



8. Remove intermediate inner seal from cylinder bore, using O-Ring Tool T71P-19703-C.

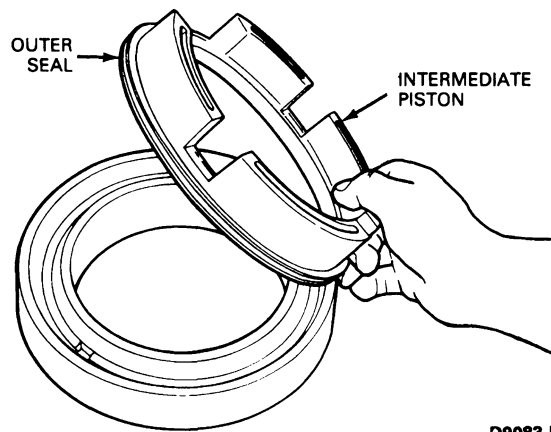


9. Remove outer seal from intermediate piston.

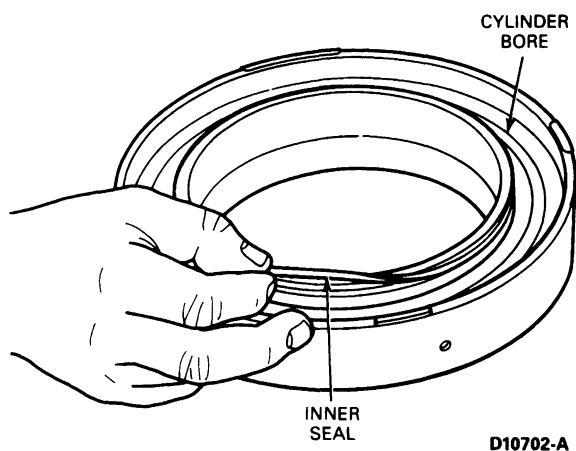
**Assembly**

NOTE: Prior to re-assembly, inspect check ball, cup plugs and feed bolt threads for contamination or damage. Clean or replace as necessary.

1. Install outer seal onto intermediate piston with lip seal facing down toward cylinder.

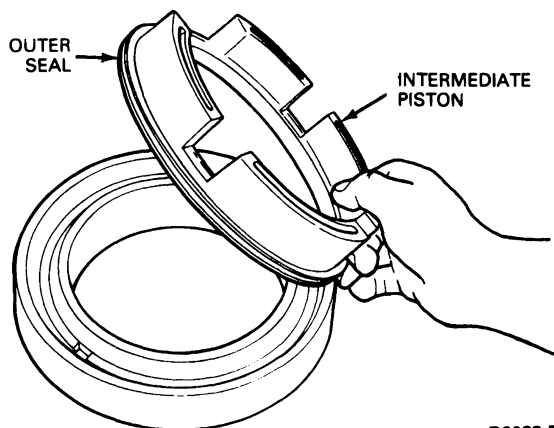


2. Install intermediate inner seal into cylinder bore with lip seal facing down toward cylinder.



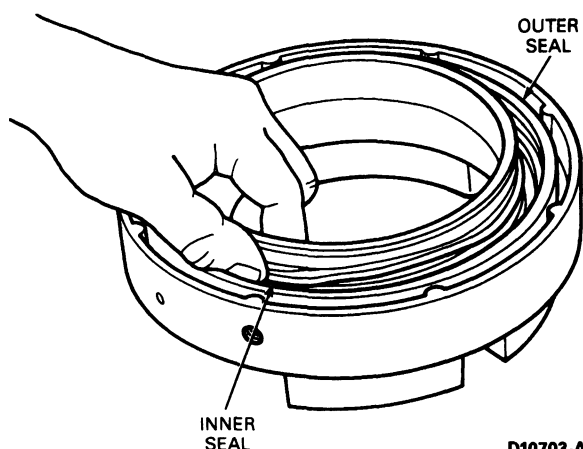
DISASSEMBLY AND ASSEMBLY (Continued)

3. Install intermediate piston.



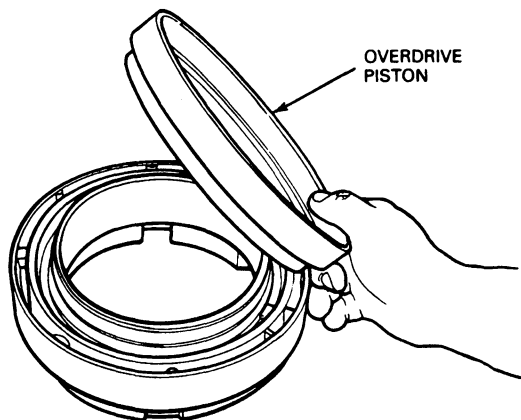
D9083-B

4. Install overdrive outer and inner seals with lip seal facing down towards cylinder.



D10703-A

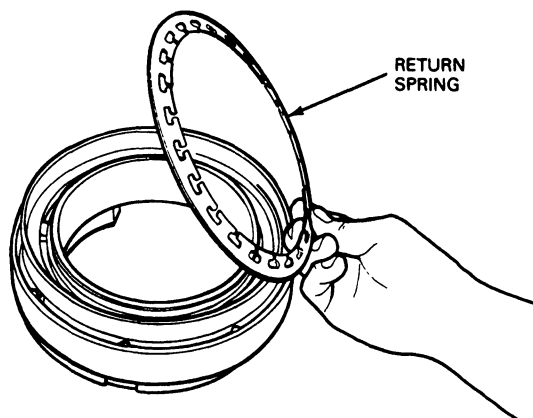
5. Install overdrive piston.



D9081-1A

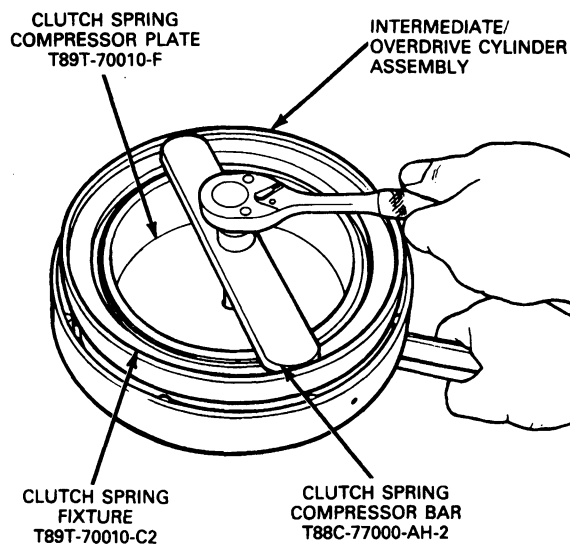
6. Install return spring.

NOTE: Return spring must be installed with fingers facing up.



D9080-1A

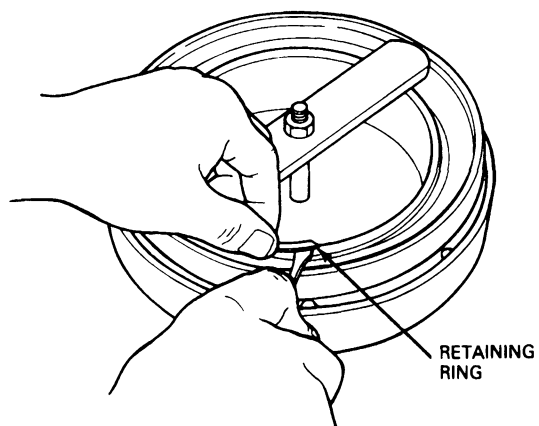
7. Using Clutch Spring Compressor Plate T89T-70010-F, Clutch Spring Compressor Bar T88C-77000-AH2 and Intermediate Clutch Spring Fixture T89T-70010-C2, compress return spring.



D9078-B

DISASSEMBLY AND ASSEMBLY (Continued)

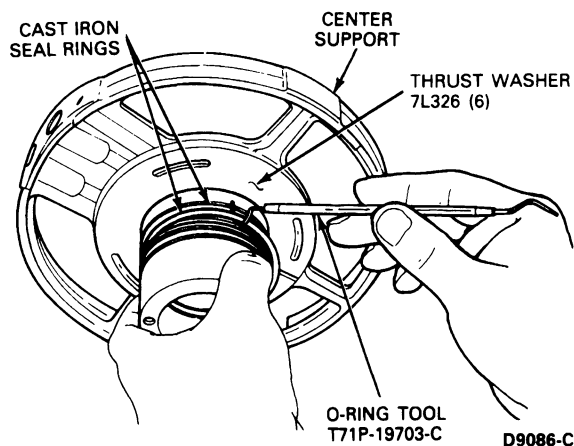
8. Install overdrive return spring retaining ring. Make sure retaining ring is fully seated in groove.



9. Remove tool assembly.

Center Support**Disassembly and Assembly**

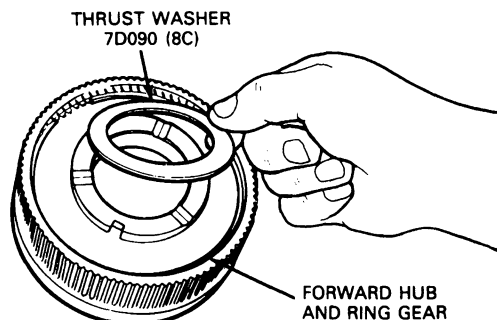
1. Remove two cast iron seal rings and thrust washer.



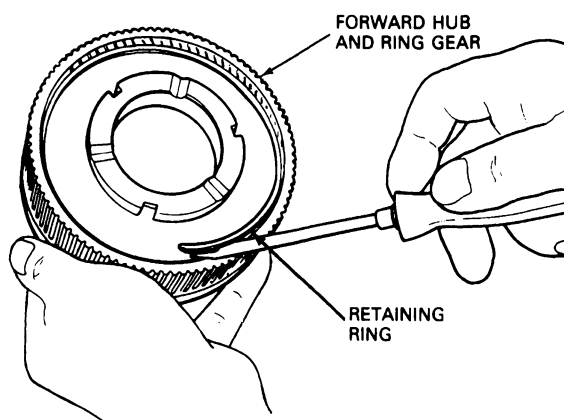
2. Inspect thrust washer, center support seal ring grooves, hub inner and outer diameters and feed bolt threads for contamination or damage. Clean or replace as necessary.
3. Install thrust washer using a light film of petroleum jelly to hold in place.
4. Install two cast iron seal rings.

Forward Hub and Ring Gear**Disassembly**

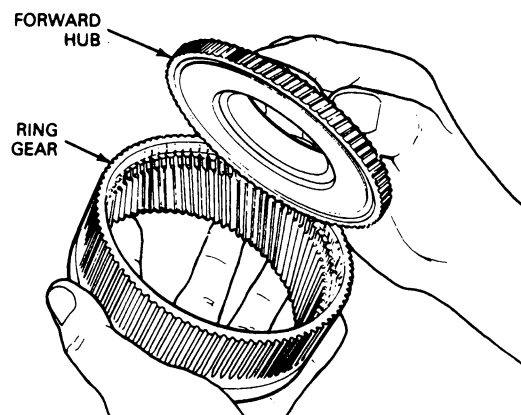
1. Remove plastic thrust washer 7D090 (8C) from front face of hub.



2. Remove retaining ring using screwdriver.

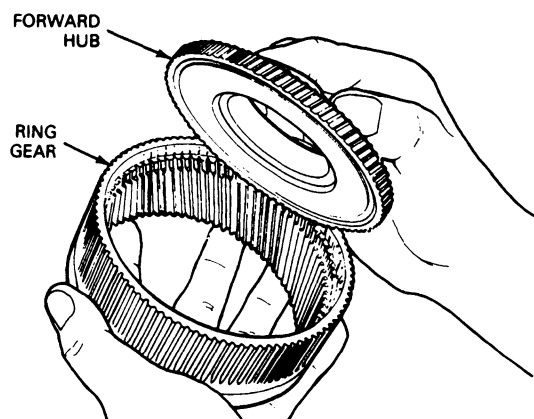


3. Remove forward hub from ring gear.



DISASSEMBLY AND ASSEMBLY (Continued)**Assembly**

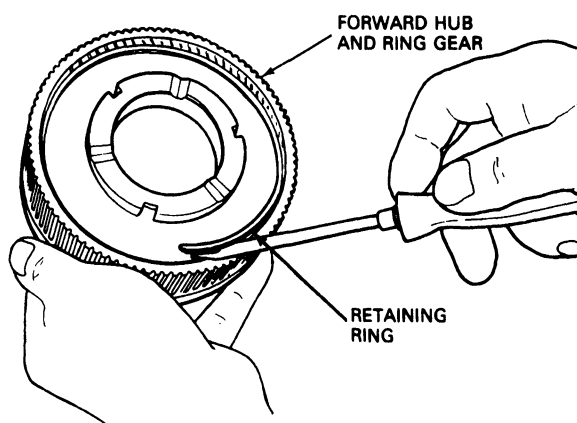
1. Install forward hub into gear.



D9089-1A

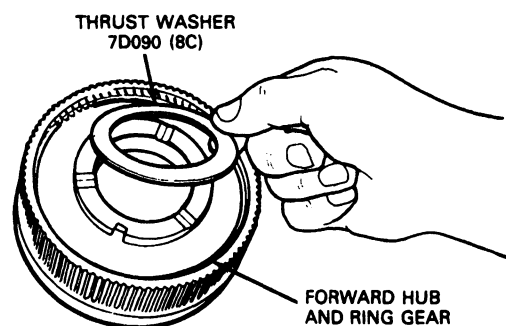
2. Install retaining ring securing forward hub to ring gear.

NOTE: Make sure retaining ring is fully seated in ring groove.

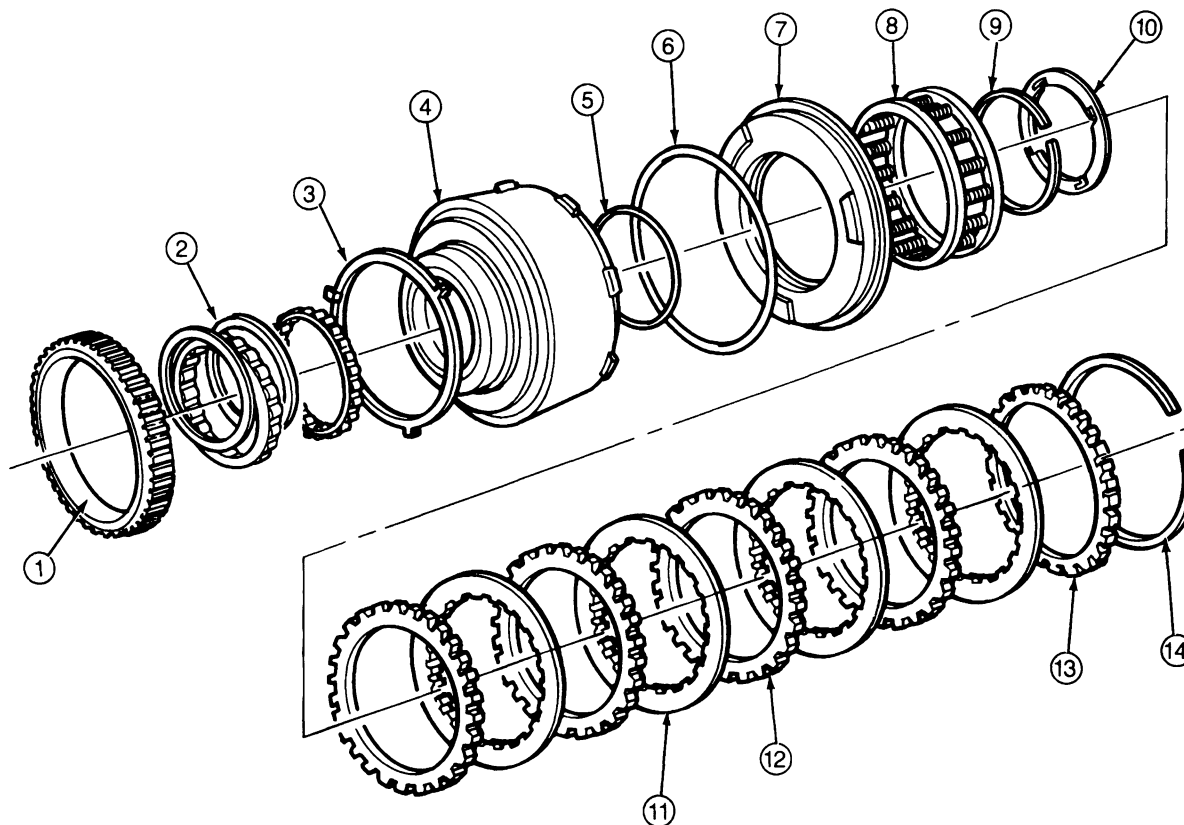


D9089-B

3. Install plastic thrust washer 7D090 (8C) on the hub, using petroleum jelly.



D9087-B

DISASSEMBLY AND ASSEMBLY (Continued)**Intermediate Brake Drum**

D9260-D

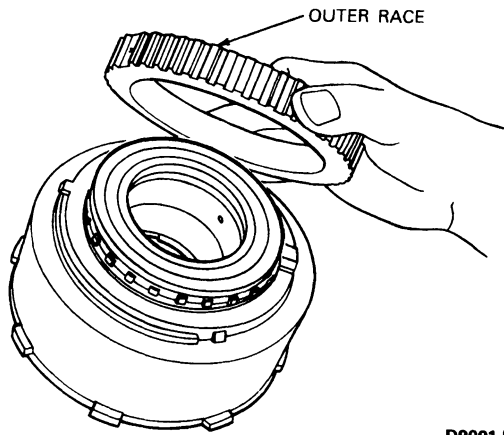
Item	Part Number	Description
1	7A089	One-Way Clutch — Outer Race
2	7A089	One-Way Clutch — Inner Race
3	7G401	Washer, Int. OWC, Thrust
4	7D044	Drum Assembly, Int. Brake
5	7A548	Seal, Direct Clutch Piston, Inner
6	7A548	Seal, Direct Clutch Piston, Outer
7	7A262	Piston Assembly, Direct Clutch
8	7F25	Retainer and Spring Assembly, Direct Clutch

Item	Part Number	Description
9	7C122	Retainer Ring, Direct Clutch Support Spring
10	7C096	Washer, Int. Brake Drum, Thrust
11	7B164	Plate, Internal Spline, Direct Clutch, Friction
12	7B442	Plate, External Spline, Direct Clutch, Steel
13	7B066	Plate, Direct Clutch Pressure
14	377126-S 377127-S 377128-S 377437-S 377444-S	Retainer Ring, Direct Clutch Plate, Selective Fit

(Continued)

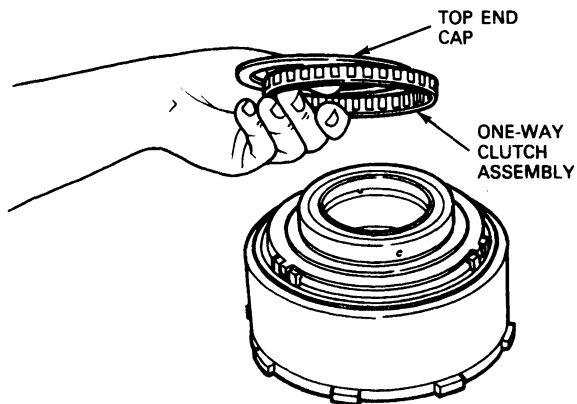
DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

1. Remove outer race.



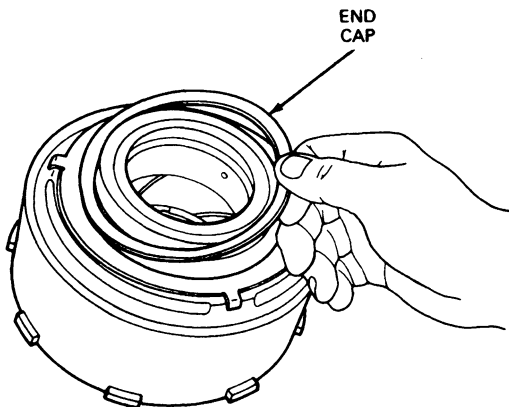
D9091-B

2. Remove one-way clutch assembly and top end cap.



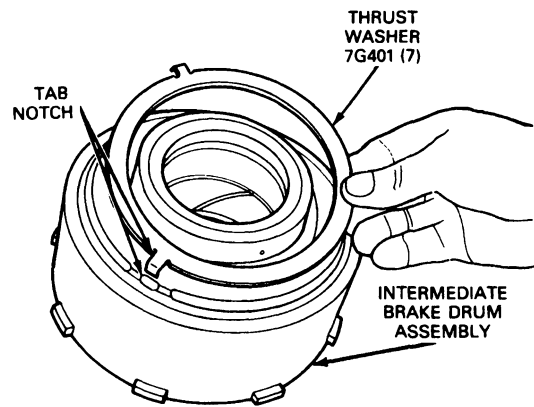
D10704-A

3. Remove bottom end cap.



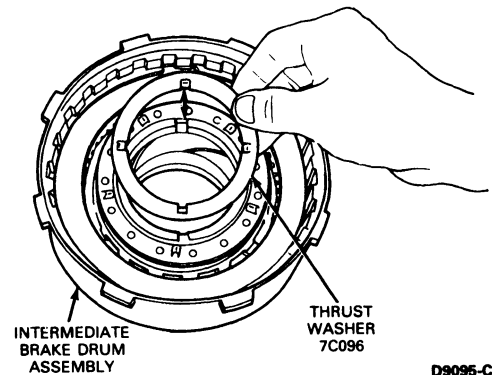
D9093-1A

4. Remove large thrust washer 7G401 (7) from rear face of intermediate brake drum assembly.



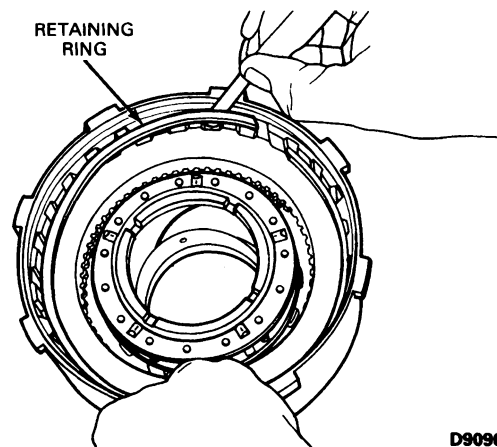
D9094-C

5. Remove small thrust washer 7C096 (8A) from front face of intermediate brake drum assembly.



D9095-C

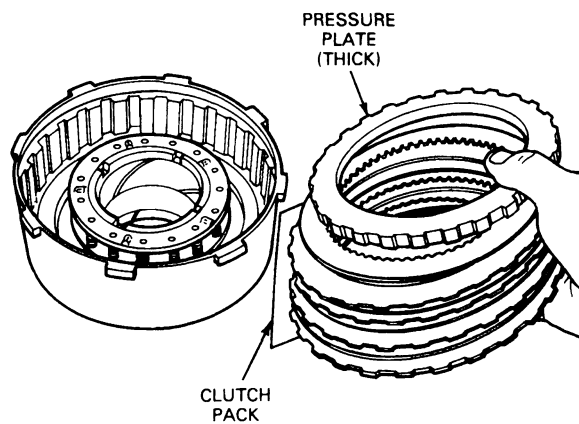
6. Remove retaining ring using screwdriver.



D9096-B

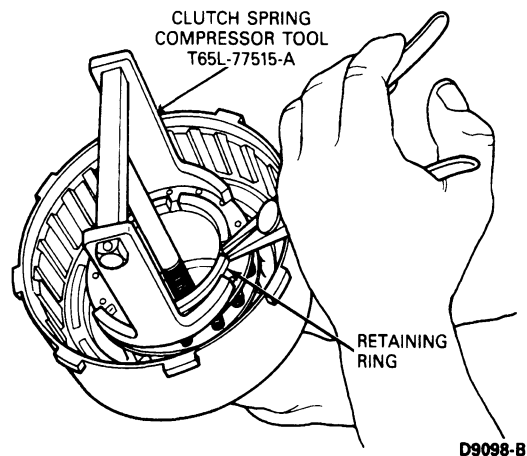
DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove pressure plate (thick) and clutch pack. Tag for re-assembly.



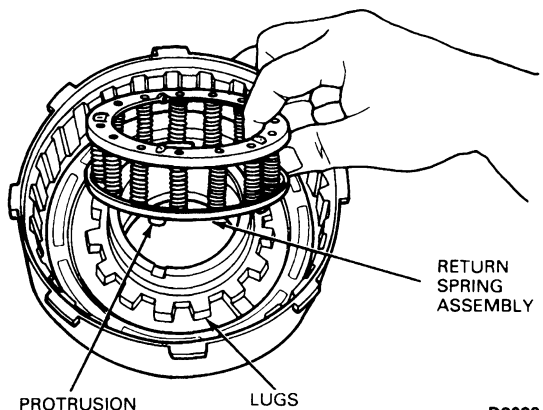
D9097-D

8. Install Clutch Spring Compressor Tool T65L-77515-A and remove return spring retaining ring. Remove compressor tool.



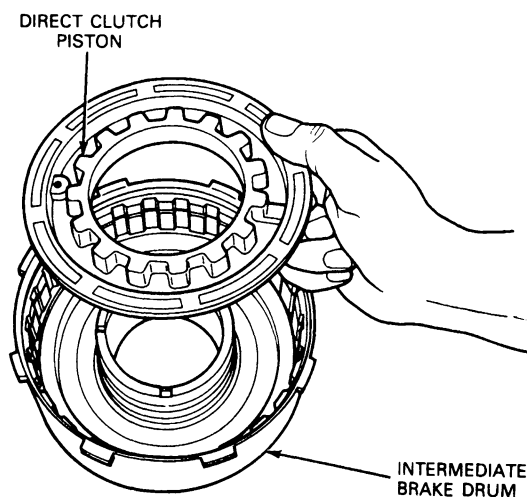
D9098-B

9. Remove return spring assembly.



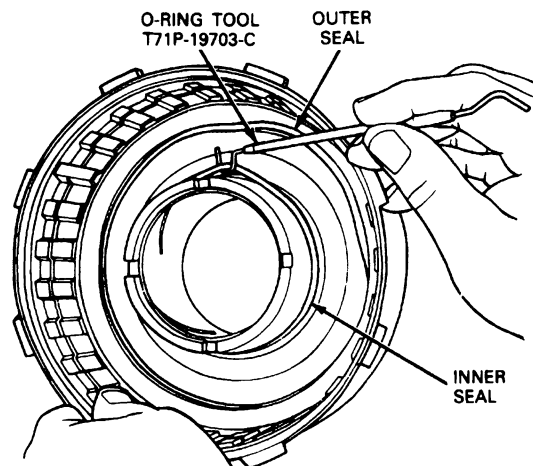
D9099-B

10. Remove direct clutch piston from intermediate brake drum.



D9100-B

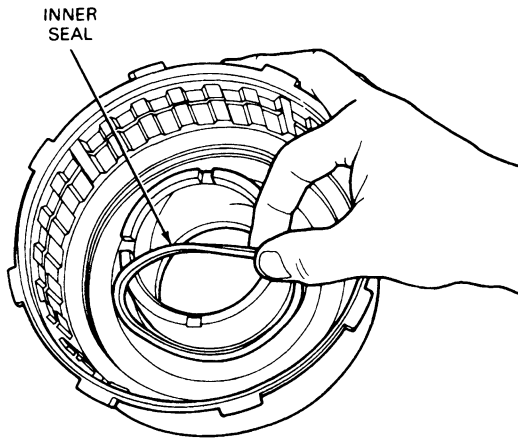
11. Remove inner and outer seals from drum using O-Ring Tool T71P-19703-C.



D9101-1A

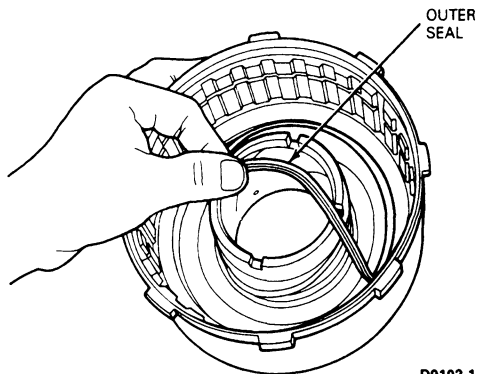
DISASSEMBLY AND ASSEMBLY (Continued)**Assembly**

1. Install inner seal into intermediate brake drum with seal lip facing down.



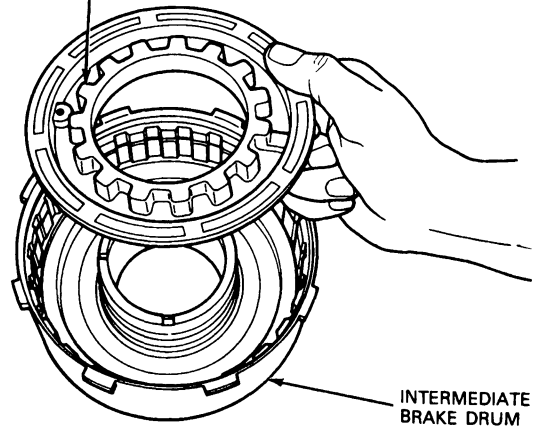
D9103-1A

2. Install outer seal into intermediate brake drum with seal lip facing down.



D9102-1A

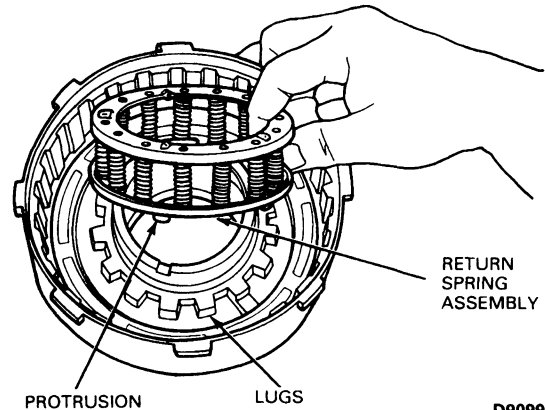
3. Inspect direct clutch piston check ball for freedom of movement and proper seating. Clean with solvent if necessary. Replace piston if damaged.
4. Install direct clutch piston into intermediate brake drum.

DIRECT CLUTCH
PISTON

D9100-B

5. Install return spring assembly.

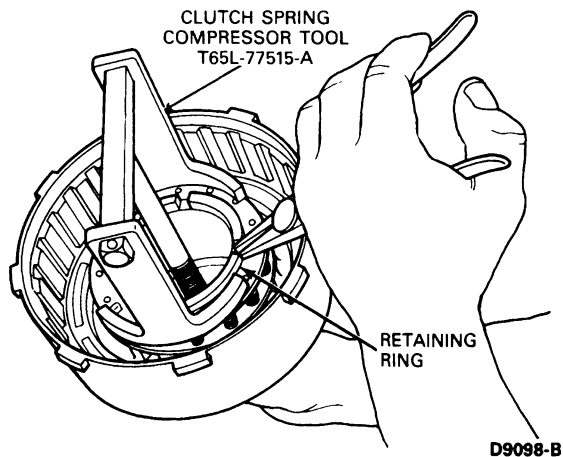
NOTE: Make sure protrusions on spring retainer are properly engaged with lugs on clutch piston.



D9099-B

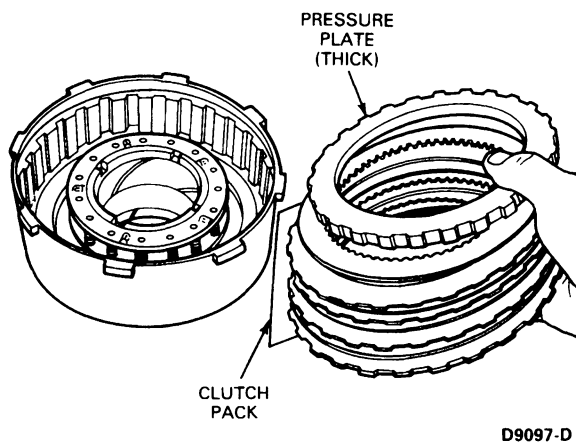
DISASSEMBLY AND ASSEMBLY (Continued)

6. Compress return spring assembly using Clutch Spring Compressor Tool T65L-77515-A. Install retaining ring, then remove compressor tool.



NOTE: Soak the clutch plates with clean Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) or equivalent for fifteen minutes.

7. Install three or four plate clutch pack (depending on model), starting with steel plate and alternating with friction plates. Install pressure plate (thick).



8. Install selective retaining ring. Check stack-up in three positions 120° apart using feeler gauge. If not within specification, install correct selective retaining ring and recheck.

Specification:

1.52-1.15mm (0.060-0.045 inch) - 4 plate

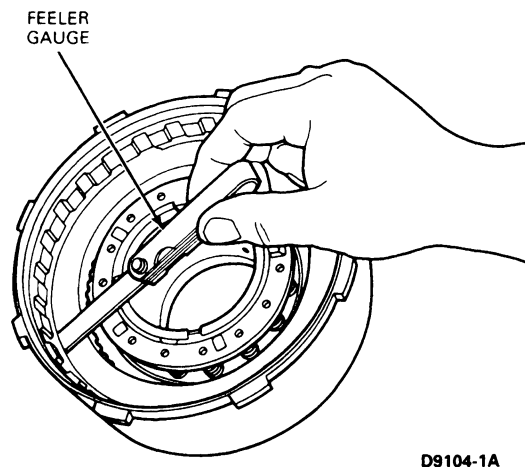
1.15-.76mm (0.045-0.030 inch) - 3 plate

Selective Retaining Rings

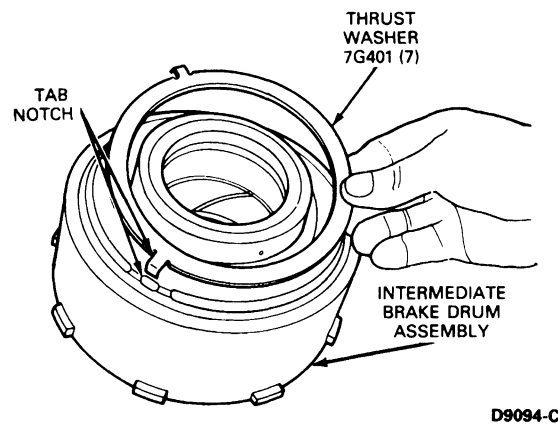
1.65-1.75mm (0.065-0.069 inch)

1.88-1.98mm (0.074-0.078 inch)

2.11-2.21mm (0.083-0.087 inch)

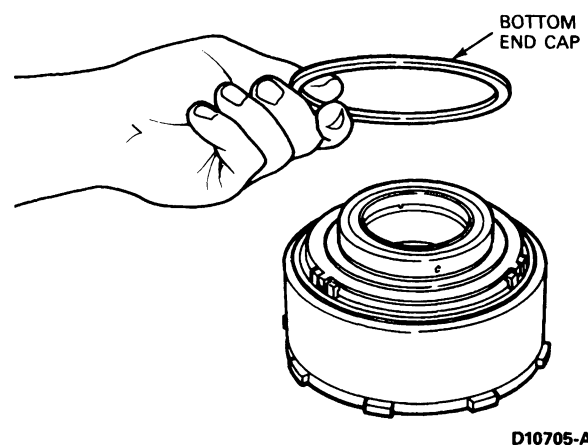


9. Install large intermediate one-way thrust washer 7G401 (7) on face of cylinder.



10. Install bottom end cap up.

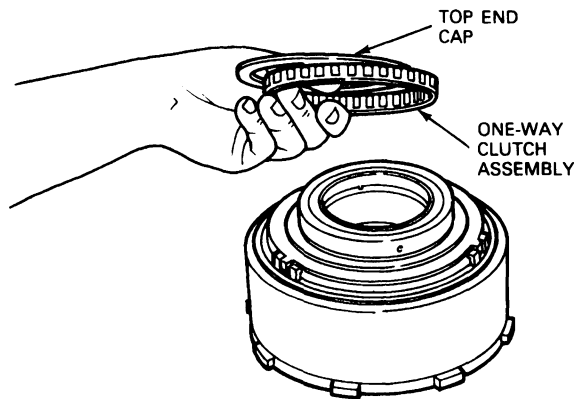
NOTE: Top and bottom end caps are identical.



DISASSEMBLY AND ASSEMBLY (Continued)

11. Install one-way clutch assembly onto inner race. Install top end cap.

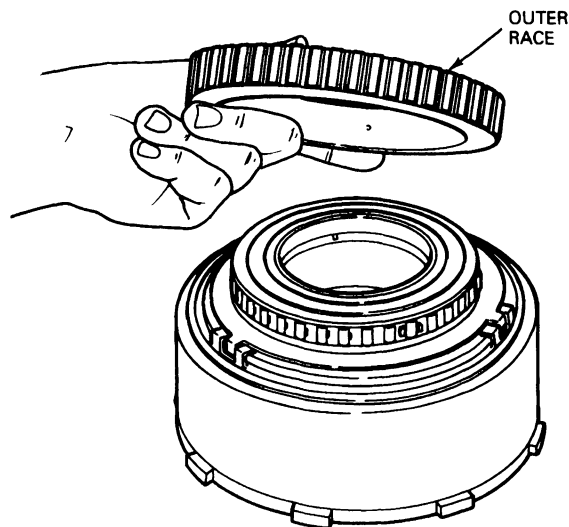
NOTE: Lip on the one-way clutch should be up.



D10704-A

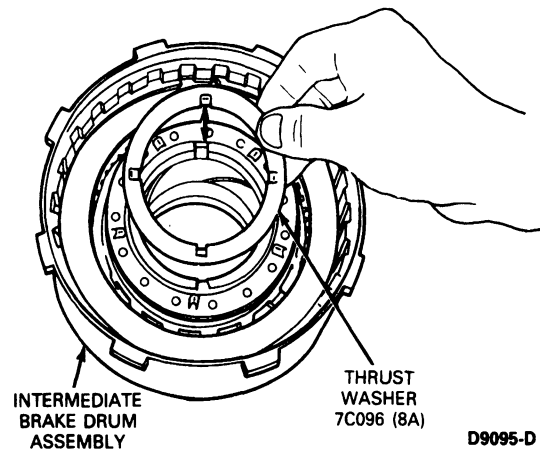
12. Install outer race and check that race turns **counterclockwise**.

NOTE: Shoulder on outer race must be up.

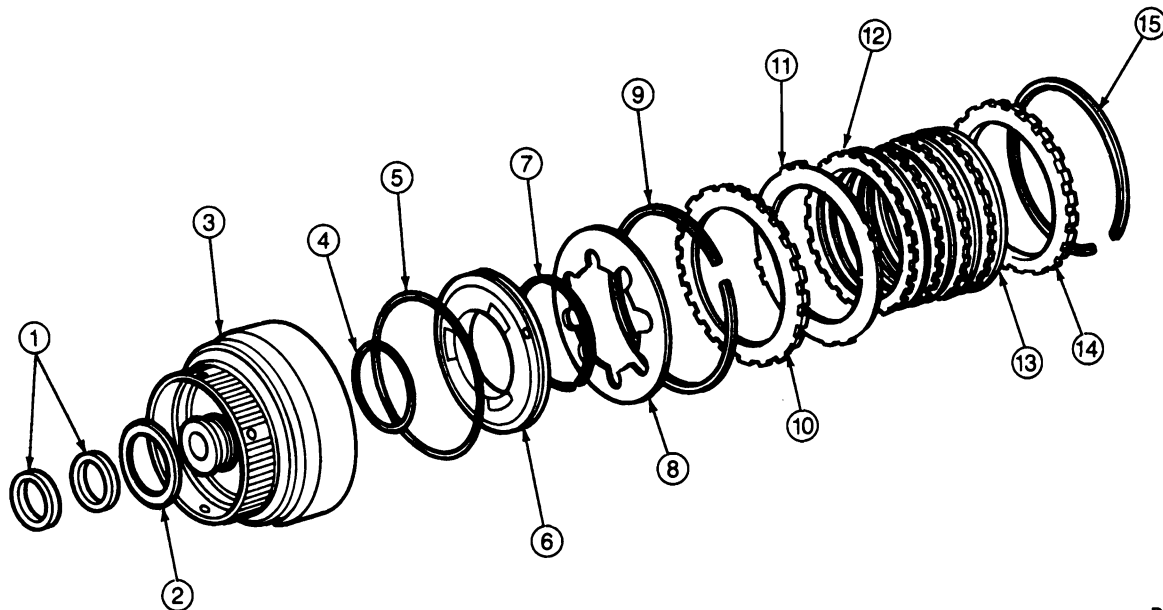


D10706-A

13. Using a light film of petroleum jelly, install intermediate brake drum thrust washer 7C096 (8A) on face of cylinder.



D9095-D

DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

D9261-D

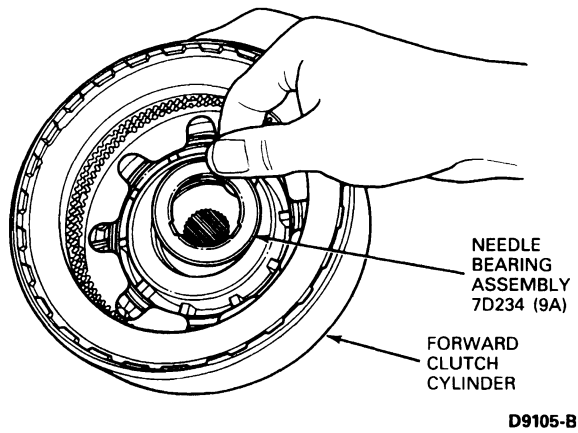
Item	Part Number	Description
1	7D019	Seal, Forward Clutch Cylinder
2	7F374 (8B)	Bearing, Forward Clutch Needle (8B)
3	7A360	Cylinder Assembly, Forward Clutch
4	7A548	Seal, Forward Clutch Piston, Inner
5	7A548	Seal, Forward Clutch Piston, Outer
6	7A262	Piston Assembly, Forward Clutch
7	7D256	Ring, Forward Clutch Piston Spring
8	7B070	Spring, Forward Clutch Piston Disc

(Continued)

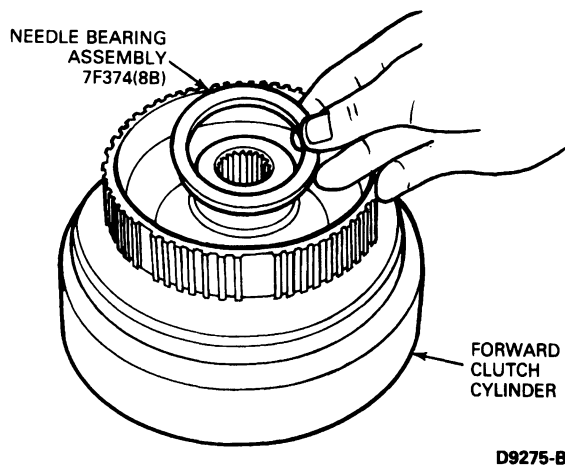
Item	Part Number	Description
9	377 127-S	Ring, Forward Clutch Spring
10	7B066	Plate, Forward Clutch Pressure (Beveled)
11	7E085	Spring, Forward Clutch Pressure
12	7B442	Plate, External Spline, Forward Clutch, Steel
13	7E311	Plate, Internal Spline, Forward Clutch, Friction
14	7B066	Plate, Forward Clutch Pressure, Rear (Thick)
15	377 127-S 377 437-S 377 444-S 386 841-S 386 842-S	Ring, Forward Clutch Pressure Plate, Retaining, Selective Fit

DISASSEMBLY AND ASSEMBLY (Continued)

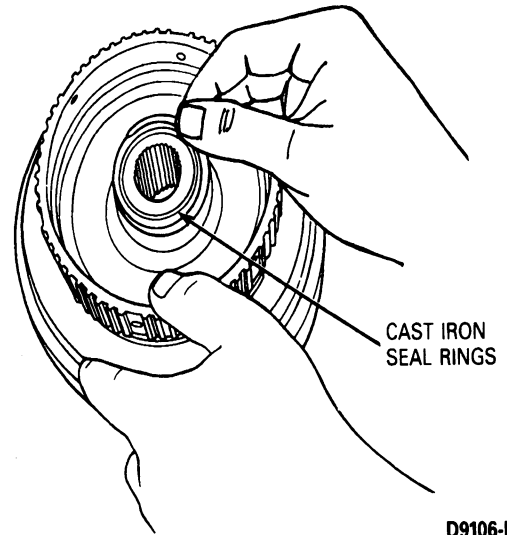
1. Remove needle bearing assembly 7D234 (9A) from inner face of cylinder.



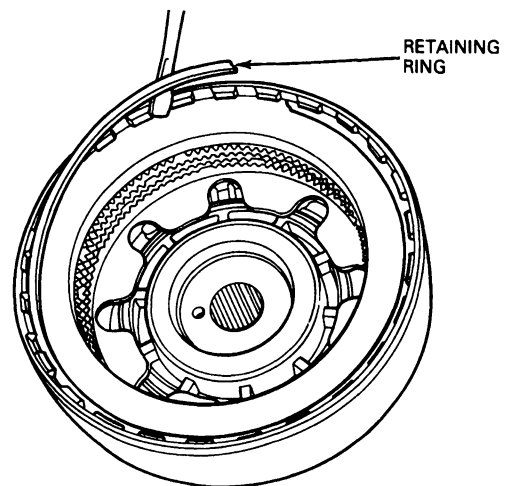
2. Remove needle bearing assembly 7F374 (8B).



3. Remove both seal rings from grooves.



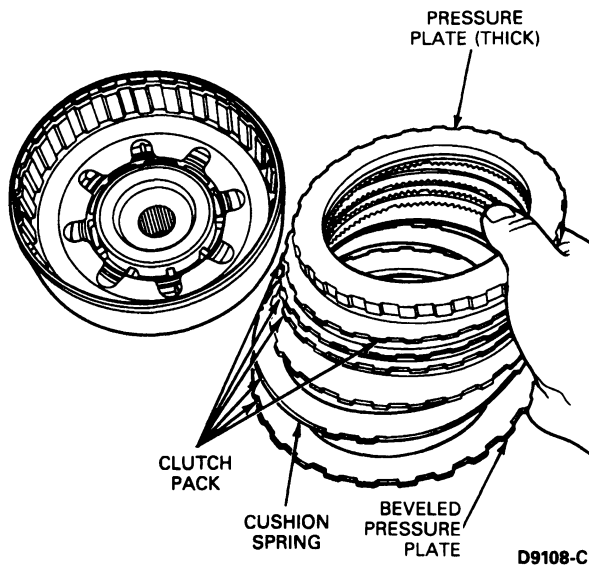
4. Remove retaining ring.



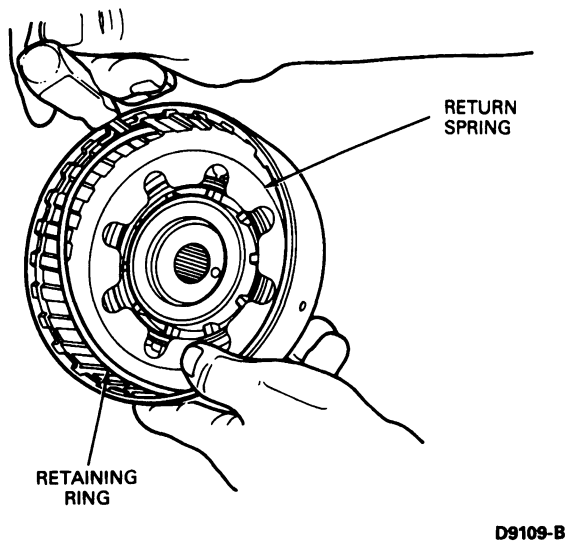
5. Remove pressure plate (thick).

DISASSEMBLY AND ASSEMBLY (Continued)

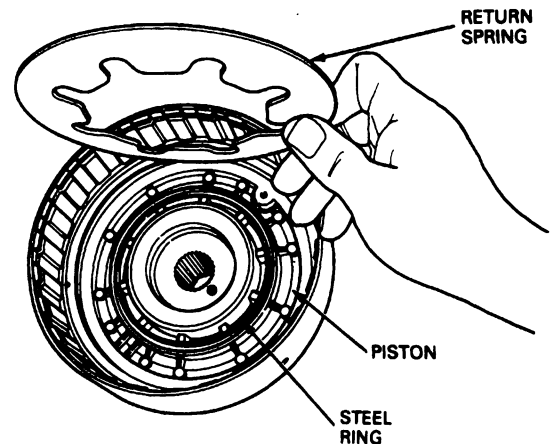
6. Remove three or four plate clutch pack, (depending on transmission model), cushion spring and beveled pressure plate. Tag for re-assembly.



7. Remove return spring retaining ring.

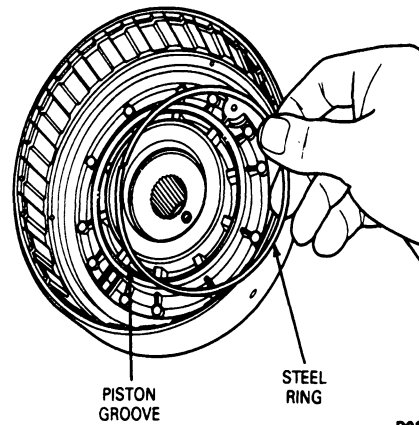


8. Remove return spring.



D9110-1A

9. Remove steel ring from piston groove.



D9111-1A

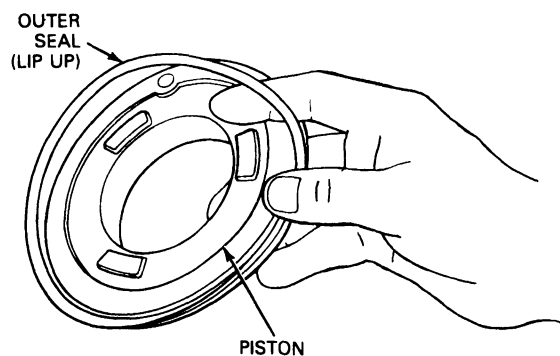
10. Remove piston from cylinder using compressed air.



D10707-A

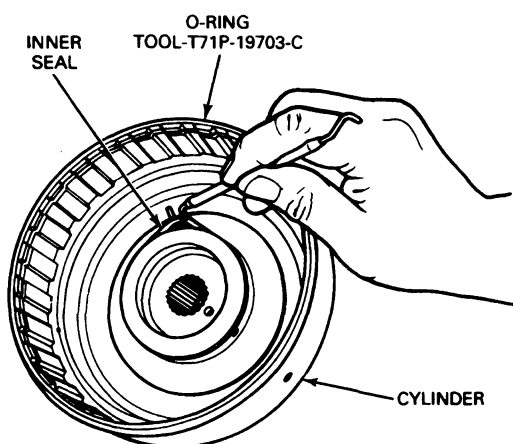
DISASSEMBLY AND ASSEMBLY (Continued)

11. Remove outer seal from piston.



D9113-B

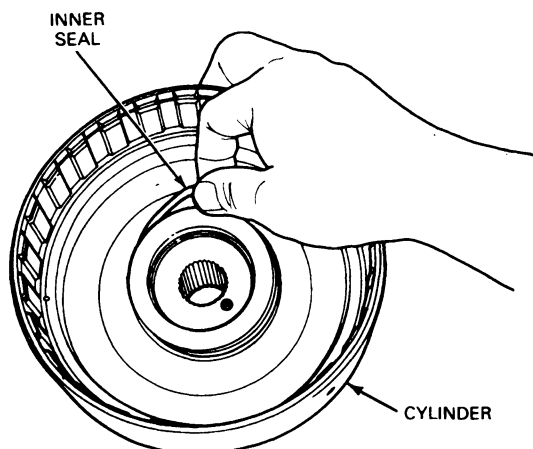
12. Remove inner seal from the cylinder using O-Ring Tool T71P-19703-C.



D9114-1A

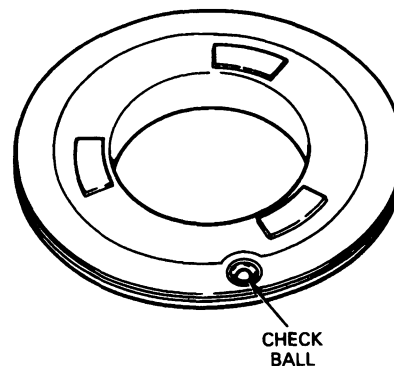
Assembly

1. Install inner seal in cylinder.



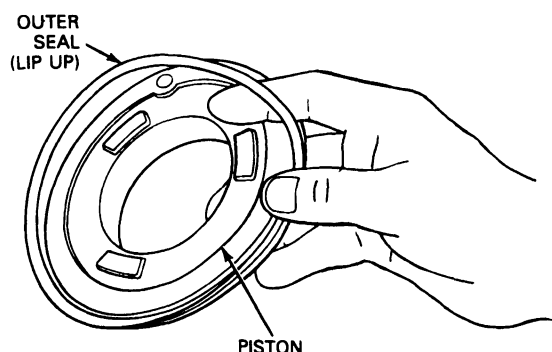
D9115-1A

2. Inspect piston check ball for freedom of movement and proper seating. Replace piston assembly if necessary. Clean with a suitable solvent if necessary.



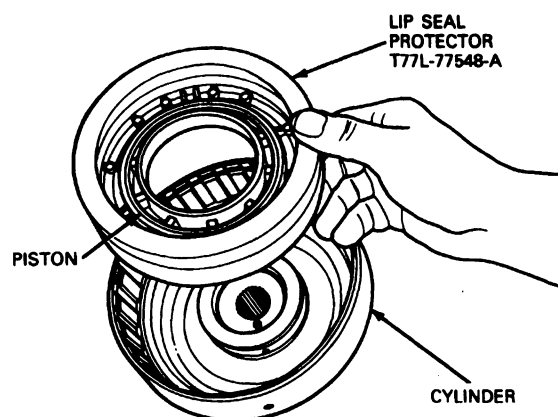
D10708-A

3. Install outer seal on piston with lip facing up as shown.



D9113-B

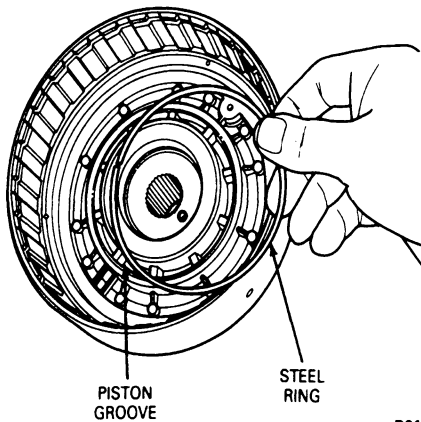
4. Install piston into cylinder using Lip Seal Protector T77L-77548-A.



D9116-1A

DISASSEMBLY AND ASSEMBLY (Continued)

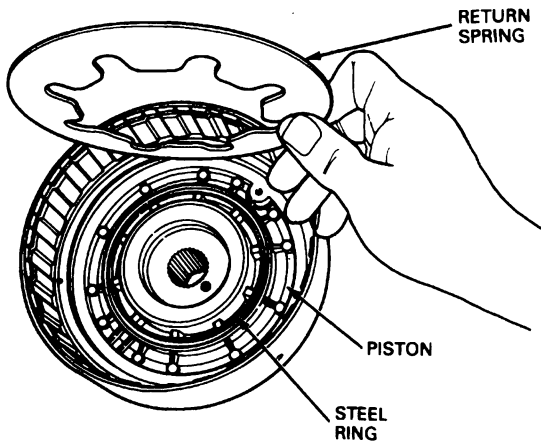
5. Install steel ring into groove on piston.



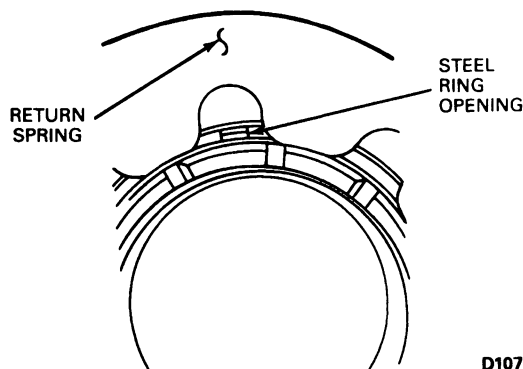
D9111-1A

6. Install return spring with the return spring fingers against the piston / steel ring.

CAUTION: Return spring and steel ring must be positioned so that both ends of the ring are visible in the notch between the fingers of the spring to ensure durability of the return spring.

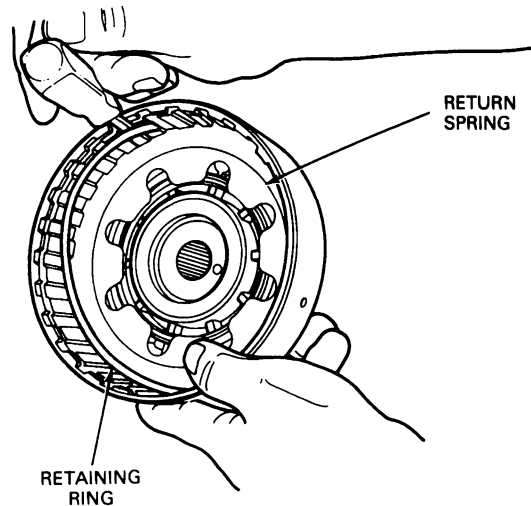


D9110-1A



D10709-A

7. Install retaining ring. Verify proper seating in groove.

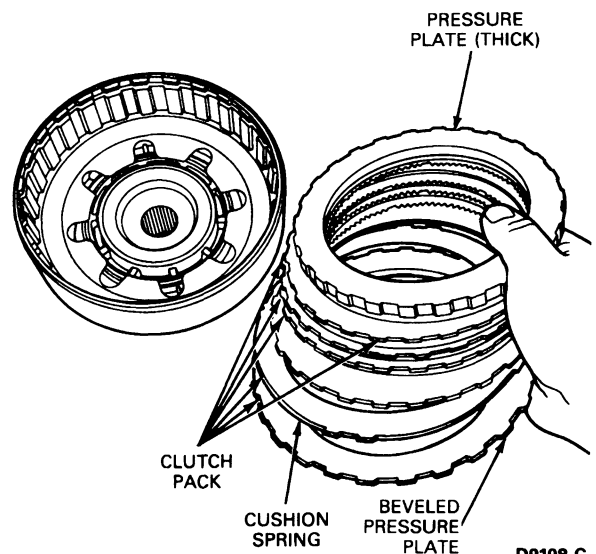


D9109-B

8. Install pressure plate (beveled face down).
9. Install cushion spring.
10. Install three steel plates and three friction plates, or four steel plates and four friction plates (depending on transmission model). Alternate steel and friction starting with a steel plate.

NOTE: Soak the clutch plates with clean Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) or equivalent for fifteen minutes.

11. Install pressure plate (thick).



D9108-C

12. Install selective retaining ring.

DISASSEMBLY AND ASSEMBLY (Continued)

13. Using feeler gauge, check stack-up clearance in three positions 120° apart. If not within specification install correct snap ring and recheck.

Stack Up Clearance Specification:

1.40-0.76mm (0.055-0.030 inch)

Selective Snap Ring Thickness:

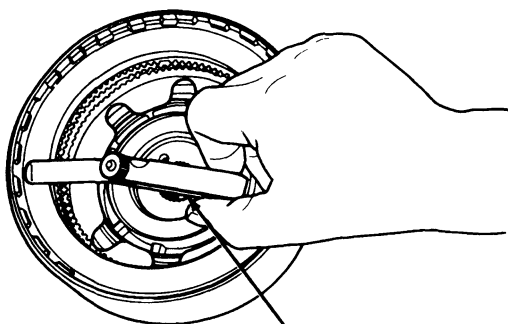
1.42-1.52mm (0.056-0.060 inch)

1.88-1.98mm (0.074-0.078 inch)

2.34-2.44mm (0.092-0.096 inch)

2.79-2.90mm (0.110-0.114 inch)

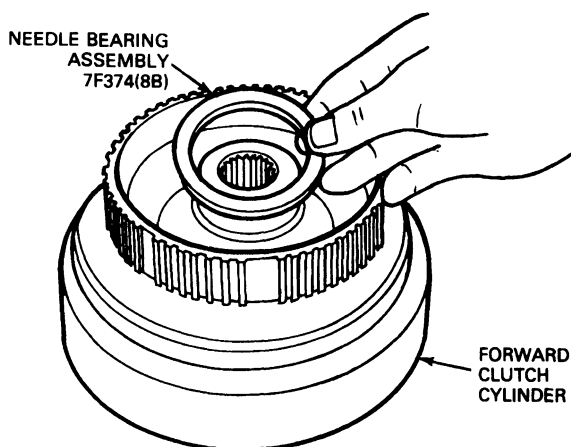
3.25-3.35mm (0.128-0.132 inch)



FEELER
GAUGE

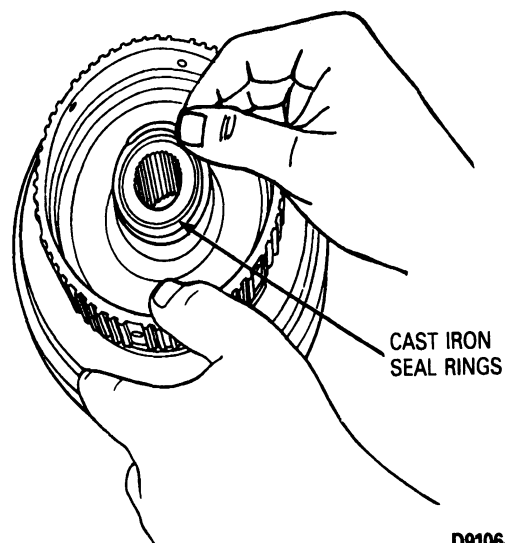
D7877-1A

14. Using a light film of petroleum jelly, install needle bearing assembly 7F374 (8B) with large I.D. radius facing inward.



D9275-B

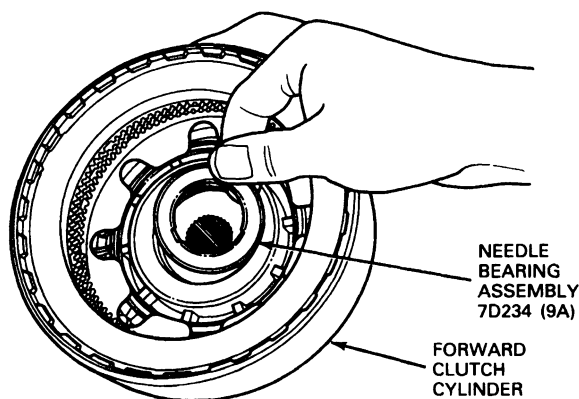
15. Install cast iron seal rings in grooves.



CAST IRON
SEAL RINGS

D9106-B

16. Using a light film of petroleum jelly, install needle bearing assembly on inner face of cylinder, with large O.D. radius facing inward.



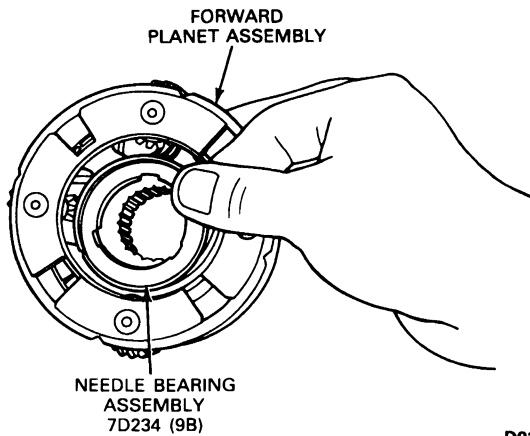
NEEDLE
BEARING
ASSEMBLY
7D234 (9A)

FORWARD
CLUTCH
CYLINDER

D9105-B

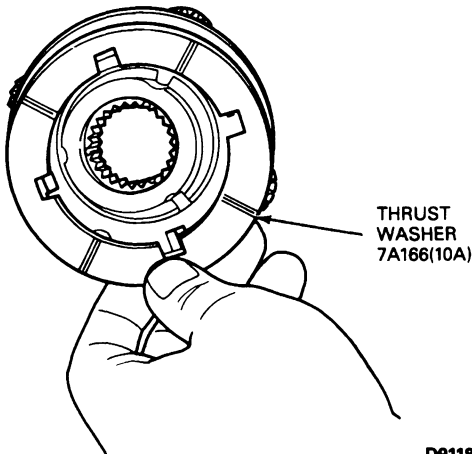
DISASSEMBLY AND ASSEMBLY (Continued)**Forward Planet Assembly****Disassembly**

1. Remove needle bearing assembly 7D234 (9B) from carrier.



D9117-C

2. Remove thrust washer 7A166 (10A) from front side of forward planet assembly.

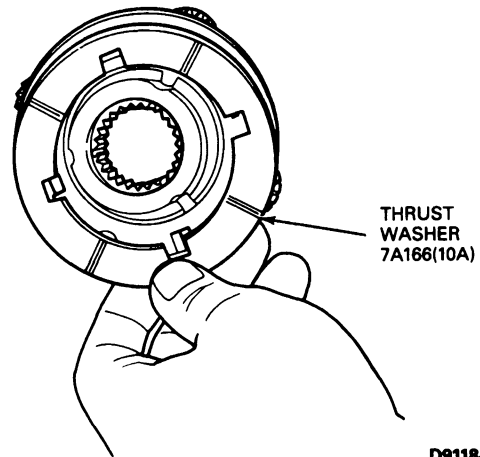


D9118-B

Assembly

1. Place thrust washer 7A166 (10A) on front side of planet assembly, using petroleum jelly to hold in place.

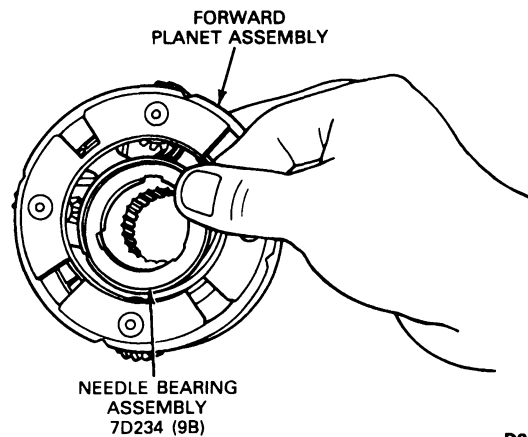
NOTE: Thrust washer tabs go into carrier slots.



D9118-B

2. Install needle bearing assembly 7D234 (9B) on inner face of planet assembly.

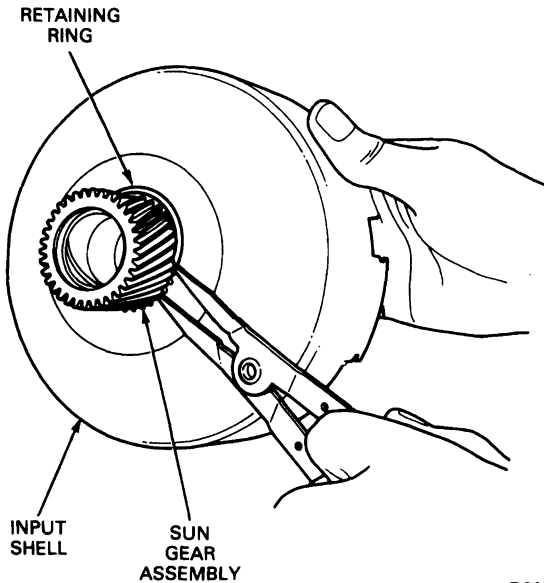
NOTE: Install notched inner race facing outward and large O.D. radius facing inward.



D9117-C

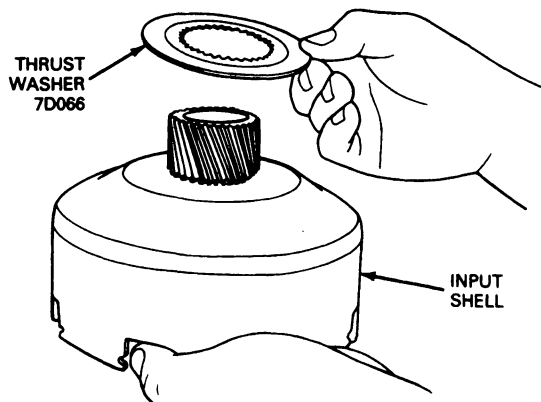
DISASSEMBLY AND ASSEMBLY (Continued)**Input Shell****Disassembly and Assembly**

1. Remove and **discard** retaining ring from reverse sun gear using retaining ring pliers.



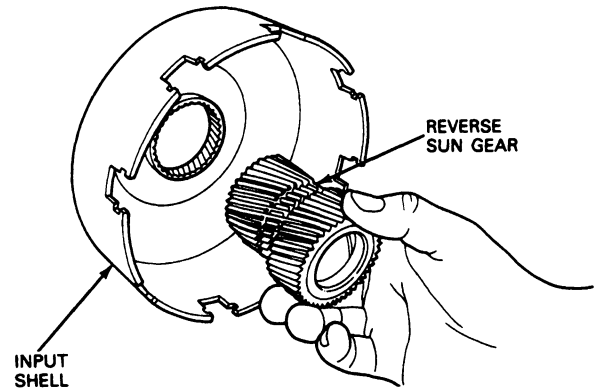
D9119-C

2. Remove thrust washer 7D066 from input shell.



D9120-1A

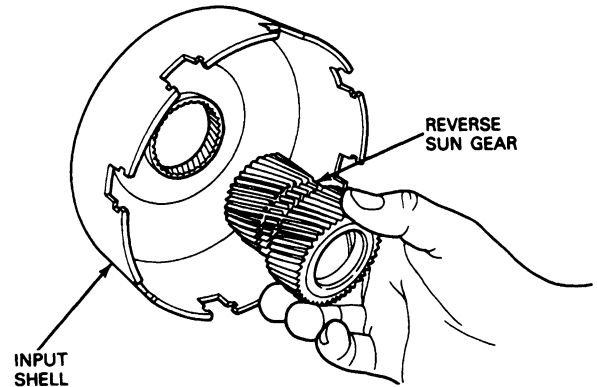
3. Remove reverse sun gear from input shell.



D9121-1A

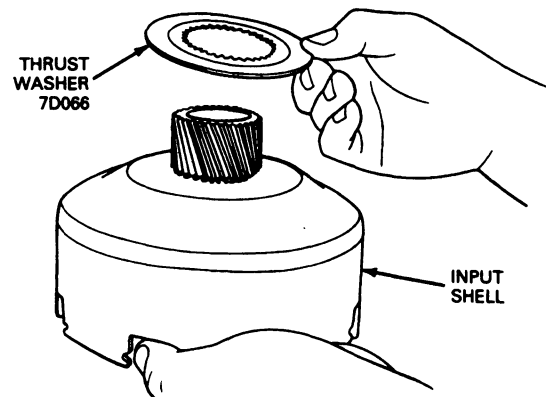
Assembly

1. Install reverse sun gear, so that lube hole in sun gear is between stand-off pads on input shell.



D9121-1A

2. Install input shell thrust washer 7D066 onto reverse sun gear.

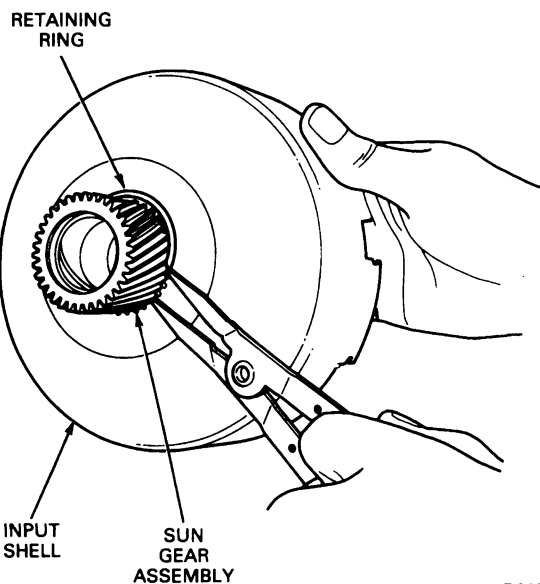


D9120-1A

DISASSEMBLY AND ASSEMBLY (Continued)

3. Install **new** retaining ring onto reverse sun gear using retaining ring pliers.

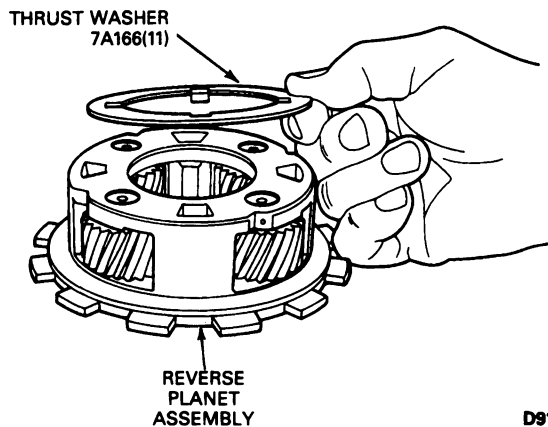
CAUTION: Use care not to over-extend retaining ring.



D9119-C

Reverse Planet Assembly**Disassembly**

1. Remove rear thrust washer 7A166 (11).

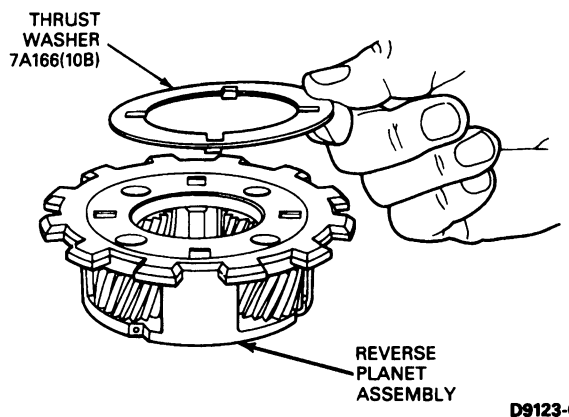


D9122-C

2. Remove front thrust washer 7A166 (10B).

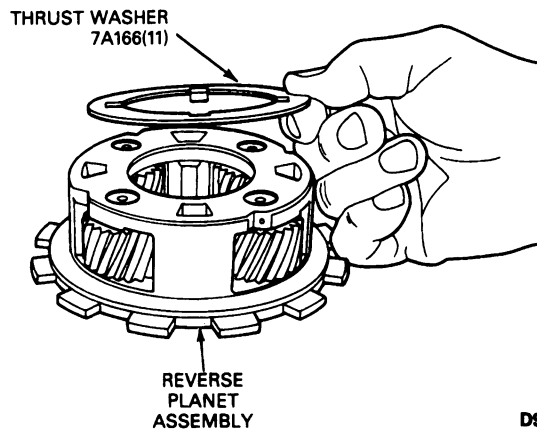
Assembly

1. Install front thrust washer 7A166 (10B) with tabs positioned in slots on planet assembly. Hold in place using petroleum jelly.

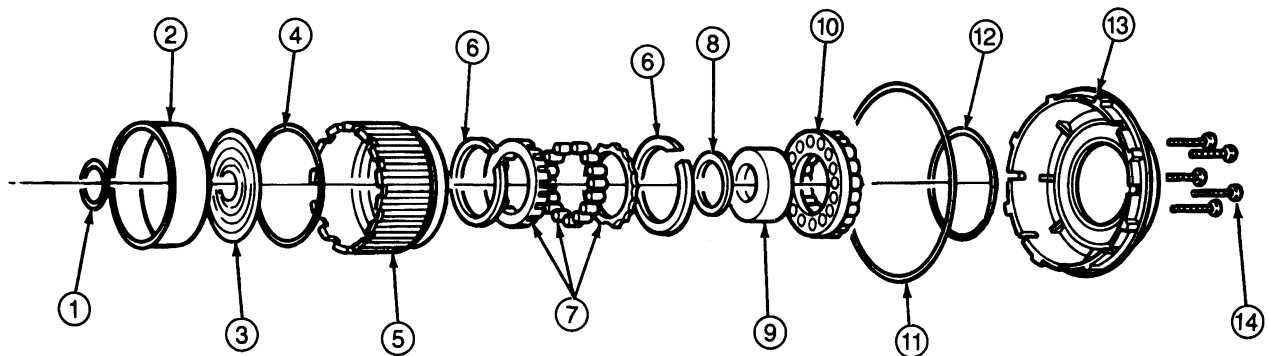


D9123-C

2. Install rear thrust washer 7A166 (11) with tabs positioned into slots on planet assembly. Hold in place using petroleum jelly.



D9122-C

DISASSEMBLY AND ASSEMBLY (Continued)**Low Reverse One-Way Clutch**

D9262-D

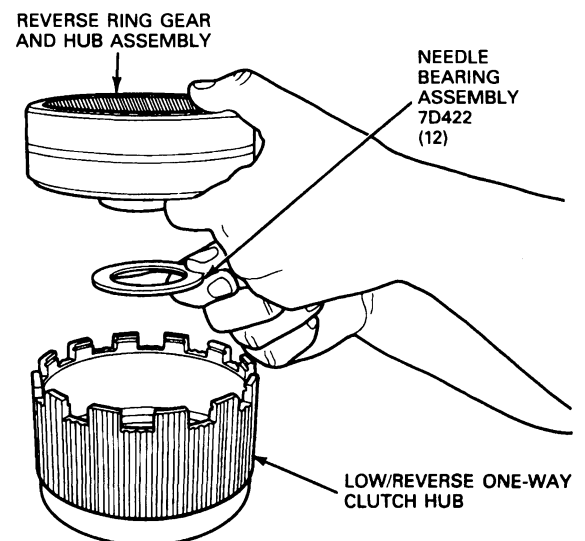
Item	Part Number	Description
1	387031-S5	Retaining Ring (For Output Shaft)
2	7A153	Gear, Output Shaft Ring
3	7D164	Hub and Race, Output Shaft
4	377132-S	Retaining Ring
5	7B067	Hub Assembly, Reverse Clutch
6	377135-S	Retaining Ring
7	7A089	Clutch Assembly, Reverse Overrunning

(Continued)

Item	Part Number	Description
8	76178	Bearing Assembly, Output Shaft Hub, Thrust
9	7D171	Race, One-Way Clutch Inner
10	7D046	Retainer and Spring Assembly, Reverse Clutch
11	7D403	Seal, Reverse Clutch Piston, Outer
12	7D404	Seal, Reverse Clutch Piston, Inner
13	7D402	Piston, Reverse Clutch
14	7D167	Bolts, 5/16 x 1.9 (OWC to Case)

Disassembly and Assembly

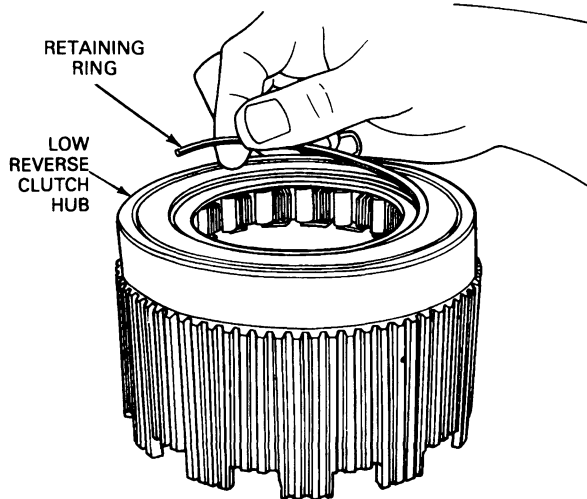
1. Remove reverse ring gear and hub assembly and needle bearing assembly 7G178/7D422 (12) from low reverse one-way clutch hub.



D9124-C

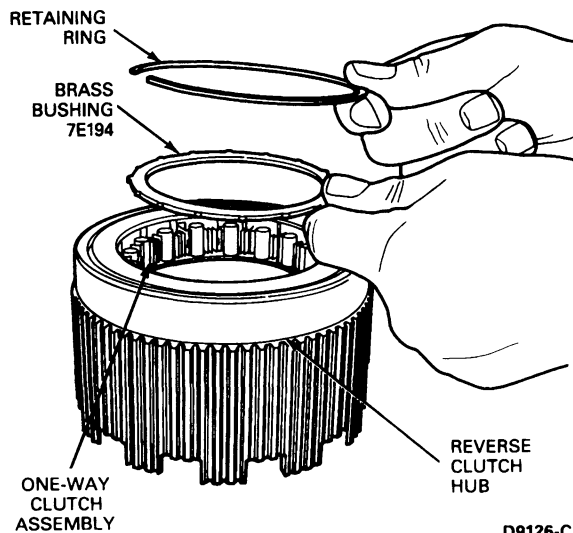
DISASSEMBLY AND ASSEMBLY (Continued)

2. Remove retaining ring from low reverse one-way clutch hub.



D9125-B

3. Remove brass bushing 7E194 and, if necessary, one-way clutch assembly from reverse clutch hub.



D9126-C

Assembly

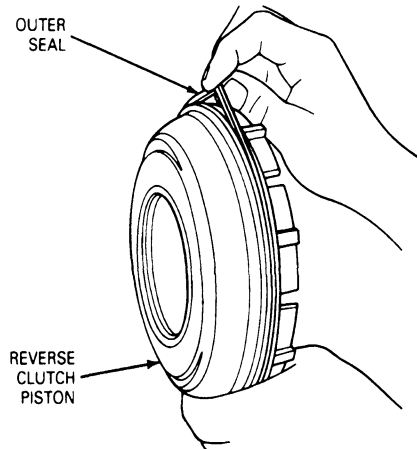
NOTE: Check clutch hub thrust surfaces for scores and clutch hub splines for wear. Replace all worn parts.

NOTE: Inspect outer and inner races for scores or damaged surface areas where rollers or sprags contact races. Inspect rollers, sprags and springs for excessive wear or damage. Inspect spring and cage for bent or damaged spring retainers.

1. Install one-way clutch rollers and brass bushing 7E194.
2. Install retaining ring onto one-way clutch hub.

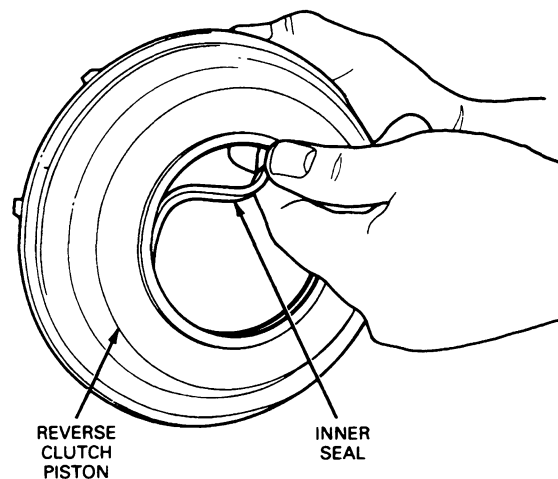
Reverse Clutch Piston**Disassembly and Assembly**

1. Remove outer piston seal.



D9127-1A

2. Remove inner piston seal.

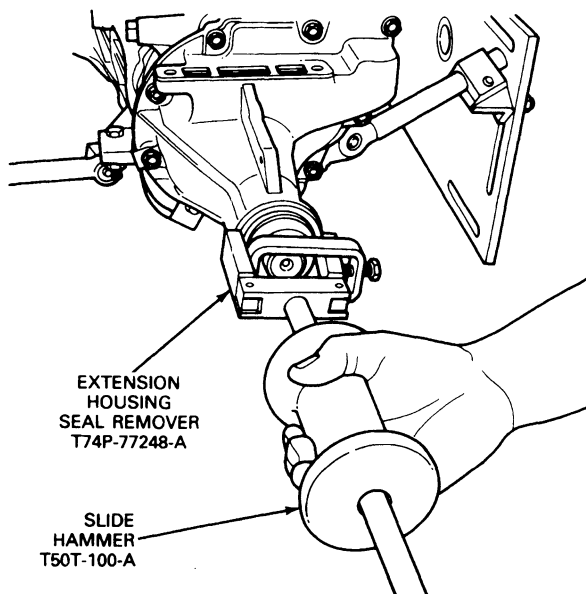


D9128-1A

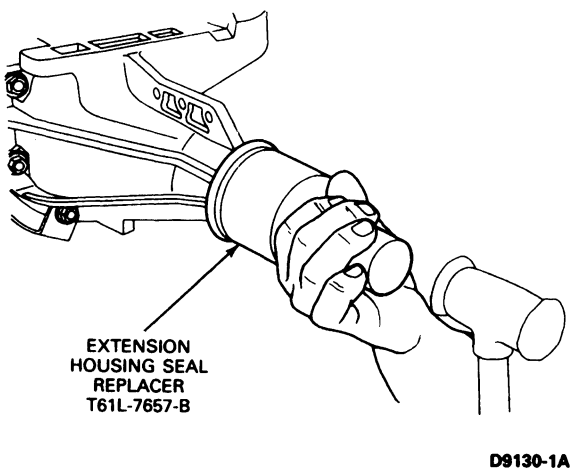
3. Install inner and outer piston seals.

DISASSEMBLY AND ASSEMBLY (Continued)**Extension Housing****Disassembly and Assembly**

1. Using Extension Housing Seal Remover T74P-77248-A and Slide Hammer T50T-100-A remove seal.

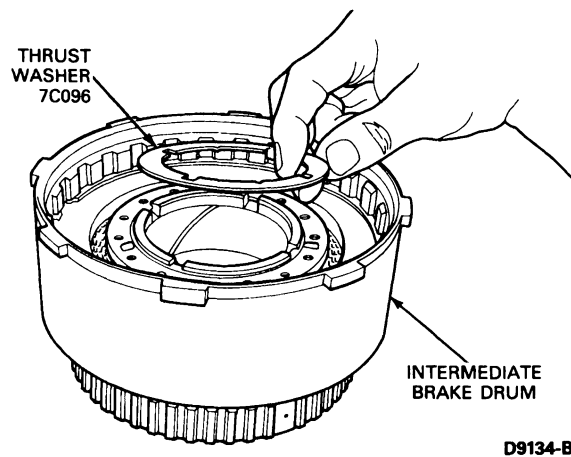


2. Install extension housing seal, using Extension Housing Seal Replacer T61L-7657-B.

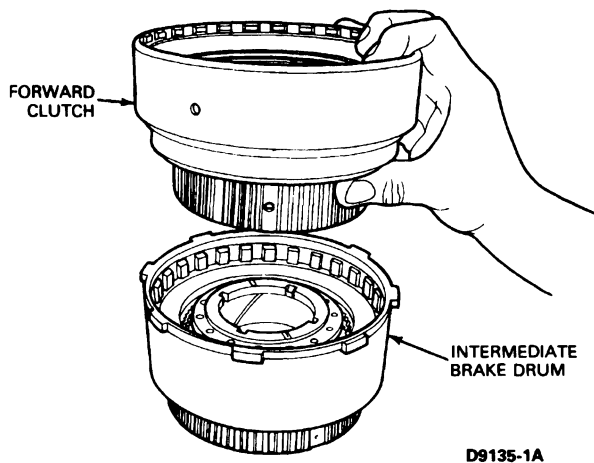
**Subassemblies****Intermediate Brake Drum and Forward Clutch Assemblies****Assembly**

1. Verify that thrust washer 7C096 (8A) is installed onto intermediate brake drum. Make sure tabs are seated properly into slots.

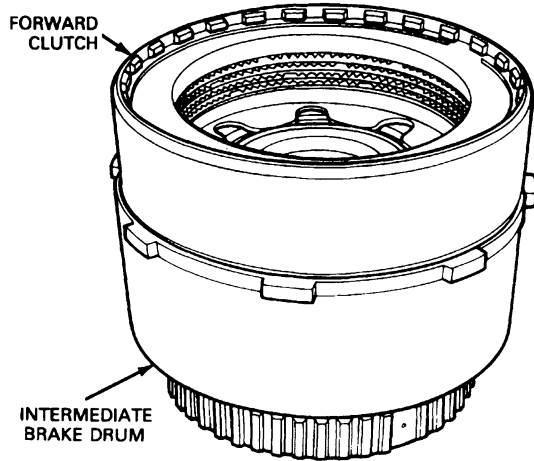
NOTE: Use a light film of petroleum jelly on the thrust washer.



2. Install forward clutch onto intermediate brake drum by rotating until fully seated.



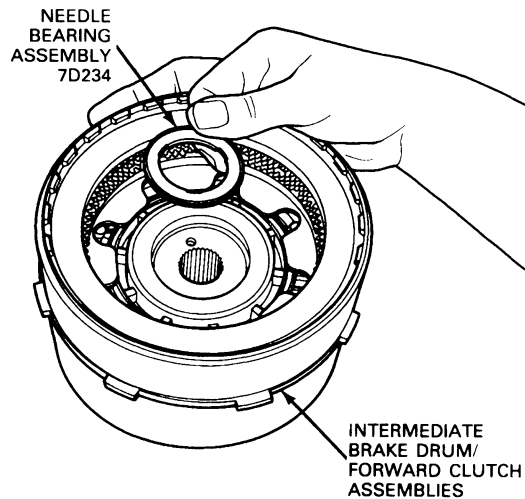
DISASSEMBLY AND ASSEMBLY (Continued)



D9136-1A

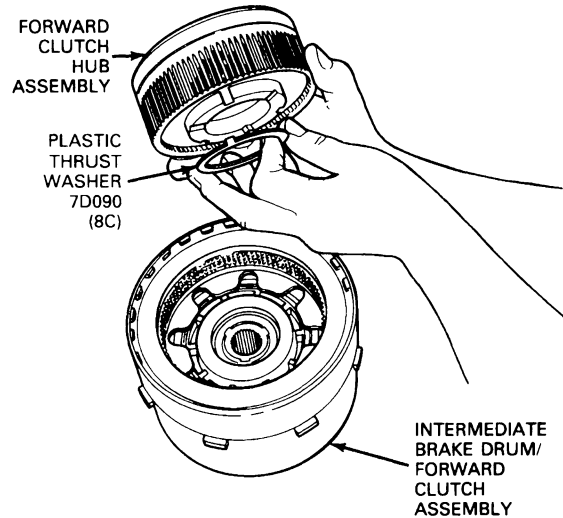
3. Verify that the needle bearing assembly 7D234 (9B) is installed into the forward clutch assembly.

NOTE: Use a light film of petroleum jelly on the needle bearing assembly. Install with large O.D. radius facing inward.

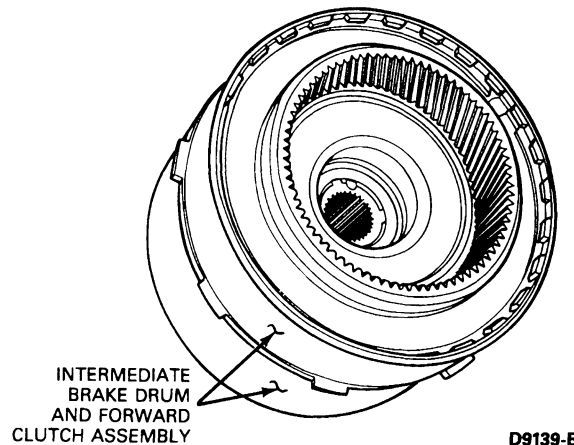


D9137-C

4. Apply a light film of petroleum jelly to plastic thrust washer 7D090 (8C) and place onto forward clutch hub. Place forward clutch hub assembly into intermediate brake drum and forward clutch assembly.



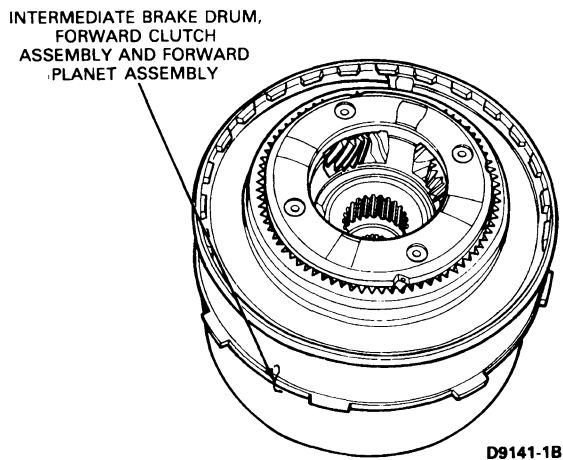
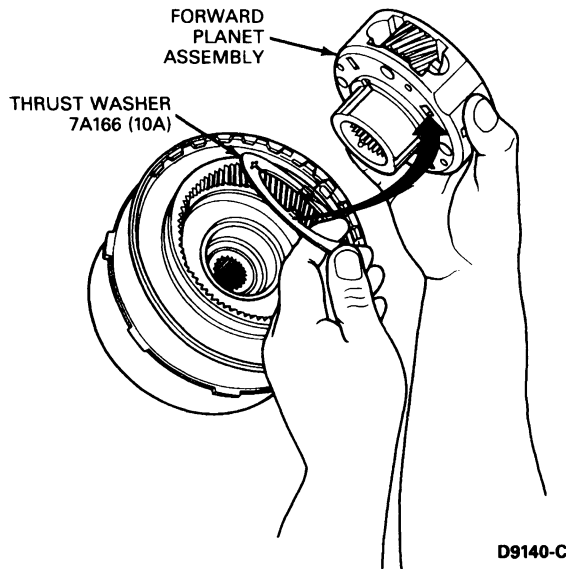
D9138-D



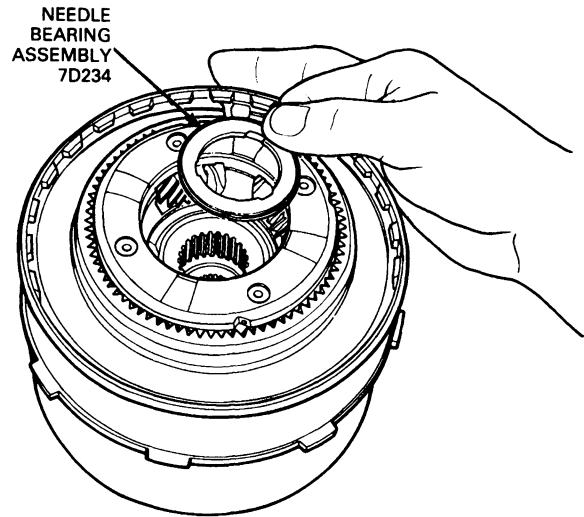
D9139-B

DISASSEMBLY AND ASSEMBLY (Continued)

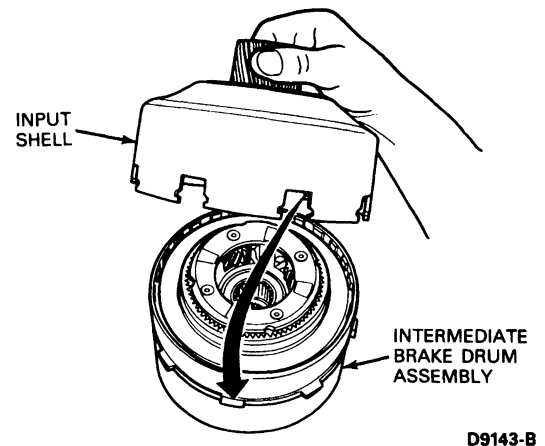
5. Apply a light film of petroleum jelly to thrust washer 7A166 (10A) and place onto forward planet assembly. Tabs on thrust washer must engage slots on planet assembly. Place planet assembly into forward clutch hub assembly.



6. Verify needle bearing assembly 7D234 (9A) is installed into forward planet assembly.
- NOTE: Apply a light film of petroleum jelly to needle bearing to hold in place. Install with large O.D. radius facing inward.

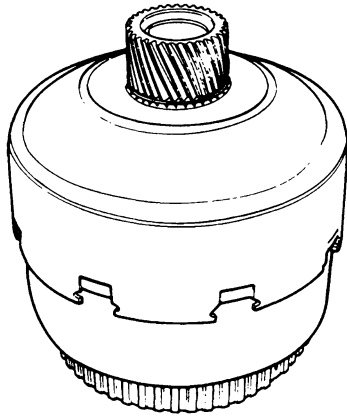


7. Align input shell notches with intermediate brake drum lugs.



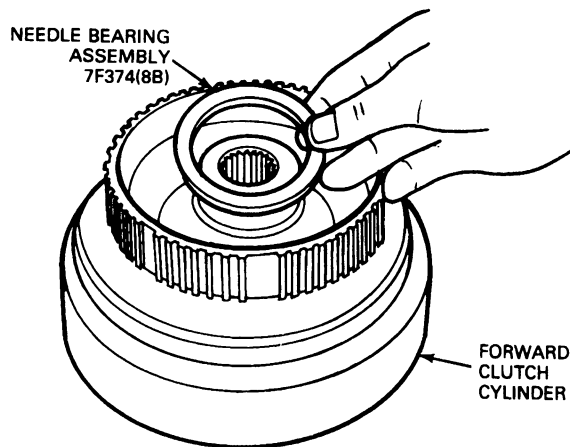
DISASSEMBLY AND ASSEMBLY (Continued)

8. Install input shell onto assembly and rotate until fully seated.

DIRECT, FORWARD CLUTCH AND INPUT SHELL ASSEMBLY

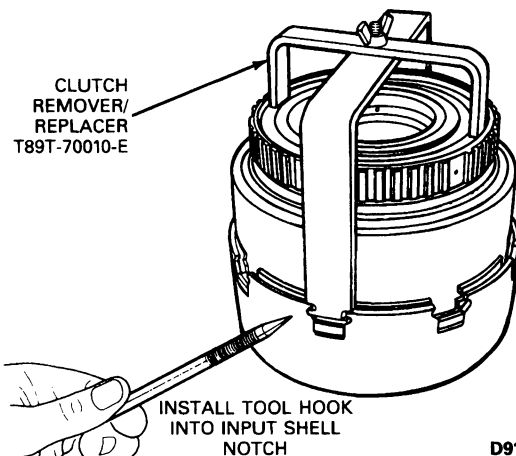
D9144-1A

9. Verify that the needle bearing 7F374 (8B) is installed. If not, apply a light film of petroleum jelly to needle bearing 7F374 and install into front end of forward clutch assembly with the large O.D. radius facing inward.



D9275-B

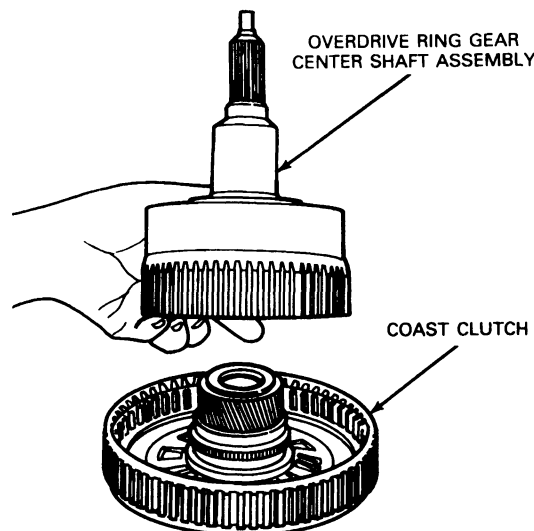
10. Install Intermediate Brake Drum, Forward Clutch and Input Shell Clutch Remover / Replacer T89T-70010-E and proceed with transmission assembly.



D9145-B

Overdrive Ring Gear / Center Shaft / Coast Clutch Assembly

1. Install overdrive ring gear / center shaft assembly onto coast clutch.

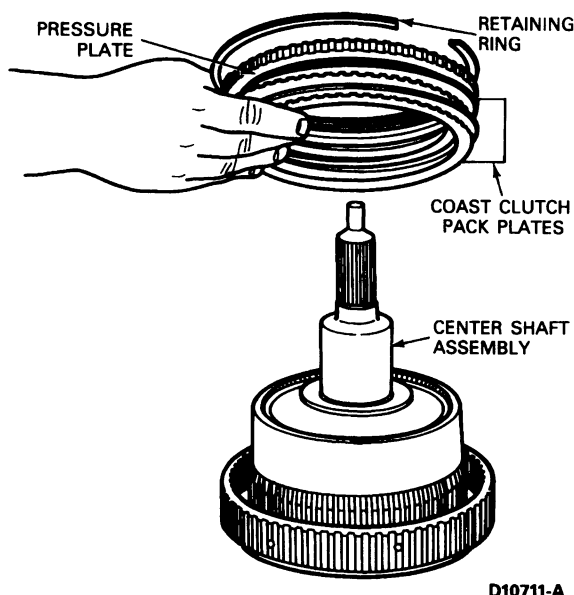


D10710-B

NOTE: Soak friction plates in Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT2-QDX, DDX E4AZ-19582-B (ESP-M2C166-H) or equivalent for 15 minutes.

DISASSEMBLY AND ASSEMBLY (Continued)

2. Install coast clutch pack plates alternately, starting with steel plate, then install pressure plate. Install retaining ring.

**Forward, Direct, Intermediate, Overdrive, Coast and Reverse Clutches**

1. Inspect the clutch cylinder thrust surfaces, piston bore, and clutch plate splines for scores, burrs or wear. Minor scores or burrs may be removed with an oil stone. Replace the clutch cylinder if it is badly scored or damaged.
2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect clutch piston for scores and replace if necessary. Inspect the check balls for freedom of movement and proper seating.
3. Check the clutch release spring for distortion and cracks. Replace the spring (including wave spring) if it is distorted or cracked.
4. Inspect the friction clutch plates, steel clutch plates, and clutch pressure plate for worn or scored surfaces. Replace all parts that are scored, burred or burnt.
5. Check the clutch plates for flatness and fit on the clutch hub splines. Discard any plate that does not slide freely on the splines or that is not flat.
6. Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear. Replace all worn parts.

CLEANING AND INSPECTION**Transmission**

CAUTION: The friction clutch plates, bands and synthetic seals should not be cleaned in a vapor degreaser or with any type of detergent solution.

To clean these parts, wipe them off with a lint-free cloth. New clutch plates or bands should be soaked in the specified transmission fluid for 15 minutes before being assembled.

Clean all other parts with suitable solvent and use moisture-free air to dry off all parts and clean out fluid passages.

Output Shaft

1. Inspect the output shaft bearing surfaces for wear or scores. If excessive wear or scores are found, replace shaft and inspect mating components.
2. Check the splines on the output shaft for wear. Replace the shaft if the splines are excessively worn. Inspect all the bushings for wear. Replace if worn or damaged.

Electrical Connectors and Solenoid Body

Any time an electrical connector or solenoid body is disconnected, inspect the connector for terminal condition, corrosion and contamination. Also inspect the connector seal for damage. Clean, repair or replace as required.

Valve Bodies

1. Clean all parts, except non-metallic check balls, thoroughly in clean solvent and blow dry with moisture-free compressed air.
2. Inspect all valve and plunger bores for scores. Check all fluid passages for obstructions. Inspect all mating surfaces for burrs and scores. **If necessary, use an oil stone to polish valves and plungers. Avoid rounding the sharp edges of the valves and plungers.**
3. Inspect all springs for distortion. Check all valves and plungers for free movement in their respective bores when dry.
4. Roll the valves on a flat surface to check for bent condition.

One-Way Clutches

1. Inspect the outer and inner races for scores or damaged surface areas where the rollers or sprags contact the races.
2. Inspect the rollers, sprags and springs for excessive wear or damage.
3. Inspect the spring and cage for bent or damaged spring retainers.

CLEANING AND INSPECTION (Continued)

Case Assembly

Inspect the case assembly for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions, and check all fluid passages for obstructions.

Inspect the case assembly bushing for scores. Check all parking linkage parts for wear or damage.

If the transmission case assembly thread is damaged, service kits (helicoil) may be purchased from local jobbers. To service a damaged thread, follow procedures furnished in the helicoil kit.

Planet Assemblies

NOTE: Individual parts of the planet assemblies are not serviceable.

1. The pins and shafts in the planet assemblies should be checked for loose fit and / or damage. Use a **new** planet assembly if either condition exists.
2. Inspect the pinion gears for damaged or excessively worn teeth.
3. Check for free rotation of the pinion gears.
4. Check for damage in the overdrive planet assembly.

Thrust Bearings

Wash the thrust bearings thoroughly in cleaning solvent. Blow the bearings dry with compressed air.

Make certain the bearings are clean and then lubricate with transmission fluid. Replace any bearings and races which show signs of pitting or roughness.

Converter and Transmission Cooler

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and **MUST** be removed from the system before the transmission is put back into service.

Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body valves stick repeatedly from foreign material, the torque converter, transmission cooler and cooler lines **MUST** be cleaned by using a mechanically agitated cleaner, such as Rotunda Torque Converter / Oil Cooler Cleaner 014-00028 or equivalent.

NOTE: Mineral spirits used to clean the torque converter **must** be fresh, non-chlorinated and non-halogenated.

Flush the converter of the remaining solvent using this procedure.

1. **Thoroughly drain** remaining solvent through the drain plug.
2. Add 1.9L (2.0 U.S. quarts) of clean transmission fluid to the converter. Agitate by hand.
3. **Thoroughly drain** solution through the drain plug.

Transmission Fluid Drain and Refill

Normal maintenance and lubrication requirements do not necessitate periodic automatic transmission fluid changes. If a major service, such as a clutch, band, bearing, etc., is required in the transmission, it will have to be removed for service. **At this time the converter transmission cooler and cooler lines must be thoroughly flushed to remove any contamination.**

The transmission fluid and torque converter should be drained and refilled every 48,000 km (30,000 miles) if the vehicle is operated under severe conditions. Use only Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) or equivalent. Severe service would include one or more of the following driving conditions:

- Operating during hot weather (above 32°C (90°F) and carrying heavy loads and driving in hilly terrain.
- Operating at maximum loads.
- Towing a trailer or slide-in camper.
- Door-to-door delivery, police or taxi.
- Operating a PTO unit.

CAUTION: Use of a fluid other than specified could result in transmission malfunction and/or failure.

When filling a dry transmission and converter, refer to Specifications for capacity. Check the fluid level.

Oil Cooler Line Leakage

When fluid leakage is found at the oil cooler, the cooler must be replaced. Refer to Section 03-03.

When fluid cooler steel lines must be replaced, each replacement line must be fabricated from the same size inside diameter and length steel line as the original line.

Using the old line as a guide, bend the new line as required. Add the necessary fittings, and install the line.

After the fittings have been tightened, check and add fluid as necessary. Check for fluid leaks. If anti-drain back valve was present in replaced line, it must be reinstalled in the new steel line.

SPECIFICATIONS

Transmission

Description	N-m	Lb-Ft
4.9/5.0/5.8L Eng. Plate to Trans.	16-22	12-16
7.5L Engine Plate to Trans.	16-22	12-16
Center Support to Fluid Feed	11-16	8-12
Center Support to Hub	9-13	80-120 (In-Lb)
Connector-Cooler Line to Case	24-31	18-23
Conn. 3/8 Cooler Line Motorhome	24-31	18-23
Connector — Radiator-to-Tube	23-31	17-23
Connectors, Radiator-to-Tube, Motorhome, 3/8 O.D.	27-31	20-23
Motorhome 5/16 O.D.	24-30	18-22
Cooler Tube, Transmission, 5/16 O.D.	12-24	9-18
Cooler Tube, Motorhome, 3/8 O.D.	22-30	16-22
Cooler Tube, Motorhome, 5/16 O.D.	16-24	12-18
Auxiliary Cooler Tube, Transmission, 5/16 O.D.	9-18	7-13
Auxiliary Cooler Tube, Motorhome, 3/8 O.D.	22-30	16-22
Auxiliary Cooler Tube, Motorhome, 5/16 O.D.	16-24	12-18
Control Assembly to Pump	24-31	18-23
Converter Drain Plug	24-27	18-20
Dust Cover to 7.3L Plate	16-22	12-16
Dust Cover to 7.5L Plate	3-7	30-60 (In-Lb)
Dust Cover to Case 4.9/5.0/5.8L	16-22	12-16
Dust Cover to Case 7.3L	16-22	12-16
Extension Housing to Case (4x2)	27-39	20-29
Extension Housing to Case (4x4)	33-54	24-40
Extension Housing to Case (4x2)	27-39	20-29
Extension Housing to Case (4x4)	33-40	24-40
Extension to Rear Engine Mount (4x2)	81-108	60-80
Extension to Rear Engine Mount (4x4)	81-108	60-80
Extension to Rear Engine Mount — Motorhome	68-95	50-70
Filler Tube to 7.3L Engine	33-47	24-35
Filler Tube to Intake Manifold — 7.3L	4-6	39-57 (In-Lb)
Filler Tube to Manifold — Nut 4.9/5.8/7.5	18-23	13-17
Flywheel to Converter — Nut	27-46	20-34
Heat Shield to Solenoid Body	9-11	80-100 (In-Lb)

(Continued)

Description	N-m	Lb-Ft
In and Out Lever to Manual Control Shaft	41-54	30-40
Inner OWC Race to Case	24-34	18-25
Line Pressure to Case — Plug	8-16	6-12
Lower Body to Main Body	9-11	80-100 (In-Lb)
Main and Lower Body to Case	9-11	80-100 (In-Lb)
Main Accum and Sol. Body to Case	9-11	80-100 (In-Lb)
Manual Lever to Shaft — Nut	27-39	20-29
Manual Lever Position Sensor	6-8	55-75 (In-Lb)
O/Drive Cylinder Fluid Feed	8-14	6-10
Oil Pan Drain Plug	20-34	15-25
Oil Pan to Case	14-16	10-12
Oil Pump Body to Case	24-31	18-23
Parking Rod Abutment to Case	22-27	16-20
Parking Rod Guide Plate to Case	22-27	16-20
Positive Detent Spring to Case	9-11	80-100 (In-Lb)
Reinforcing Plate to Case	9-11	80-100 (In-Lb)
Solenoid Body to Main Body	9-11	80-100 (In-Lb)
Speedo Plug to Extension Housing	4-6	36-54 (In-Lb)
Starter to Engine Plate 4.9/5.8L	27-46	20-34
Start to Engine Plate 7.5L	27-46	20-34
Stator Support to Pump Body	9-11	80-100 (In-Lb)
Throttle Pressure Case — Plug	8-16	6-12
Trans. to 4.9/5.0/5.8L Engine	52-71	38-52
Trans. to 7.3L Engine	66-89	49-66
Trans. to 7.3L Engine	66-89	49-66
Trans. to 7.5L Engine	52-71	38-52
Trans. to 7.5L Engine	52-71	38-52
Trans. to 5.8L Engine 0.8500	52-71	38-52
Valve — 3/8 Cooler Line — Motorhome	24-31	18-23
Valve Assembly — Cooler Check to Case	24-31	18-23
Valve Body to Case — Long	9-11	80-100 (In-Lb)
Valve Body to Case — Short	9-11	80-100 (In-Lb)
Valve Body to Case — Nut	9-11	80-100 (In-Lb)

SPECIFICATIONS (Continued)

Cooling Lines — E4OD

Vehicle	Radiator Connector Nuts		Transmission Tube Nuts		Auxiliary Cooler Tube Nuts		Tube O.D.
	Ft-Lbs	N-m	Ft-Lbs	N-m	Ft-Lbs	N-m	
F-Series, Econoline and Bronco	17-23	23-31	9-18	12-25	7-13	9-18	5/16
F-Super Duty Motorhome Chassis	20-23	28-32	16-22	22-30	16-22	22-30	3/8

CLUTCH PLATE USAGE & CLEARANCE SPECIFICATIONS

Intermediate Clutch	Steel	Friction	Clearance	Selective Snap Rings	
				Part Number	Thickness (In.)
4.9L/5.0L	1	2	.057-.023 in. (1.44-0.59mm)	E9TP-7B421-BA*	.081-.077*
5.8L/7.3LD/7.5L	2	3	.063-.029 in. (1.61-0.73mm)		
Direct Clutch					
4.9L/5.0L	3	3	.045-.030 in. (1.15-.076mm)	377128-S 377127-S	.087-.083 .078-.074
5.8L/7.3LD/7.5L	4	4	.060-.045 in. (1.52-1.15mm)	377126-S	.069-.065
Overdrive Clutch					
4.9L/5.0L/5.8L/7.3L/7.5L* (Prior to 93-1/2)	2	2	.047-.022 in. (1.20-0.55mm)	E9TP-7B421-EA E9TP-7B421-DA E9TP-7B421-CA	.142-.138 .122-.118 .102-.098
7.5L (93-1/2 and Later)	3	3	.059-.033 in. (1.5-.85mm)	E9TP-7B421-BA E9TP-7B421-AA	.081-.077 .061-.057
Coast Clutch					
All	2	2	.045-0.25 in. (1.14-0.62mm)	N804952-S N804951-S N804950-S	.089-.085 .073-.069 .057-.053
Forward Clutch					
4.9L/5.0L	3 ^b	3	.055-.030 in. (1.40-0.76mm)	377437-S 377127-S	.056-.060 .074-.078
5.8L/7.3LD/7.5L	4 ^b	4	—	377444-S 386841-S 386842-S	.092-.096 .110-.114 .128-.132
Low/Reverse Clutch					
4.9L/5.0L/5.8L/7.3LD	5	5	.104-.027 in. (2.64-0.68mm)	N805207-S*	.074-.078*
7.5L	6	6	.113-.027 in. (2.87-0.68mm)		

a A non-selective snap ring.

b Plus a steel wave cushion spring installed between the front pressure plate and a steel separator plate.

SPECIFICATIONS (Continued)

Fluid Capacity




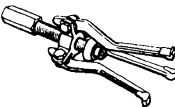
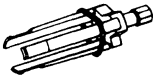

Motorcraft Mercon® Multi-Purpose Automatic Transmission Fluid Ford Part No. EAZ-19582-B Ford Specification ESP-M2C166-H or equivalent.

Transmission Type	Liters	Quarts
4 x 2	14.8	15.7
4 x 4	15.3	16.2

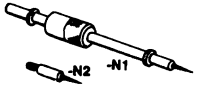

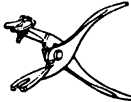
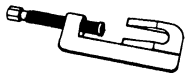
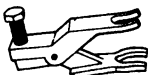

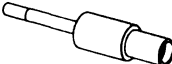
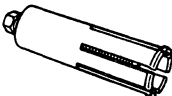

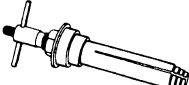
Approximate capacity includes cooler and lines. Fluid level indicator should be used to determine actual fluid requirement and fluid specifications. Check level at operating temperature. DO NOT OVERFILL. An additional .3 quart (.3 liter) is required if vehicle has an auxiliary cooler.

NOTE: The F-Super Duty Motorhome stripped chassis used an additional 1.0 quart (0.9 liter) of fluid for the auxiliary cooler.

SPECIAL SERVICE TOOLS/EQUIPMENT

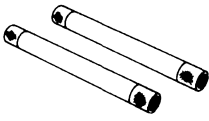

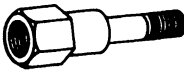

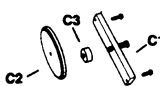




Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer (use w/ T89T-70010-A)	 T50T-100-A
T59L-100-B Impact Slide Hammer	 T59L-100-B
T58L-101-B Puller	 T58L-101-B
T77F-1102-A Puller	 T77F-1102-A
TOOL-1175-AC Seal Remover	 TOOL-1175-AC
T77F-1176-A Clutch Spring Compressor	 T77F-1176-A

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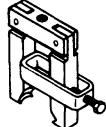
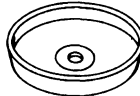

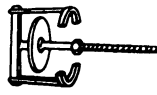

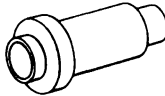
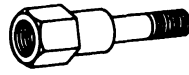

Tool Number / Description	Illustration
T78P-3504-N Locknut Pin Remover	 T78P-3504-N
TOOL-4201-C Dial Indicator with Bracketry	 TOOL-4201-C
T67P-7341-A Shift Linkage Insulation Tool	 T67P-7341-A
T84P-7341-A Shift Linkage Grommet Remover	 T84P-7341-A
T84P-7341-B Shift Linkage Grommet Replacer	 T84P-7341-B
T61L-7657-B Extension Housing Seal Replacer	 T61L-7657-B
T77L-7697-C Extension Housing Bushing Replacer	 T77L-7697-C
T77L-7697-D Extension Housing Bushing Remover	 T77L-7697-D
T57L-77820-A Pressure Gauge	 T57L-77820-A
T80L-7902-A End Play Checking Tool	 T80L-7902-A

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT **(Continued)**

Tool Number / Description	Illustration
T81P-7902-C Torque Converter Handles	 T81P-7902-C
T71P-19703-C O-Ring Tool	 T71P-19703-C
T89T-70010-A Pump Puller Adaptors	 T89T-70010-A
T89T-70010-B Aligning Pin	 T89T-70010-B
T89T-70010-C Clutch Spring Fixture	 T89T-70010-C
T89T-70010-E Clutch Remover / Replacer	 T89T-70010-E
T89T-70010-F Clutch Spring Compressor Plate	 T89T-70010-F
T89T-70010-G Stub Tube Installer	 T89T-70010-G
T88C-77000-AH Clutch Spring Compressor	 T88C-77000-AH

(Continued)

Tool Number / Description	Illustration
T74P-77248-A Extension Housing Seal Remover	 T74P-77248-A
T80L-77405-A Clutch Spring Compressor	 T80L-77405-A
T74P-77498-A Shift Lever Seal Replacer	 T74P-77498-A
T65L-77515-A Clutch Spring Compressor	 T65L-77515-A
T77L-77548-A Lip Seal Protector	 T77L-77548-A
T63L-77837-A Pump Seal Replacer	 T63L-77837-A
T89T-70100-A E4OD Test Harness	 T89T-70010-A
T92T-7B200-AH VRV Gauge Block	 T83T-7B200-AH

ROTUNDA EQUIPMENT

Tool Number	Description
014-00028	Torque Converter / Oil Cooler Cleaner
014-00104	Transmission Stand Fixture
014-00106	Rotunda Twin Post Engine Stand
021-00054	Torque Converter Leak Test Kit
014-00763	Powertrain / Transmission Lift
014-00763	E4OD Transmission Adapter

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT
(Continued)**ROTUNDA EQUIPMENT (Cont'd)**

Tool Number	Description
007-00017	STAR Tester
007-00041	SUPER STAR II Tester
007-00085	Transmission Tester

SECTION 07-01B Transmission, Automatic, C6

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ADJUSTMENTS		DIAGNOSIS AND TESTING (Cont'd.)	
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Park/Neutral Position (PNP) Switch	07-01B-64	Transmission Fluid Condition Check	07-01B-8
CLEANING AND INSPECTION		Transmission Fluid Cooler Flow Check	07-01B-8
Backflushing and Cleaning Transmission		Transmission Fluid Leakage Checks	07-01B-8
Cooler and Lines	07-01B-57	Vacuum Diaphragm Test, Off Vehicle.....	07-01B-14
Case	07-01B-63	Vacuum Diaphragm Test, On-Vehicle.....	07-01B-14
Control Valve Body	07-01B-58	Vacuum Pump Method	07-01B-13
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Converter End Play and One-Way Clutch		DISASSEMBLY AND ASSEMBLY	
Check	07-01B-60	Control Valve Body	07-01B-39
Extension Housing	07-01B-58	Downshift and Manual Linkage	07-01B-45
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Front Pump	07-01B-59	Front Pump	07-01B-47
Governor.....	07-01B-58	Governor.....	07-01B-45
Intermediate Servo.....	07-01B-58	Input Shell and Sun Gear.....	07-01B-56
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Reverse-High Clutch	07-01B-59	One-Way Clutch.....	07-01B-57
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Stator-to-Turbine Interference Check	07-01B-62	Reverse-High Clutch	07-01B-49
Transmission.....	07-01B-57	Servo Apply Lever	07-01B-47
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Control Pressure Test	07-01B-11	Governor.....	07-01B-34
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VEHICLE APPLICATION

E-150-250-350, F-150-250-350 4x2 and F-250-350
4x4 Vehicles with C-6 Automatic Transmission

DESCRIPTION AND OPERATION

C6 Transmission

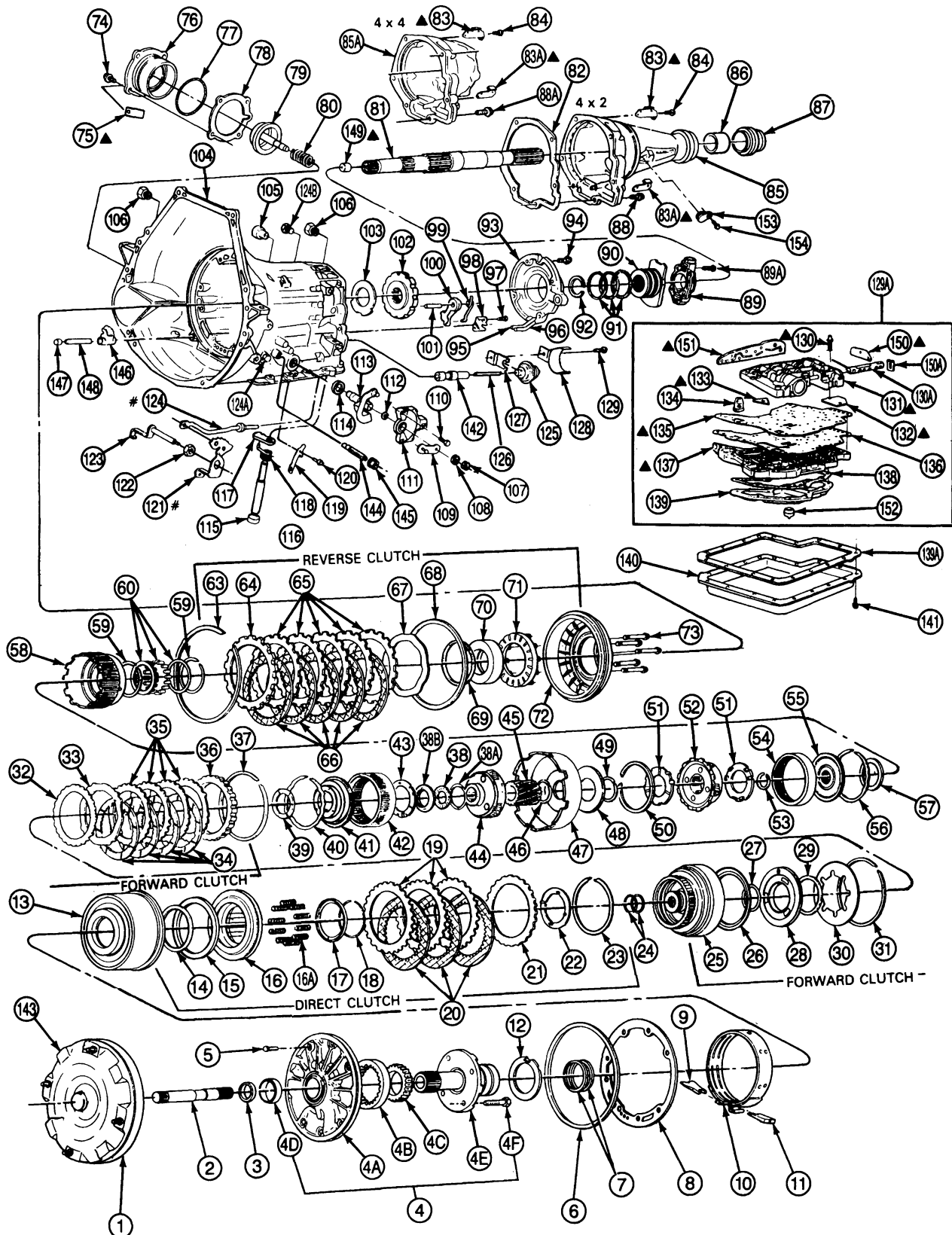
The C6 transmission is a three-speed unit capable of providing automatic upshifts and downshifts through the three forward gear ratios. The transmission is also capable of providing manual selection of first and second gears.

The converter housing and the fixed splines which engage the splined outside diameter of the low-reverse clutch steel plates are both cast integrally into the case.

Only one (intermediate) band is used in the C6 transmission. This along with the forward clutch is used to obtain intermediate gear.

DESCRIPTION AND OPERATION (Continued)

C6 Automatic Transmission, Exploded View



D10056-B

DESCRIPTION AND OPERATION (Continued)

Item No.	Part Number	Description
1	7902	Converter Assy.
2	7017	Shaft — Input
3	7A248	Seal Assy. — Front Oil Pump
4	7A103	Pump Assy. — Oil Front
★▲4A	7A106	Body Assy. — Front. Pump
★▲4B	7C011	Gear — Pump Driven
★▲4C	7C010	Gear — Pump Drive
★4D	7B258	Bushing — Frt. Oil Pump
★4E	7A108	Support Assy. — Front Pump
★4F	20346-S8	Bolt — Hex Hd (att 7A108 to 7A103)
5	58619-S2	Bolt — (Att 7A103 to 7005)
6	7A248	Seal — Front Oil Pump — Large
7	7D025	Seal — Intermediate Brake Drum — (2 Req'd)
8	7A136	Gasket — Oil Pump
9	7D029	Strut — Intermediate Brake Band
10	7D034	Band Assy. — Intermediate Brake
11	7D430	Strut — Intermediate Band Anchor
12	7D014	Washer Pump Support Thrust — Sel Fit — #1
13	7D044	Drum Assy. — Intermediate Brake
14	7E056	Seal — Clutch Piston Oil — Inner — Direct Clutch
15	7A548	Seal — Clutch Piston Oil — Outer — Direct Drive
16	7A262	Piston Assembly — Direct Clutch
16A	7B488	Spring — Direct Drive Clutch Piston (10 Req'd)
17	7A527	Retainer — Direct Drive Clutch Piston Spring
18	377136-S	Ring — (Used as Direct Drive CL Pst Spg Retainer)
19	7B442	Plate — Clutch External Spline — Direct (Steel)
20	7B164	Plate Assy. — Clutch Internal Spline — Direct (Friction)
21	7B066	Plate — Direct Drive Clutch Pressure
22	7C096	Washer — Intermediate Brake Drum Thrust — #2
23	377126-128-S 377437-S 377444-S	Ring — (Ret. 7B066 in 7D044 Drum) — Sel Fit
24	7D019	Seal — Forward Clutch Cylinder (2 Req'd)
25	7A360	Cylinder Assy. — Forward Clutch
26	7A548	Seal — Clutch Piston Oil — Outer — Forward Clutch
27	7A548	Seal — Clutch Piston Oil — Inner — Forward Clutch
28	7A262	Piston Assy. — Forward Clutch
29	7D256	Ring — Forward Clutch Piston Spring
30	7B070	Spring — Forward Clutch Piston Disc
31	377127-S	Ring — Ret. 7B070 in 7D424) — Not Sel Fit
32	7B066	Plate — Forward Clutch Pressure — Front
33	7E085	Spring — Forward Clutch Pressure
34	7B164	Plate Assy. — Clutch Internal Spline — Forward (Friction)
35	7B442	Plate — Clutch External Spline — Forward Clutch (Steel)

Item No.	Part Number	Description
36	7B066	Plate — Forward Clutch Pressure — Rear
37	377127-S 377437-S 377444-S 386841-2-S	Ring — (Ret. 7B066 in 7D424) — Sel Fit
38	7D234	Brg. Assy. — Fwd. Clutch Hub — Thrust — #3
38A	7D235	Race — Fwd. Clutch Hub — Thrust
38B	7D236	Race — Fwd. Clutch Hub — Thrust
39	7D090	Washer — Forward Clutch Hub Thrust — #4
40	377132-S	Ring — (Att. Ring Gear 7D392 to Hub 7B067)
41	7B067	Hub — Forward Ring Gear
42	7D392	Gear — Forward Ring
43	7A166	Washer — Planet Carrier Thrust — #5
44	7A398	Planet Assy. — Forward
45	7D063	Gear Assy. — Sun
46	377300-S	Retainer — (Ret. 7D063 to 7D064) — Front
47	7D064	Shell — Input
48	7D066	Washer — Input Shell Thrust — #6
49	377300-S	Retainer — (Ret. 7D064 to 7D063) — Rear
50	377155-S	Ring — (Ret. 7D006 to 7D164)
51	7A166	Washer — Reverse Planet Carrier Thrust — #7 & #8
52	7D006	Planet Assembly — Reverse
53	387031-S5	Ring — (Ret. 7D164 to 7060)
54	7A153	Gear — Output Shaft Ring
55	7D164	Hub — Output Shaft
56	377132-S	Ring — Ret. 7A153 to 7D164)
57	7D422	Brg. Assy. — Output Shaft Hub Thrust — #9
58	7B067	Hub Assy. — Reverse Clutch
59	377135-S	Ring — (2 — Att 7A089 in 7B067 Assy.)
#60	7A089	Clutch Assy. — O/Run
61		
62		
63	385044-S	Ring — Ret. (Ret. 7B066 in 7005)
64	7B066	Plate — Reverse Clutch Pressure
65	7B442	Plate — External Spline Reverse Clutch (Steel)
66	7B164	Plate Assy. — Reverse Clutch Internal (Friction)
67	7E085	Spring — Reverse Clutch Pressure
68	7D403	Seal — Reverse Clutch Piston — Outer
69	7D404	Seal — Reverse Clutch Piston — Inner
▲70	7D171	Race — Overrunning Clutch — Inner — Serv. with (7D164) Hub
71	7D406	Retainer & Spring Assy. — Reverse Clutch
72	7D402	Piston — Reverse Clutch
73	7D167	Bolt — Overrunning Clutch to Case (5 Req'd)
74	57633-S2	Bolt — (4 — Att 7D027 to 7005)
▲75	7B148	Identification Tag — Model
76	7D027	Cover — Intermediate Band Servo

▲Not Serviced — (130, 131, 132, 133, 135 & 137 Serviced in 7A100)

#Service in Kits Only

★Part of 7A103 Assy.

CD10057-A

DESCRIPTION AND OPERATION (Continued)

Item No.	Part Number	Description
77	7D024	Seal - Intermediate Band Servo Cover Piston - Large
78	7D026	Gasket - Intermediate Band Servo Cover
79	7D021	Piston & Rod Assy. - Intermediate Band Servo
80	7D028	Spring - Intermediate Band Servo Piston
81	7060	Shaft Assy. - Output
82	7086	Gasket - Extension
▲83	7G496	Retainer - Vacuum Tube
▲83A	7G496	Retainer - Switch Wiring Harness
84	380209-S	Bolt - (4 - 7A039 to 7005)
85	7A039	Hsg. Extension - (4x2)
85A	7A309	Hsg. Extension - (4x4)
86	7A034	Bushing - Extension Housing
87	7052	Seal Assy. - Extension Hsg. Oil
88	380207-S2	Bolt - (2 - 7A039 to 7005) - 4x2 Only
88A	58642-S2	Bolt (2 - Att. 7A039 to 7005) 4x4 Only
89	7C063	Body Assy. - Governor
89A	34805-S8	Bolt - (4 - Att 7C063 to 7D220)
90	7D220	Body - Governor Oil Collector
91	7D011	Ring - Governor Seal (3 Req'd.)
91A	7D011	Cast Iron Seal Ring
91B	7D011	Teflon® Seal Ring
92	387035-S5	Ring - Retaining (Retain 7C063 to 7060)
93	7C232	Sleeve - Oil Distributor
94	20386-S8	Bolt - (4 - Att. 7C232 to 7005)
95	7D000-A	Tube - Oil Distributor - Inlet
96	7D000-B	Tube - Oil Distributor - Outlet
97	379058-S	Screw & Washer Assy. (Att. 7D419 to 7005)
#98	7D419	Plate - Park Rod Guide
99	7D070	Spring - Park Pawl Return
100	7A441	Pawl - Parking Brake
101	7D071	Shaft - Parking Pawl
102	7A233	Gear - Output Shaft Parking
103	7B368	Washer - Output Shaft Thrust Rear - #10
104	7005	Case Assy.
105	7034	Vent Assy. - Case
106	7D273	Connector Assy. - Oil Tube (2 Req'd)
107	33798-S8	Nut - 5/16-24 (att 7D261 to 7A394)
108	34806-S7	Washer - Hex Lock (Att 7D261 to 7A394)
109	7A394	Lever Assy. - Downshift Control - Outer
110	55651-S2	Screw & Washer Assy. (2 - Att. 7A247 to 7005)
111	7A247	Switch Assy. - Park/Neutral Position
112	386078-S	Seal - Throttle Contl Outer Lvr
113	7A256	Lever Assy. - Manual Control
114	7B498	Seal - Man. Contr. Lvr.
115	6572	Plug - Parking Plate Shaft
116	7D418	Shaft - Park Plate
117	7D414	Plate - Park Rod Support

Item No.	Part Number	Description
118	7D417	Spring - Park Plate Torsion
119	7A261	Spring Assy. - Manual Valve Detent Lvr.
120	56501-S2	Bolt - 1/4-20 x .50 Hex Flg (Att. 7E332 to 7005)
#121	7A115	Lever Assy. - Man Vlv Detent - Inner
122	380525-S	Nut - 9/16-18 Hex Lock (Att. 7A115 to 7A256)
123	7D261	Lever Assy. - Downshift Detent - Inner
#124	7D411	Rod - Parking Pawl Actuating
124A	87650-S	Pipe Plug - 1/8-27 Dryseal Tapered Thread (Used in Case for Measuring Pump Pressure)
124B	87650-S	Pipe Plug - 1/8-27 Dryseal (Used in Case for Measuring TV Pressure)
125	7A377	Diaphragm Assy. - TV Control
126	7A380	Rod - Throttle Control Valve
127	7F006	Clip - Diaphragm Retainer
128	7F013	Heat Shield - Vacuum Diaphragm
129	56119-S	Bolt - 5/16-18 x .82 Hex Flg Hd (Att 7F013, 7F006 & 7A377 to 7005)
129A	7A100	Control Assy. - Main
▲130	7D075	Stop - Downshift Lever - Inner
130A	7326	Rod - Gear Selector Valve
▲131	7A092	Body - Control Upper Valve
▲132	7C056	Reinforcement - Lower Valve Body Plt
▲133	7D259	Reinforcement - Lwr Vlv Body Sd Plt
134	7E387	Screen - Man Control Pump - Inlet
▲135	7A008	Plate - Control Valve Body Sep.
136	7D100	Gasket - Valve Body Sep Plate
▲137	7A101	Body - Control Lower Valve
138	7E062	Gasket - Oil Pan Screen
139	7A098	Screen Assy. - Oil Pan
139A	7A191	Gasket - Oil Pan
140	7A194	Oil Pan - (Shallow - 4x2)
		Oil Pan - (Deep - 4x4)
141	378782-S	Bolt - (17 - Att 7A264 to 7005)
142	7D080	Valve - Primary Throttle
143	87650-S	Plug - Conv. Drain - 1/8-27 Dryseal Tapered Thread
144	7A178	Screw - Rev. Band Adj.
145	375185-S100	Nut - (7A178 to 7005)
146	7330	Lever - Intermediate Band Servo
147	7E206	Retainer - Intermediate Servo Lever Shaft
148	7D433	Shaft - Intermediate Band Adjusting - Lever
▲149	378259	Plug - Cup
▲150	7D094	Plate - Throttle Press Booster Valve
150A	7D227	Spacer - Throt. Press. Vlv. - Secondary
▲151	7D058	Plate - Shift Valve
152	7A102	Tube - Main Control Lower Vlv. Bdy. Suction
153	7H183	Plug Assy. - Extension Housing (Used to Plug Speedo Gear Hole)
154	57621-S2	Screw & Washer Assy. - 1/4-20 x .62 (Retain 7H183 in 7A039)

▲Not Serviced - (130, 131, 132, 133, 135 & 137 Serviced in 7A100)

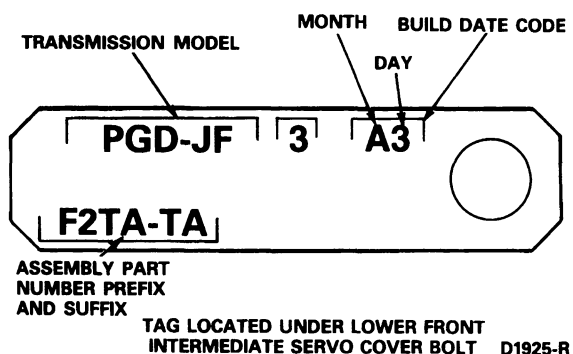
#Service in Kits Only

★Part of 7A103 Assy.

CD10058-B

DESCRIPTION AND OPERATION (Continued)

The identification tag is attached to the intermediate servo lower front cover bolt. The first line on the tag shows the transmission model prefix and suffix. A number appearing after the suffix indicates that the internal parts in the transmission have been changed after initial production start-up. For example, a PGD-JF model transmission that has been changed internally would read PGD-JF 1. Both transmissions are basically the same, but some service parts in the PGD-JF transmission are slightly different than the PGD-JF 1 transmission. **Therefore, it is important that the codes on the transmission identification tag be checked when ordering parts or making inquiries about the transmission.**



Hydraulic Control System, C6 Transmission



DIAGNOSIS AND TESTING

Troubleshooting the automatic transmission is simplified by using proven methods of diagnosis. One of the most important things to remember is that there is a definite procedure to follow. Do not try to short cut or take it for granted that someone else has done the critical checks or adjustments.

The following procedures are recommended for checking and / or verifying that the various components are adjusted and operating properly. If an Automatic Transmission Tester is used, Rotunda model 014-00737 or equivalent, follow the manufacturer's instructions.

DIAGNOSIS AND TESTING

Linkage Check

Accelerator Linkage and Operation

The linkage must be free and must return to idle when released. Refer to Section 10-02 for accelerator linkage adjustment.

Kickdown Linkage

With the accelerator pedal held in the wide-open throttle position (at the floor), check throttle body and linkage travel to be sure they have attained full wide-open throttle. The throttle stop must be contacted by the throttle linkage and there must be movement left in the downshift linkage. Be sure the downshift linkage return spring is connected and the downshift lever returns to a closed position.

For MFI system kickdown linkage procedures, refer to Section 10-02.

Manual Control Cable

This is a CRITICAL adjustment. Be sure the D detent in the transmission corresponds exactly with the D gatestop in the steering column or console. Refer to Section 07-05 for adjustment procedures. Hydraulic leakage at the manual valve can cause delay in engagements and / or slipping while operating if the linkage is not correctly adjusted. Please note that the column mounted PRNDL is adjustable. Once the shift cable has been properly adjusted, the PRNDL can be adjusted to correspond exactly to the shift cable adjustment.

Automatic Transmission, Fluid Checking and Adding Procedure

Under normal circumstances, you do not need to check the fluid level of the transmission, since your vehicle does not use up transmission fluid. However, if the transmission is not working properly — for instance, the transmission may slip or shift slowly, or you may notice some sign of fluid leakage — the fluid level should be checked.

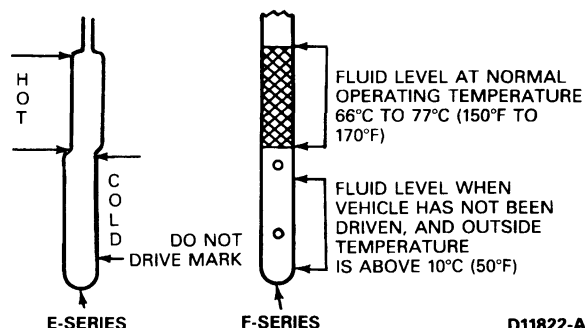
It is preferable to check the transmission fluid level at normal operating temperature, after approximately 32 km (20 miles) of driving. However, if necessary, you can check the fluid level without having to drive 32 km (20 miles) to obtain a normal operating temperature if outside temperatures are above 10°C (50°F).

NOTE: If the vehicle has been operated for an extended period at high speeds, in city traffic during hot weather, or pulling a trailer, the vehicle should be turned off for about 30 minutes to allow the fluid to cool before checking.

NOTE: Vehicles equipped with 4x4 applications must have the 4x4 shift selector in any position other than neutral.

1. With vehicle on a level surface, start the engine and move the transmission shift selector through all of the gear ranges allowing sufficient time for each position to engage. Securely latch the transmission shift selector in the park position, fully set the parking brake and leave the engine running.
2. Wipe off the dipstick cap, pull the dipstick out and wipe the indicator end clean. Put the dipstick back into the filler tube and make sure it is fully seated. Pull the dipstick out and read the fluid level.

When checking fluid at normal operating temperature, the fluid level should be within the crosshatched area (F-Series) or HOT area (E-Series) on the dipstick. When the vehicle has not been driven, and outside temperature is above 10°C (50°F), the fluid level should be between the holes (F-Series) or COLD area (E-Series) on the dipstick.



Ford automatic transmissions use Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid (E4AZ-19582-B) transmission fluid or equivalent. Before adding any fluid, be sure that the correct type will be used.

DIAGNOSIS AND TESTING (Continued)

Add fluid in .25L (1/2 pint) increments through the filler tube to bring the level to the correct area on the dipstick. If an overfill occurs, excess fluid should be removed by a qualified technician.

Refer to the specifications at the end of this section for automatic transmission fluid requirements and capacities.

Fluid Level High Before Starting Engine, OK During Normal Check

It is normal for the fluid level to be high prior to the engine starting. The torque converter will drain due to the absence of a drainback valve. All clutch assemblies of the transmission will drain to the sump also, causing fluid level to be high.

Transmission Fluid Condition Check

1. Make the normal fluid check according to the above procedure.
2. Observe color and odor of the fluid. It should be dark reddish not brown or black. A burnt odor can sometimes indicate that there is an overheating condition or clutch disc or band failure.
3. Use a clean, white lint-free rag to wipe the dipstick. Examine the stain for evidence of solids (specks of any kind) and for antifreeze signs (gum or varnish on dipstick).

NOTE: Fluid used with the automatic transmission contains a detergent which retains in suspension particles generated during normal transmission use. This characteristic may result in a dark coloring of the fluid and does not by itself indicate malfunction or need for repair.

If specks are present in the oil or there is evidence of antifreeze, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive solids in the oil pan, the transmission must be disassembled and completely cleaned and repaired. This includes cleaning the torque converter (if applicable) and transmission cooling system. It would be a waste of time to perform any further checks before cleaning and repairing the transmission.

During disassembly and assembly, all overhaul checks and adjustments of clearances and end play must be made.

Transmission Fluid Cooler Flow Check

NOTE: The linkage, fluid level and control pressure must be within specifications before performing this flow check.

1. Remove the transmission dipstick from the filler tube. Place a funnel in the transmission filler tube.
2. Raise the vehicle, remove the cooler return line from its fitting in the case. Attach a hose to the cooler return line and fasten the free end of the hose in the funnel installed in the filler tube.
3. Start the engine and set idle speed at 1000 rpm with the transmission in neutral.
4. Observe the fluid flow at the funnel. When the flow is "solid" (air bleeding has been completed), the flow should be liberal. (Fluid flow is considered "liberal" when at least 1/2 quart of fluid flows from tube within 30 seconds.) If there is not a liberal flow at 1000 rpm in neutral, low pump capacity, main circuit system leakage, or cooler system restriction is indicated.
5. Check both metal cooler lines between the transmission and radiator for restrictions. Check for restrictions in the metal or rubber cooler lines to and from the auxiliary cooler, if the vehicle is so equipped. Visually check and physically feel all bends for kinks, especially rubber cooler lines, that would restrict flow and could result in transmission overheating or lack of lubrication.

NOTE: To separate transmission trouble from cooler system trouble, observe the flow at the transmission case converter-out fitting.

High or Low Fluid Level

A fluid level that is too high will cause the fluid to become aerated. Aerated fluid will cause low control pressure, and the aerated fluid may be forced out the vent.

A fluid level that is too low can affect the operation of the transmission such as slippage or no engagement. Low level may indicate fluid leaks that could cause transmission damage.

Transmission Fluid Leakage Checks

1. Check the speedometer bore plug at the transmission extension housing. Replace or re-seal the plug if necessary.
2. Leakage at the oil pan gasket often can be stopped by tightening the attaching bolts to the proper torque. If necessary, replace the gasket.
3. Check the fluid filler tube connection at the transmission case. If leakage is found, install a new O-ring. The filler tube brackets, should align properly and be attached to the transmission or engine locations.

DIAGNOSIS AND TESTING (Continued)

4. Check the fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear or damage. If leakage is found, tighten the fitting, or replace the damaged parts.

Transmission	Radiator		Transmission		Fluid Line Nut	
	Ft-Lbs	N-m	Ft-Lbs	N-m	Ft-Lbs	N-m
C6	8-12	11-16	18-23	24-31	12-18	17-24

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NOTE: Do not mistake radiator rust inhibitor coating as evidence of transmission cooler leakage.

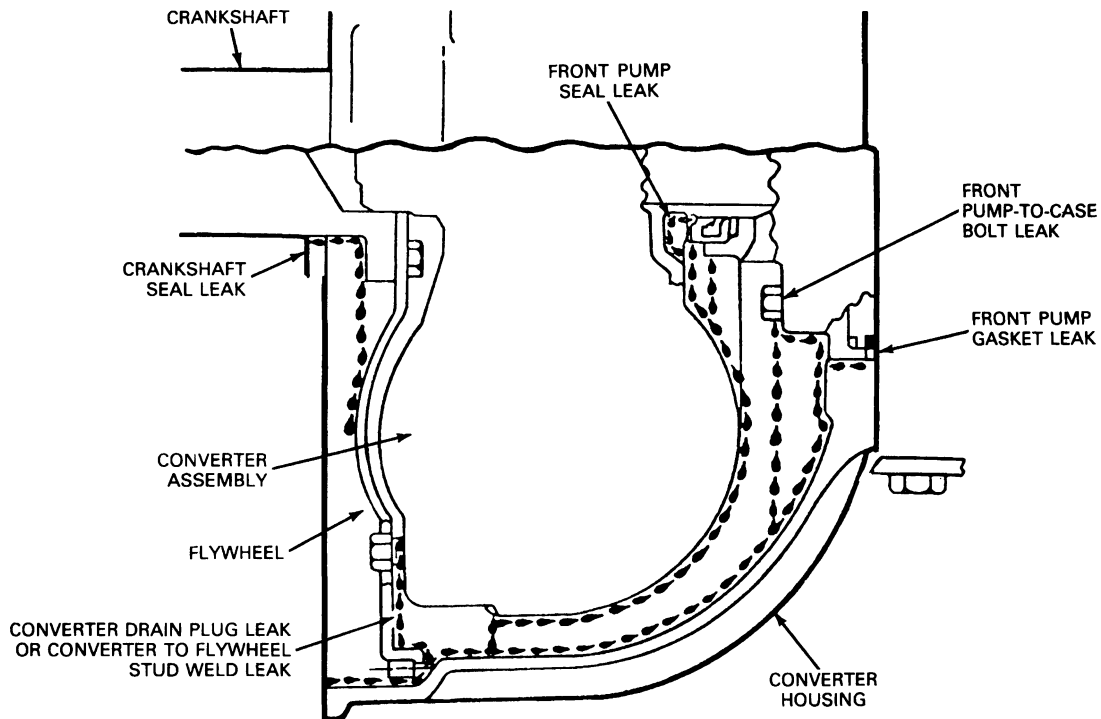
5. Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the cooler in the radiator is probably leaking.
- CAUTION: Do not remove a radiator cap from a hot cooling system. Allow vehicle cooling system to cool down before making the next leakage check.**
6. Check further for leaks by disconnecting the lines from the cooler fittings and applying 172-310 kPa (25-45 psi) air pressure to the fittings. Remove the radiator cap to relieve the pressure build up at exterior of the oil cooler tank. If the cooler is leaking and / or will not hold pressure (watch for bubbles through radiator cap opening), the cooler must be replaced. Cooler replacement is described in Section 03-03.
7. Replace either or both seals if leakage is found at either the downshift control lever shaft or the manual lever shaft.
8. Inspect the pipe plug on the left front side of the transmission case. If the plug shows leakage, tighten the plug to specifications. If leakage continues, replace the plug. Inspect the TV pressure plug on the right rear side of the case. If the plug shows leakage, coat the threads with Motorcraft Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7) or equivalent and tighten the plug to specification as listed at the end of the appropriate transmission section. If leakage continues, replace the plug.

When a converter drain plug leaks, remove the drain plug with a six-point wrench. Coat the threads with Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A) or equivalent and install the plug. Tighten the drain plug to 11-37 N-m (8-27 ft-lb). **Fluid leakage from the converter housing may also be caused by engine oil leaking past the rear main bearing, from oil galley plugs, power steering oil leakage from steering system or transmission front pump seal. Be sure to determine the exact cause of the leak before starting repair procedures.**

Oil-soluble aniline or fluorescent dyes premixed at the rate of 1/2 teaspoon of dye powder to 0.23 liter (1/2 pint) of transmission fluid have proved helpful in locating the source of fluid leakage. Such dyes may be used to determine whether an engine oil or transmission fluid leak is present, or if the fluid in the oil cooler leaks into the engine coolant system. A black light must be used with the fluorescent dye solution.

Fluid Leakage in Converter Area

In diagnosing and correcting fluid leaks in the front pump and converter area, use the following procedures to locate the exact cause of the leakage. Leakage at the front of transmission, evidenced by fluid around the converter housing, may have several sources. By careful observation it is possible, in many instances, to pinpoint the source of the leak before removing the transmission from the vehicle. The paths which the fluid takes to reach the bottom of the converter housing are illustrated.

DIAGNOSIS AND TESTING (Continued)**Converter Housing Fluid Leaks**

D2934-E

Fluid leaking by the front pump seal lip will tend to move along the drive hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the housing.

Fluid leakage by the outside diameter of the seal and front pump body will follow the same path which the leaks by the front pump seal follow.

Fluid that leaks by a front pump-to-case bolt will be deposited on the inside of the converter housing only. Fluid will not be deposited on the back of the converter.

Leakage by the front pump-to-case gasket may cause fluid to be deposited inside the converter housing, or it may seep down between the front of the case and converter housing.

Fluid leakage from the converter drain plugs or converter-to-flywheel stud weld will appear at the outside diameter of the converter on the back face of the flywheel, and in the converter housing only near the flywheel.

Engine oil leaks are sometimes improperly diagnosed as transmission front pump seal leaks. The following areas of possible leakage should also be checked to determine if engine oil leakage is causing the problem:

- a. Leakage at the rocker arm cover or rear intake manifold gasket may allow oil to flow over the converter housing or seep down between the converter housing and cylinder block, causing oil to be present in or at the bottom of the converter housing.
- b. Oil galley plug leaks will allow oil to flow down the rear face of the block to the bottom of the converter housing.
- c. Leakage by the crankshaft seal will work back to the flywheel, and then into the converter housing.

Fluid leakage from other areas, such as the power steering system forward of the transmission, could cause fluid to be present around the converter housing due to blow back or road draft. The following procedures should be used to determine the cause of the leakage before any repairs are made:

1. Remove the transmission dipstick and note the color of the fluid. Original factory-fill fluid is dyed red, to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the color should assist in pinpointing the leak. Since road draft may cause leaking power steering fluid to be present on the transmission, this leakage, if present, should be eliminated before checking the transmission for fluid leakage.

DIAGNOSIS AND TESTING (Continued)

2. Remove the converter housing cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case, and rear face of the engine and engine oil pan. Clean the converter area by washing with a suitable non-flammable solvent and blow dry with compressed air.
3. Wash out the converter housing, the front of the flywheel and the converter drain plugs. The converter housing may be washed out using cleaning solvent and a squirt-type oil can. Blow all washed areas dry with compressed air.
4. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist and run the engine at fast idle, then at engine idle, occasionally shifting to the drive and reverse ranges to increase pressure within the transmission. Observe the front of the flywheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

Converter Leakage Check

If welds on the torque converter indicate leakage, remove the converter and make the following check.

Assemble a Rotunda 021-00054 Torque Converter Leak Detector or an equivalent to the converter. Test the converter for leaks following the directions supplied with the detector kit.

Engine Idle Speed Check (with the Throttle Positioner Application)

If the idle speed is too low, the engine will run roughly. An idle speed that is too high will cause the vehicle to creep, have harsh engagements and harsh closed-throttle downshifts.

Refer to the Powertrain Control/Emissions Diagnosis Manual¹ if you suspect an idle problem.

On vehicles equipped with an Exhaust Gas Recirculation (EGR) system, it is important to check the system for proper operation and for restricted or leakage conditions.

Control Pressure Test

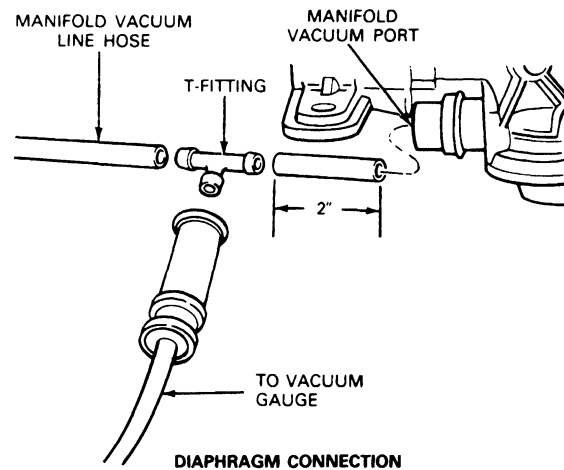
There are two methods of performing the control pressure test. One is to perform the test using the engine vacuum. The second method is to use a remote vacuum source such as the one provided in the distributor tester or a hand operated vacuum pump.

Engine Vacuum Pressure

When the vacuum diaphragm unit is operating properly and the manual and downshift linkage is adjusted properly, all the transmission shifts (automatic and kickdown) should occur within the road speed limits listed in the Technical Service Bulletin — Special Specifications Issue.

If the shifts do not occur within limits, or the transmission slips during shift point, use the following procedure to determine whether the engine, transmission, linkage, vacuum diaphragm unit or valve body is causing the condition.

1. Attach a tachometer to the engine and a vacuum gauge Rotunda Number 059-00008 or equivalent to the transmission vacuum line at the manifold vacuum port.

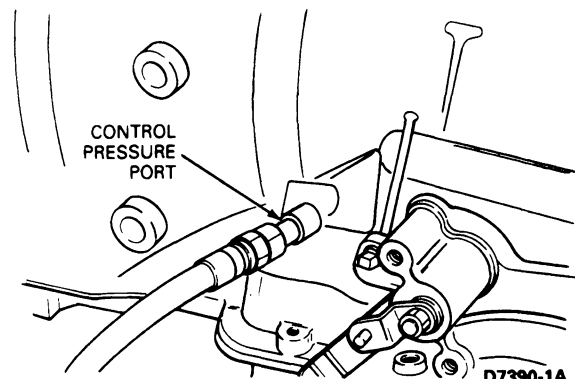


D7388-1A

2. Attach a pressure gauge to the control pressure outlet at the transmission.

CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken NOT to accelerate or decelerate rapidly. Possible transmission failure could result.

Control Pressure Connecting Point

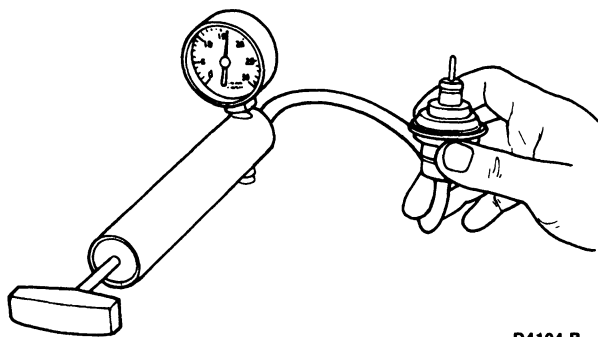


D7390-1A

¹ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

3. Firmly apply the parking brake and start the engine.
4. If the engine idle speed is not within specifications, refer to the Powertrain Control/Emissions Diagnosis Manual² for repair procedures. Also check throttle and downshift linkages for binding conditions. If linkage is satisfactory, check for vacuum leaks in the transmission diaphragm unit and its connecting tubes and hoses. Check all other vacuum operated units (such as the power brake) for vacuum leaks. Refer to the appropriate brake section in Group 06.

Testing Transmission Vacuum Unit for Leakage

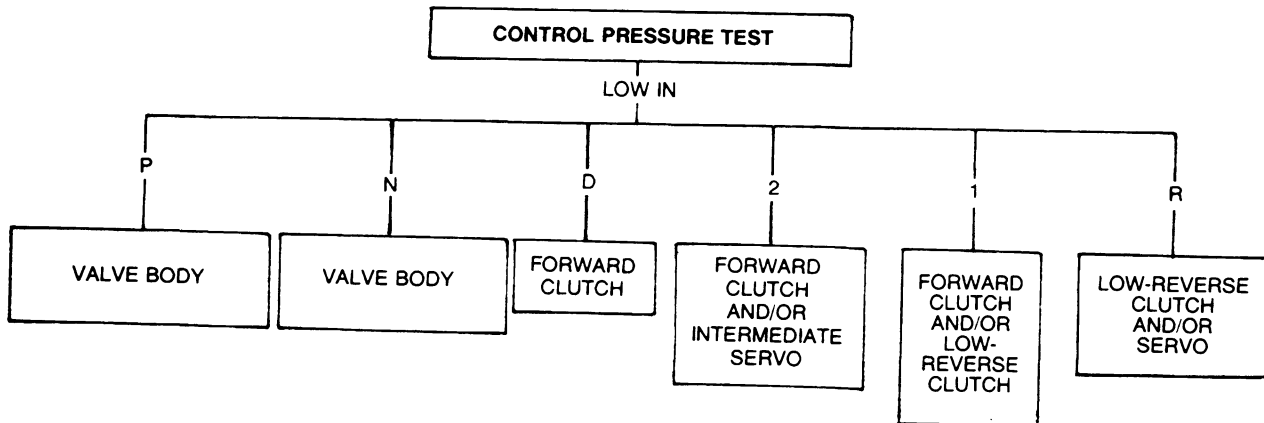
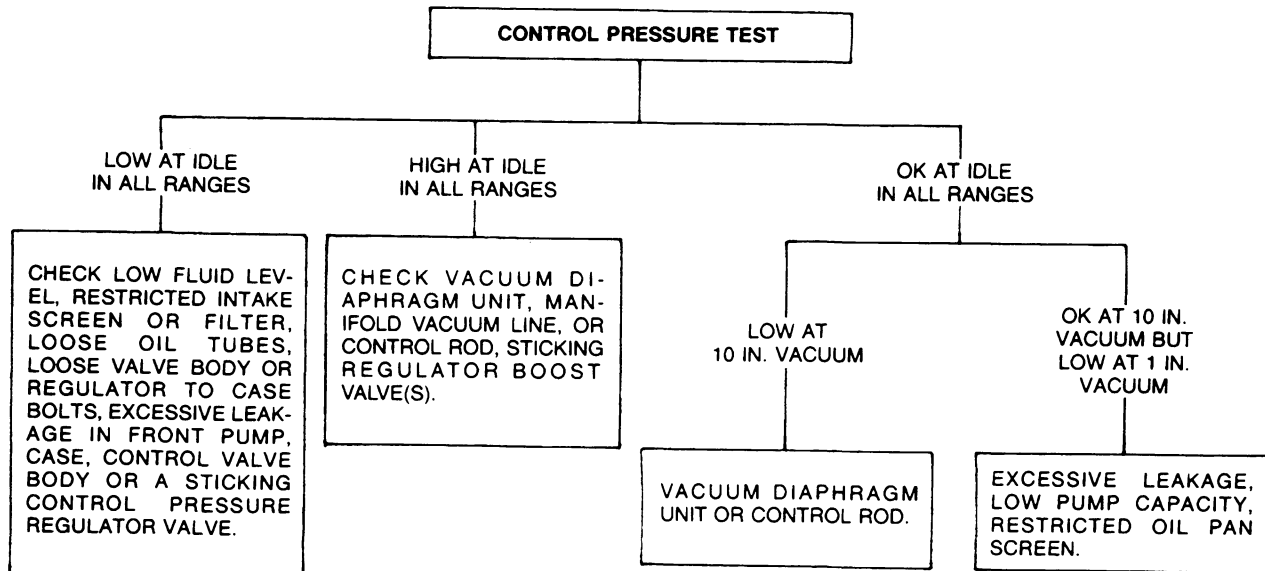
D4104-B

Refer to the two control pressure diagnostic guides to show what components are inoperative when the control pressure test is not within specifications. Do not proceed with the main diagnosis guide until you have made any repairs, as required, and the control pressure is within specifications as listed in the Technical Service Bulletin — Special Specifications Issue.

² Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Control Pressure Test Diagnostic Chart



CD2935-C

Vacuum Pump Method

1. Disconnect and temporarily plug the vacuum line at the vacuum diaphragm unit. Attach a vacuum pump to the vacuum diaphragm.
2. Apply both the parking and service brakes. Start the engine and vacuum pump.
3. Set the vacuum at 15 inches, read and record the control pressure in all selector positions. Run the engine up to 1000 rpm, and reduce the vacuum to 10 inches. Read and record the control pressure in D, 2 and 1. Keep the engine rpm at 1000 and reduce the vacuum to 1 inch. Read and record the control pressure in D, 1, 2 and R.

4. Refer to the two control pressure diagnostic guides in the Control Pressure Test chart to show what components are inoperative when the control pressure test is not within specifications. Do not proceed with the main diagnosis guide until you have made any repairs, as required, and the control pressure is within specifications as listed in the Technical Service Bulletin — Special Specifications Issue.

Vacuum Supply Test

The vacuum supply to the vacuum diaphragm unit and the diaphragm itself must be checked.

DIAGNOSIS AND TESTING (Continued)

1. Disconnect the vacuum line at the diaphragm unit and connect it to a vacuum gauge. With the engine idling, the gauge must have a steady acceptable vacuum reading for the altitude at which the test is being performed. If the vacuum reading is low, check for a vacuum leak. If the vacuum reading is OK, rapidly accelerate the engine momentarily while applying the service brake and with the transmission in PARK. The vacuum reading must drop rapidly at acceleration and return immediately upon release of the accelerator. If the vacuum reading does not change or changes slowly, the transmission vacuum line is plugged, restricted or connected to a reservoir supply.
2. Correct as required.

Vacuum Diaphragm Test, On-Vehicle

1. To check the vacuum diaphragm unit, start the vacuum pump and set the regulator knob so that the vacuum gauge reads 18 inches with the end of the vacuum hose blocked off.

2. Connect the vacuum hose to the diaphragm unit. If the gauge still reads 18 inches, the vacuum diaphragm unit is not leaking. If the reading does not remain at 18 inches, but drops, the vacuum diaphragm unit is leaking. Remove vacuum diaphragm heat shield and replace the vacuum diaphragm unit. Reinstall vacuum diaphragm heat shield.

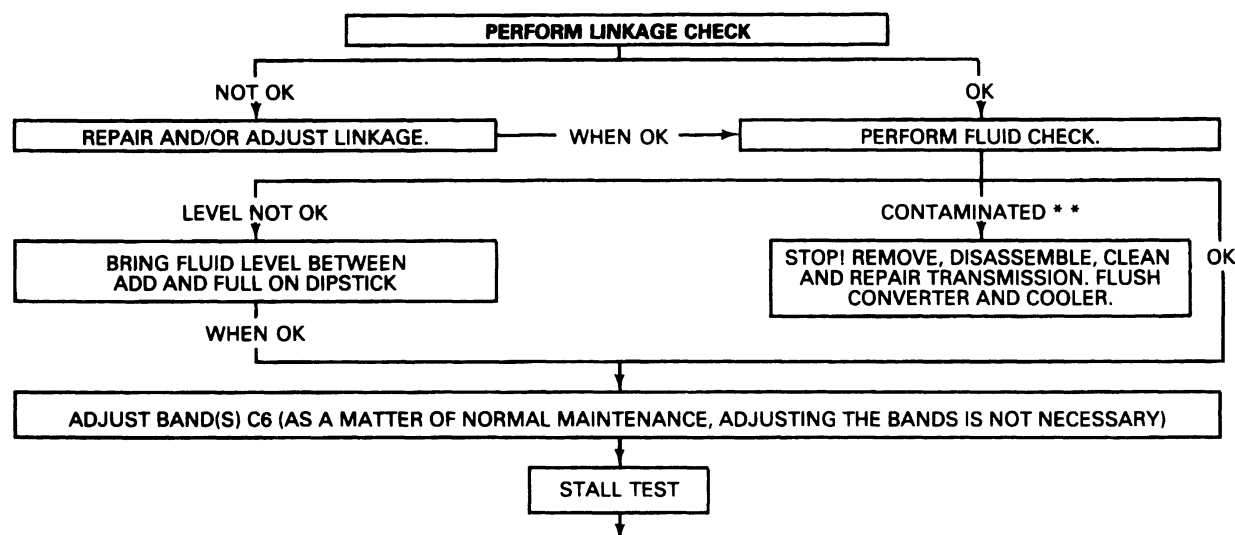
NOTE: If automatic transmission fluid is present in the vacuum side of the diaphragm or in the vacuum hose, the diaphragm is leaking and must be replaced.

Vacuum Diaphragm Test, Off Vehicle

1. To check the vacuum unit for diaphragm leakage, remove the unit from the transmission. Use a distributor tester equipped with a vacuum pump, Rotunda Vacuum Tester 021-00014 or equivalent. Set the regulator knob until the vacuum gauge reads 18 inches with the end of the vacuum hose blocked off.

DIAGNOSIS AND TESTING (Continued)

2. Connect the vacuum hose to the manifold vacuum port as shown previously. If the gauge still reads 18 inches, the vacuum unit diaphragm is not leaking. A second leakage check can be made as the hose is removed from the transmission vacuum unit. Hold a finger over the end of the control rod. When the hose is removed, the internal spring of the vacuum unit should push the control rod outward. If the vacuum diaphragm needs replacing, install a new unit modulator assembly that has been released for service. Reinstall the vacuum diaphragm heat shield. Vacuum diaphragm assembly identification is given at end of this section.



SELECTOR POSITION	STALL SPEEDS HIGH	STALL SPEEDS LOW
D ONLY	FORWARD CLUTCH OR PLANETARY ONE-WAY CLUTCH	CONVERTER STATOR ONE-WAY CLUTCH, INCORRECT CONVERTER OR ENGINE PERFORMANCE
D, 2 & 1	FORWARD CLUTCH OR ONE-WAY CLUTCH	CONVERTER STATOR ONE-WAY CLUTCH, INCORRECT CONVERTER OR ENGINE PERFORMANCE
D, 2, 1 & R	INCORRECT OR FAILED TORQUE CONVERTER	CONVERTER STATOR ONE-WAY CLUTCH, INCORRECT CONVERTER OR ENGINE PERFORMANCE
R ONLY	HIGH AND/OR REVERSE CLUTCH	CONVERTER STATOR ONE-WAY CLUTCH, INCORRECT CONVERTER OR ENGINE PERFORMANCE

** For definition of contamination see "Transmission Fluid Condition Check," in this section.

CD2828-H

DIAGNOSIS AND TESTING (Continued)

Governor Check

The governor can be checked at the same time as the Control Pressure Test is performed and in the same manner.

NOTE: Connect pump vacuum diaphragm with a hose long enough to reach up to the driver's seat.

1. Raise the vehicle with an axle or frame hoist so that the rear wheels are clear of the floor.
2. Disconnect and plug the vacuum line to the vacuum diaphragm unit. Connect Vacuum Pump D83L-7059-A or equivalent to the vacuum diaphragm unit.

CAUTION: Never exceed 96 km (60 mph) speedometer speed.

3. Place the transmission in D (drive), no load on the engine and apply 10 inches of vacuum to the vacuum diaphragm unit. Increase the speed slowly and watch the speedometer. Check the mph at which the control pressure cutback occurs. It should occur between 16-32 km (10-20 mph).

NOTE: After each test, move the selector to N (neutral) and run the engine at 1000 rpm to cool the transmission.

The governor is good if the cutback occurs within these specifications. If the cutback does not occur within specifications, check shift speeds to verify that it is the governor and not a stuck cutback valve, then repair or replace the governor.

Shift Point Checks

Road Test

This check will determine if the governor pressure and shift control valves are functioning properly.

Check the minimum throttle upshifts in D (drive). The transmission should start in first gear, shift to second, and then shift to third, within the shift points listed in Technical Service Bulletin — Special Specifications Issue.

With the transmission in third gear, depress the accelerator pedal through the detent (to the floor). The transmission should shift from third to second unless vehicle is traveling above downshift lock-out speed, or third to first, (perform at 15-20 mph).

Check the closed throttle downshift from third to first by coasting down from about 48 km (30 mph) in third gear. The shift should occur within the limits listed in the specifications.

When the selector lever is at 2 (second), the transmission can operate only in second gear.

With the transmission in third gear and road speed over 80 km (50 mph) the transmission should shift to second gear when the selector lever is moved from D (drive) to 2 (second) or 1 (first).

The transmission will downshift from second or third to first gear when this same manual shift is made below approximately 30 km (18 mph).

Refer to the band application chart to aid in diagnosis of transmission conditions.

C6 AUTOMATIC TRANSMISSION CLUTCH AND BAND APPLICATION SUMMARY							
Gear	Holding Members	Front Planetary Gearset			Rear Planetary Gearset		
		Driven	Held	Output	Driven	Held	Output
Manual Low 1	Forward Clutch Low-and-Reverse Clutch	Ring Gear	*Carrier	Sun Gear	Sun Gear	Carrier	Ring Gear
D Low	Forward Clutch One-way Clutch	Ring Gear	*Carrier	Sun Gear	Sun Gear	Carrier	Ring Gear
*The carrier is actually turning with the output shaft, but at a slower speed than the input.							
D Second or 2	Forward Clutch & Band	Ring Gear	Sun Gear	Carrier	EFFECTIVELY IN NEUTRAL		
High	Forward Clutch Reverse-and-High Clutch	Sun Gear Ring Gear	None	Carrier	TURNS AS A UNIT		
Reverse	Reverse-and-High Clutch Low-and-Reverse Clutch	EFFECTIVELY IN NEUTRAL			Sun Gear	Carrier	Ring Gear

CD5040-E

In Shop

Although a road test is more accurate, a shift test can be performed in the shop to check shift valve operation, governor circuits, shift delay pressures, throttle boost and downshift valve action.

1. Raise the vehicle with an axle or frame hoist so that the rear wheels are clear of the floor.

2. Disconnect and plug the vacuum line to the vacuum diaphragm unit. Connect the line from the distributor tester vacuum pump to the vacuum diaphragm unit.

CAUTION: Never exceed 96 km (60 mph) speedometer speed.

DIAGNOSIS AND TESTING (Continued)

3. To check the shift valves and governor circuits, apply 18 inches of vacuum to the transmission vacuum diaphragm unit. Place the transmission in Drive and make a minimum throttle 1-2 and 2-3 shift. At the shift points you will see the speedometer needle make a momentary surge and feel the driveline bump. Engine speed will also decrease as shown on the tachometer. If the shift points are within specification, the 1-2 and 2-3 shift valves and governor are OK.

If the shift points are not within specification, perform a Governor Check to isolate the problem.

NOTE: After each test, move the selector lever to Neutral, run the engine at 1000 rpm to cool the transmission.

4. To check the shift delay pressures and throttle boost, decrease the vacuum at the vacuum diaphragm to 0-2 inches. Make a part-throttle (not W.O.T.), 1-2 shift test. If the shift point raises to specification, the throttle boost and shift delay systems are functioning.
5. To check downshift valve action, leave the vacuum to the vacuum diaphragm at 0-2 inches. Position the downshift linkage in the wide open throttle position (through the detent) and repeat the 1-2 shift test. The speed at the shift point should be higher than the speed at which the 1-2 shift occurred during Step 2.

NOTE: Shift speed specifications can be found in the Technical Service Bulletin — Special Specifications Issue.

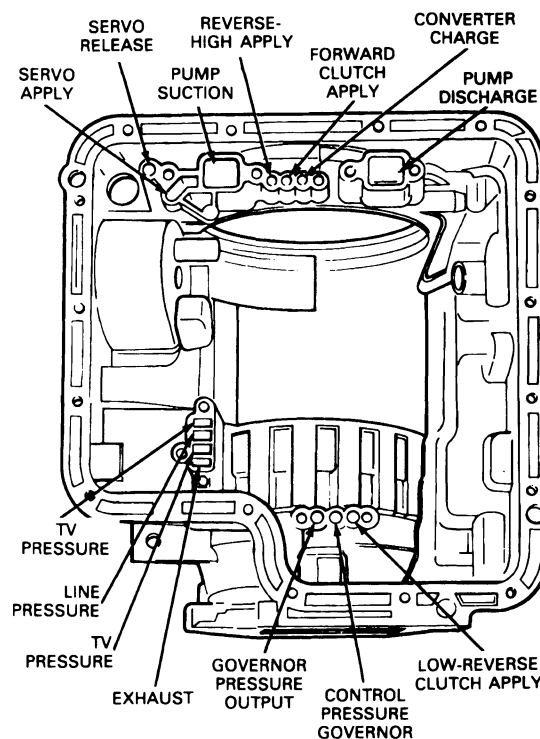
Air Pressure Checks

A no-drive condition can exist, even with correct transmission fluid pressure, because of inoperative clutches or bands. On automatic transmissions, an erratic shift can be caused by a stuck governor valve. The inoperative units can be located through a series of checks by substituting air pressure for fluid pressure to determine the location of the malfunction.

When the selector lever is at D (drive), 2 (second) or l (low) a no-drive condition may be caused by an inoperative forward or one-way clutch. Failure to drive in R (reverse) could be caused by a malfunction of the reverse-high clutch or low-reverse clutch.

NOTE: When you have a slip problem but don't know whether it is in the valve body or in the hydraulic system beyond the valve body, the air pressure tests can be very valuable.

To make the air pressure checks, loosen the oil pan bolts and lower one edge to drain the transmission fluid. Remove the oil pan and the control valve body assembly. The inoperative clutches or bands can be located by introducing air pressure into the various transmission case passages.

Case Fluid Passage Hole Identification

D7392-B

Forward Clutch

Apply air pressure to the transmission case forward clutch passages. A dull thud can be heard when the clutch piston is applied. If no noise is heard, place the finger tips on the input shell and again apply air pressure to the forward or front clutch passage. Movement of the piston can be felt as the clutch is applied.

Governor

Apply air pressure to the control pressure to governor passage and listen for a sharp clicking or whistling noise. The noise indicates governor valve movement.

Reverse-High Clutch

Apply air pressure to the reverse-high clutch. A dull thud indicates that the reverse-high or rear clutch piston has moved to the applied position. If no noise is heard, place the finger tips on the clutch drum and again apply air pressure to detect movement of the piston.

DIAGNOSIS AND TESTING (Continued)**Intermediate Servo**

Hold the air nozzle in the front servo apply tube or the intermediate servo apply passages. Operation of the servo is indicated by a tightening of the front or intermediate band around the drum. Continue to apply air pressure to the servo apply tube or passage, and introduce air pressure into the front release tube or the intermediate servo release passage. The front or intermediate servo should release the band against the apply pressure.

Low-Reverse Clutch

Apply air pressure to the low-reverse clutch apply passage. A dull thud should be heard if the clutch is operating properly. If the passages are clear, remove the clutch assemblies, clean and inspect the malfunctioning clutch to locate the trouble.

Diagnosis Guides

The diagnosis guides in this section can be used as an aid when diagnosing the C6 automatic transmission.

DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE SOURCE	ACTION
Slow initial engagement.	<ul style="list-style-type: none"> ● Improper fluid level. ● Damaged or improperly adjusted linkage. ● Contaminated fluid. ● Improper clutch and band application, or low main control pressure. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Service or adjust linkage. ● Perform fluid condition check. ● Perform control pressure test.
Rough initial engagement in either forward or reverse.	<ul style="list-style-type: none"> ● Improper fluid level. ● High engine idle. ● Check VRV for 7.3L Diesel, C6 applications. ● Looseness in the driveshaft, U-joints or engine mounts. ● Improper clutch or band application, or oil control pressure. ● Sticking or dirty valve body. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Adjust idle to specifications. Refer to the Powertrain Control/Emissions Diagnosis Manual. ● Adjust or replace VRV. ● Service as required. ● Perform control pressure test. ● Clean, service or replace valve body.
Harsh engagements — warm engine.	<ul style="list-style-type: none"> ● Improper fluid level. ● Engine curb idle too high. ● Check VRV for 7.3L Diesel, C6 applications. ● Valve body bolts — loose / too tight. ● Valve body dirty / sticking valves. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Check engine curb idle. Refer to the Powertrain Control/Emissions Diagnosis Manual³. ● Adjust or replace VRV. ● Tighten to specification. ● Determine source of contamination. Service as required.

³ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
No / delayed forward engagement (reverse OK).	<ul style="list-style-type: none"> Improper fluid level. Manual shift cable — misadjusted / damaged. Low main control pressure (leakage). Forward clutch stator support seal rings leaking (#3, #4). Forward clutch assembly burnt / damaged / leaking. Check ball in piston / leaking piston seals. Valve body bolts — loose / too tight. Valve body dirty / sticking valves. Transmission valve body screen plugged. Pump damaged / leaking. 	<ul style="list-style-type: none"> Perform fluid level check. Check and adjust or service as required. Control pressure test, note results. Perform air pressure test. Tighten to specification. Determine source of contamination. Service as required. Replace screen. Visually inspect pump gears. Replace pump if necessary.
No / delayed reverse engagement (forward OK).	<ul style="list-style-type: none"> Improper fluid level. Manual shift cable misadjusted / damaged. Low main control pressure in reverse. High reverse clutch OK. Reverse clutch assembly burnt / worn / leaking. Leaking check ball in high / reverse piston / leaking piston seals. Valve body bolts — loose / too tight. Valve body dirty / sticking valves. Transmission valve body screen plugged. Pump damaged. 	<ul style="list-style-type: none"> Perform fluid level check. Check and adjust or service as required. Control pressure test. Perform air pressure test. Tighten to specification. Determine source of contamination. Service as required. Replace screen. Visually inspect pump gears. Replace if necessary.
No / delayed reverse engagement and / or no engine braking in manual low.	<ul style="list-style-type: none"> Improper fluid level. Reverse-high or low-reverse piston seals, leaking. 	<ul style="list-style-type: none"> Perform fluid level check. Check and replace piston seal.
No engine braking in manual second gear.	<ul style="list-style-type: none"> Intermediate band out of adjustment. Improper band or clutch application, or oil pressure control system. Intermediate servo leaking. Polished or glazed band or drum. 	<ul style="list-style-type: none"> Adjust intermediate band. Perform control pressure test. Perform air pressure test of intermediate servo for leakage. Service as required. Service or replace as required.
Forward engagement slips / shudders / chatters.	<ul style="list-style-type: none"> Improper fluid level. Manual shift cable misadjusted / damaged. Low main control pressure. Valve body bolts — loose / too tight. Valve body dirty / sticking valves. Forward clutch piston ball check not seating / leaking. Forward clutch piston seals cut / worn. Low one-way clutch (planetary) damaged. 	<ul style="list-style-type: none"> Perform fluid level check. Check and adjust or service as required. Control pressure test. Tighten to specification. Determine source of contamination. Service as required. Replace forward clutch cylinder. Service transmission as required. Replace seals and service clutch as required. Determine cause of condition. Service as required.

DIAGNOSIS AND TESTING (Continued)**DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
Reverse shudders / chatters / slips.	<ul style="list-style-type: none"> ● Improper fluid level. ● Low main control pressure in reverse. ● Low-reverse clutch / leaking pressure. ● Low-reverse clutch or high-reverse clutch piston seals cut / worn. ● Looseness in the driveshaft, U-joints or engine mounts. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Control pressure test. ● Air pressure test; visually inspect seal rings and piston bore. ● Determine cause of condition. Service as required. ● Service as required.
No drive, slips or chatters in first gear in D. All other gears normal.	<ul style="list-style-type: none"> ● Low one-way clutch (planetary) damaged. 	<ul style="list-style-type: none"> ● Service or replace one-way clutch.
No drive, slips or chatters in second gear.	<ul style="list-style-type: none"> ● Intermediate band out of adjustment. ● Improper band or clutch application, or control pressure. ● Damaged or worn intermediate servo piston seals and / or internal leaks. ● Dirty or sticking valve body valves. ● Polished, glazed intermediate band or drum. 	<ul style="list-style-type: none"> ● Adjust intermediate band. ● Perform control pressure test. ● Perform air pressure test. ● Clean, service or replace valve body. ● Replace or service as required.
Starts up in 2nd or 3rd.	<ul style="list-style-type: none"> ● Improper band and / or clutch application, or oil pressure control system. ● Damaged or worn governor. Sticking governor primary valve. ● Valve body loose. ● Dirty or sticking valve body valves. ● Cross leaks between valve body and case mating surface. 	<ul style="list-style-type: none"> ● Perform control pressure test. ● Perform governor check. Replace or service governor, clean screen. ● Tighten to specification. ● Clean, service or replace valve body. ● Service or replace valve body and / or case as required.
Shift points incorrect.	<ul style="list-style-type: none"> ● Improper fluid level. ● Vacuum line damaged, clogged or leaks. ● Improper operation of EGR system. ● Improper speedometer gear installed. ● Improper clutch or band application, or oil pressure control system. ● Damaged or worn governor. ● TV control rod missing / incorrect length or vacuum diaphragm bent or leaks. ● Dirty or sticking valve body valves. ● Vacuum regulator valve (VRV) misadjusted or damaged (7.3L Diesel). 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Perform vacuum supply test. Check VRV adjustment on 7.3L Diesel. ● Service or replace as required. ● Replace gear. ● Perform shift test and control pressure test. ● Service or replace governor — clean screen. ● Replace. ● Clean, service or replace valve body. ● Check adjustment and function. Adjust or replace.

DIAGNOSIS AND TESTING (Continued)

DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
All upshifts harsh / delayed or no upshifts.	<ul style="list-style-type: none"> ● Improper fluid level. ● Manual shift cable — misadjusted / damaged ● Governor secondary valve sticking. ● Main control pressure too high. ● Valve body bolts — loose / too tight. ● Valve body dirty / sticking valves. ● Vacuum leak to diaphragm unit. ● Vacuum regulator valve misadjusted or damaged (7.3L Diesel). ● Downshift cable or lever damaged / stuck open. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Check and adjust or service as required. ● Perform governor test. Service as required. ● Control pressure test. Service as required. ● Tighten to specification. ● Determine source of contamination. Service as required. ● Check vacuum lines to diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. Check VRV adjustment on 7.3L Diesel, C6 application. ● Check adjustment and function. Adjust or replace. ● Replace / repair or adjust as required.
Mushy / early all upshifts / pile up upshifts.	<ul style="list-style-type: none"> ● Low main control pressure. ● Valve body bolts — loose / too tight. ● Valve body valve or throttle control valve sticking. ● Governor valve sticking. ● TV control rod too short. ● Vacuum regulator valve (VRV) misadjusted or damaged (7.3L Diesel). 	<ul style="list-style-type: none"> ● Control pressure test. Note results. ● Tighten to specification. ● Determine source of contamination. Service as required. ● Perform governor test. Repair as required. ● Install correct TV control rod. ● Check adjustment and function. Adjust or replace.
No 1-2 upshift.	<ul style="list-style-type: none"> ● Improper fluid level. ● For 7.3L Diesel VRV misadjusted or damaged. ● Manual shift cable — misadjusted / damaged. ● Governor valve sticking. Intermediate band out of adjustment. ● Vacuum diaphragm bent, sticking, leaks. ● Valve body bolts — loose / too tight. ● Valve body dirty / sticking valves. ● Intermediate band burnt and / or servo assembly leaking. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Check VRV for 7.3L Diesel. ● Check and adjust or service as required. ● Perform governor test. Service as required. Adjust intermediate band. ● Check diaphragm unit. Service as necessary. ● Tighten to specification. ● Determine source of contamination. Service as required. ● Perform air pressure test.

DIAGNOSIS AND TESTING (Continued)**DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
Rough / harsh / delayed 1-2 upshift.	<ul style="list-style-type: none"> ● Improper fluid level. ● Poor engine performance. ● Intermediate band out of adjustment. ● Main control pressure too high. ● Governor valve sticking. ● Engine vacuum leak. Vacuum line(s) not connected / damaged. ● Valve body bolts — loose / too tight. ● Valve body dirty / sticking valves. ● Vacuum regulator valve (VRV) misadjusted or damaged (7.3L Diesel). 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Tune engine. ● Adjust intermediate band. ● Control pressure test. Note results. ● Perform governor test. Service as required. ● Check engine vacuum lines. Service as necessary. Check vacuum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. ● Tighten to specifications. ● Determine source of contamination. Service as required. ● Adjust or replace VRV.
Mushy / early / soft / slipping 1-2 upshift.	<ul style="list-style-type: none"> ● Improper fluid level. ● Incorrect engine performance. ● Intermediate band out of adjustment. ● Low main control pressure. ● Valve body bolts — loose / too tight. ● Valve body dirty / sticking valves. ● Governor valve sticking. ● Damaged intermediate servo or band. ● Polished, glazed band or drum. ● Vacuum regulator valve (VRV) misadjusted or damaged (7.3L Diesel). 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Tune adjust engine idle as required. ● Adjust intermediate band. ● Control pressure test. Note results. ● Tighten to specification. ● Determine source of contamination. Service as required. ● Perform governor test. Service as required. ● Perform air pressure test. Service as required. ● Service or replace as required. ● Adjust or replace VRV.
No 2-3 upshift.	<ul style="list-style-type: none"> ● Low fluid level. ● For 7.3L Diesel, C6 application — VRV misadjusted or damaged. ● Low main control pressure to direct clutch. ● Valve body bolts — loose / too tight. ● Valve body dirty / sticking valves. ● Direct clutch plates or assembly burnt / worn. Piston seals damaged. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Check VRV for 7.3L Diesel. ● Control pressure test. Note results. ● Tighten to specification. ● Determine source of contamination. Service as required. ● Determine cause of condition. Service as required.

DIAGNOSIS AND TESTING (Continued)**DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
Harsh / delayed 2-3 upshift.	<ul style="list-style-type: none"> Incorrect engine performance. Engine vacuum leak. Vacuum line(s) not connected / damaged. Damaged or worn intermediate servo release and high clutch piston check ball. Valve body bolts — loose / too tight. Vacuum diaphragm or TV control rod bent, sticking, leaks. Vacuum regulator valve misadjusted or damaged (7.3L Diesel). 	<ul style="list-style-type: none"> Check engine tune-up. Check engine vacuum lines. Service as necessary. Check vacuum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. Check VRV for 7.3L Diesel. Air pressure test the intermediate servo apply and release the high clutch piston check ball. Service as required. Tighten to specification. Check diaphragm and rod. Replace as necessary. Check adjustment and function. Adjust or replace.
Soft / early / mushy 2-3 upshift.	<ul style="list-style-type: none"> Valve body bolts — loose / too tight. Valve body dirty / sticking valves. Vacuum diaphragm or TV control rod bent, sticking, leaks. Vacuum regulator valve (VRV) misadjusted or damaged (7.3L Diesel). 	<ul style="list-style-type: none"> Tighten to specification. Determine source of contamination. Service as required. Check diaphragm and rod. Replace as necessary. Check adjustment and function. Adjust or replace.
Erratic shifts.	<ul style="list-style-type: none"> Poor engine performance. Valve body bolts — loose / too tight. Valve body dirty / sticking valves. Governor valve sticking. Output shaft collector body seal rings damaged. 	<ul style="list-style-type: none"> Check engine tune-up. Tighten to specification. Line pressure test, note results. Determine source of contamination. Service as required. Perform governor test. Service as required. Service as required.
Shifts 1-3 in D.	<ul style="list-style-type: none"> Intermediate band out of adjustment. Damaged intermediate servo and / or internal leaks. Improper band or clutch application, or oil pressure control system. Polished, glazed band or drum. Dirty or sticking valve body valves. Governor valve stuck. 	<ul style="list-style-type: none"> Adjust band. Perform air pressure test. Service front servo and / or internal leaks. Perform control pressure test. Service or replace band or drum. Clean, service or replace valve body. Perform governor test. Service as required.
Engine over-speeds on 2-3 shift.	<ul style="list-style-type: none"> Band or direct clutch worn or glazed. Improper band or clutch application, or oil pressure control system. Intermediate servo piston worn / cut / leaking. Dirty or sticking valve body valves. Vacuum regulator valve (VRV) misadjusted or damaged (C6 with 7.3L diesel). 	<ul style="list-style-type: none"> Service or replace. Perform control pressure test. Replace seals. Check for leaks. Clean, service or replace valve body. Check VRV.

DIAGNOSIS AND TESTING (Continued)**DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
Rough / shudder 3-1 shift at closed throttle in D.	<ul style="list-style-type: none"> ● Incorrect engine idle or performance. ● Improper downshift shift cable adjustment. ● Improper clutch or band application or oil pressure control system. ● Improper governor operation. ● Dirty or sticking valve body valves. 	<ul style="list-style-type: none"> ● Tune, and adjust engine idle. Refer to the Powertrain Control / Engine Emissions Diagnosis Manual. Can be purchased as a separate item. ● Service or adjust shift cable. Check VRV for 7.3L Diesel. ● Perform control pressure test. ● Perform governor test. Service as required. ● Clean, service or replace valve body.
No forced downshifts.	<ul style="list-style-type: none"> ● Kickdown cable or rod out of adjustment. ● Damaged internal kickdown linkage. ● Improper clutch or band application, or oil pressure control system. ● Dirty or sticking governor. ● Dirty or sticking valve body. 	<ul style="list-style-type: none"> ● Service or adjust cable or rod. ● Service internal kickdown linkage. ● Perform control pressure test. ● Perform governor test. Service or replace governor, clean screen. ● Clean, service, or replace valve body.
Engine over-speeds on 3-2 downshift.	<ul style="list-style-type: none"> ● Intermediate band out of adjustment. ● Improper band or clutch application, and one-way clutch, or oil pressure control system. ● Damaged or worn intermediate servo piston. ● Polished, glazed band or drum. ● Dirty or sticking valve body. 	<ul style="list-style-type: none"> ● Adjust intermediate band. ● Perform control pressure test. Service clutch. ● Air pressure test check the intermediate servo. Service servo. ● Service or replace as required. ● Clean, service, or replace valve body.
Shift efforts high.	<ul style="list-style-type: none"> ● Manual lever shift cable damaged / misadjusted. ● Inner manual lever nut loose. ● Manual lever retainer pin damaged. 	<ul style="list-style-type: none"> ● Check and adjust or service as required. ● Tighten nut to specification. ● Adjust linkage and install new pin.
Transmission overheats.	<ul style="list-style-type: none"> ● Improper fluid level. ● Incorrect engine idle, or performance. ● Improper clutch or band application, or oil pressure control system. ● Restriction in cooler or lines. ● Seized converter one-way clutch. ● Dirty or sticking valve body valves. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Tune or adjust engine idle. Refer to the Powertrain Control / Engine Emissions Diagnosis Manual. Can be purchased as a separate item. ● Perform control pressure test. ● Service restriction. ● Replace one-way clutch. ● Clean, service or replace valve body.
Transmission leaks.	<ul style="list-style-type: none"> ● Case breather vent. ● Leakage at gasket, seals, etc. 	<ul style="list-style-type: none"> ● Check the vent for free breathing. Repair as required. ● Remove all traces of lube on exposed surfaces of transmission. Check the vent for free breathing. Operate transmission at normal temperatures and perform fluid leakage check. Service as required.
Poor vehicle acceleration.	<ul style="list-style-type: none"> ● Poor engine performance. ● Torque converter one-way clutch slipping. 	<ul style="list-style-type: none"> ● Check engine tune up. Refer to the Powertrain Control / Engine Emissions Diagnosis Manual. Can be purchased as a separate item. ● Replace torque converter.

DIAGNOSIS AND TESTING (Continued)

DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
Transmission noisy — valve resonance. NOTE: Gauges may aggravate any hydraulic resonance. Remove gauge and check for resonance level.	<ul style="list-style-type: none"> ● Improper fluid level. ● Linkage out of adjustment. ● Improper band or clutch application, or oil pressure control system. ● Cooler lines grounding. ● Dirty or sticking valve body valves. ● Internal leakage or pump cavitation. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Service or adjust linkage. ● Perform control pressure test. ● Free up cooler lines. ● Clean, service or replace valve body. ● Service as required.
Vehicle will not start. NOTE: For 7.3L Diesel Engines equipped with C6 Transmission, refer to the appropriate portion of Group 03 for additional information.	<ul style="list-style-type: none"> ● Misadjusted PNP switch. ● Misadjusted ignition switch. ● Defective ignition switch. ● Defective PNP switch. 	<ul style="list-style-type: none"> ● Adjust PNP switch. ● Adjust ignition switch. ● Replace ignition switch. ● Replace PNP switch.

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TRANSMISSION NOISE — OTHER THAN VALVE RESONANCE — TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	VERIFY NOISE		
	<ul style="list-style-type: none"> ● Check for gear noise to verify if within normal range. ● Is noise within normal range? 	Yes No	Normal condition. GO to A2.
A2	MANUAL LEVER SHIFT CABLE CHECK		
	<ul style="list-style-type: none"> ● Check cable for proper adjustment, wear or damage. ● Is shift cable OK? 	Yes No	GO to A3. SERVICE, REPLACE and/or ADJUST cable as required.
A3	FLUID CHECK		
	<ul style="list-style-type: none"> ● Check the fluid for proper level and / or contamination. NOTE: For definition of contamination, refer to Transmission Fluid Condition Check in the Diagnosis and Testing portion of this section.	Fluid level between ADD and FULL marks Fluid level beneath ADD mark Fluid contaminated	GO to A4. ADD specified fluid to bring level between ADD and FULL marks with vehicle at operating temperature. GO to A4. DISASSEMBLE, CLEAN and SERVICE transmission. FLUSH torque converter and backflush cooler system.
A4	STALL TEST		
	<ul style="list-style-type: none"> ● Perform the Stall Test as described under Stall Test in the Diagnosis and Testing portion of this section. ● Does noise stop? 	Yes No	GO to A5. EXAMINE torque converter and pump. SERVICE or REPLACE as required. Also CHECK for loose torque converter to flywheel bolts or nuts.

DIAGNOSIS AND TESTING (Continued)**TRANSMISSION NOISE — OTHER THAN VALVE RESONANCE — TEST A (Continued)**

TEST STEP		RESULT	ACTION TO TAKE
A5	NOISE CHECK		
<ul style="list-style-type: none"> Run transmission in all gears and check for noise. 		Noise loud in D (drive) 1st gear, or L (low) 1st gear	SERVICE both planet assemblies.
		Noise loud in 2 (second)	SERVICE front planet assembly.
		Noise loud in D (drive) 3rd gear	Problem not in transmission. REFER to Section 00-04.
		Noise loud in R (reverse)	SERVICE rear planet assembly.

REMOVAL AND INSTALLATION**Transmission Fluid Drain and Refill**

Normal maintenance and lubrication requirements do not necessitate periodic automatic transmission fluid changes.

If a major repair, such as a clutch band, bearing, etc., is required in the transmission, it will have to be removed for service. At this time the converter, transmission cooler(s) and cooler lines must be thoroughly back-flushed to remove any dirt. Refer to procedure in this section.

When used under continuous or severe conditions, the transmission and the torque converter should be drained and refilled with the specified fluid at intervals directed in the maintenance or owner's manual.

Refer to the Truck Performance Specifications Book or the end of this section for fluid requirements.

NOTE: Fluid level indicator should be used to determine actual fluid requirements. Check fluid level when the transmission is at normal operating temperature. Do not overfill.

Procedures for partial drain and refill, due to in-vehicle repair operation, are as follows:

1. Raise the vehicle on a hoist and position safety stands under vehicle.
2. Place a drain pan under the transmission.
3. Loosen the pan attaching bolts and drain the fluid from the transmission.
4. When fluid has drained to the level of the pan flange, remove the rest of the pan bolts working from the rear and both sides of the pan to allow it to drop and drain slowly.
5. When all fluid has drained from the transmission, remove and thoroughly clean the pan and the screen. Discard the pan gasket.
6. Place a new gasket on the pan, and install the pan on the transmission. Tighten the bolts to 11-16 N·m (8-12 ft·lb).

7. Remove safety stands and lower vehicle.
8. Add 4.7 liters (5 quarts) shallow pan or 5.6 liters (6 quarts) deep pan of fluid to the transmission through the filler tube.
9. Check the fluid level.

If it is necessary to perform a complete drain and refill, it will be necessary to remove the residual fluid from the torque converter and the cooler lines.

NOTE: It is recommended that this procedure be performed prior to other operations to allow sufficient time for the converter to drain properly.

1. Remove the converter housing access cover from the lower end of the converter housing.
2. Rotate the torque converter until the drain plug comes into view.
3. Remove the drain plug and allow the transmission fluid to drain.
4. Flush the cooler lines completely as described in this section.
5. When adding fluid, fill to the capacity required for that transmission.

Fluid Cooler Lines

When fluid leakage is found from the fluid cooler, the cooler must be replaced. Cooler replacement is described in Section 03-03.

When one or more of the fluid cooler steel tubes must be replaced, each replacement tube must be fabricated from the same size steel tubing as the original line.

Using the old tube as a guide, bend the new tube as required. Add the necessary fittings, and install the tube.

After the fittings have been tightened, add fluid as needed, and check for fluid leaks.

REMOVAL AND INSTALLATION (Continued)**Transmission F-150-250-350 4x2 and 4x4****Removal**

1. Drive the vehicle on a hoist, but do not raise at this time. Disconnect the battery negative cable. Disconnect park neutral position switch (PNP)(7A247) wire at the plug connector.
2. Raise the vehicle on a hoist and position safety stands under vehicle.
3. Place the drain pan under the transmission fluid pan. Carefully loosen the bolts holding the transmission pan to drain the fluid from the transmission.
4. Remove the converter drain plug access cover from the lower end of the converter housing.
5. Remove the converter-to-flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the bump switch.
6. With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to the converter drain plug. Place a drain pan under the converter to catch the fluid and remove the plug. After the fluid has been drained, re-install the plug.
7. On 4x2 applications, disconnect the driveshaft from the rear axle and slide shaft rearward from the transmission. Install a seal installation tool, or suitable plug, in the extension housing to prevent fluid leakage.
8. Disconnect the downshift and manual linkage rods or cable controls from the levers at the transmission. Disconnect PNP switch electrical connector.
9. Disconnect the oil cooler lines from the transmission.
10. Remove the vacuum hose from the vacuum diaphragm unit. Remove the vacuum line from the retaining clip.
11. Disconnect the cable from the terminal on the starter motor. Remove the three attaching bolts and remove the starter motor.
12. On F-Series 4x4 and Bronco vehicles, remove the transfer case. Refer to Sections 07-07A and 07-07B.
13. Remove the two engine rear support and insulator assembly-to-attaching bolts.
14. Remove the two engine rear support and insulator assembly-to-extension housing attaching bolts.
15. Remove the six bolts securing the No. 2 crossmember to the frame side rails.
16. Raise the transmission with Rotunda Transmission Jack 077-00019 or equivalent and remove the crossmember.
17. Secure the transmission to the jack with the safety chain.
18. Remove the transmission case-to-engine attaching bolts.

19. Move the transmission away from the engine. Lower the jack and remove the converter and transmission assembly from under the vehicle.

Installation

1. Tighten the converter drain plug to 11-37 N-m (8-27 ft-lb).
2. Position the converter on the transmission making sure the converter drive flats are fully engaged in the pump gear.
3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with the chain.
4. Rotate the converter until the studs and drain plug are in alignment with their holes in the flywheel.
5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot. **The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft. Do not allow converter drive flats to disengage from pump gear.**
6. Install and tighten the transmission-to-engine attaching bolts to 55-67 N-m (40-50 ft-lb) on gasoline engines and 68-88 N-m (50-65 ft-lb) on diesel engines.
7. Remove the transmission jack safety chain from around the transmission.
8. Position the No. 2 crossmember to the frame side rails. Install and tighten the attaching bolts to specifications as listed at the end of this section.
9. Install transfer case on F-Series 4x4 and Bronco. Refer to Sections 07-07A and 07-07B.
10. Position the engine rear support and insulator assembly above the crossmember. Install the rear support and insulator assembly-to-extension housing mounting bolts and tighten the bolts to specifications as listed at the end of this section.
11. Lower the transmission and remove the jack.
12. Secure the engine rear support and insulator assembly to the crossmember with the attaching bolts and tighten them to specifications as listed at the end of this section.
13. Connect the vacuum line hose to the vacuum diaphragm making sure that the steel vacuum line is in the retaining clip.
CAUTION: Make sure the vacuum line has not been pinched or damaged during transmission installation.
14. Connect the oil cooler lines to the transmission.
15. Connect the downshift and manual linkage rods or cable controls to their respective levers on the transmission. Refer to Section 07-05.
16. Secure the starter motor in place with the attaching bolts. Connect the cable to the terminal on the starter.

REMOVAL AND INSTALLATION (Continued)

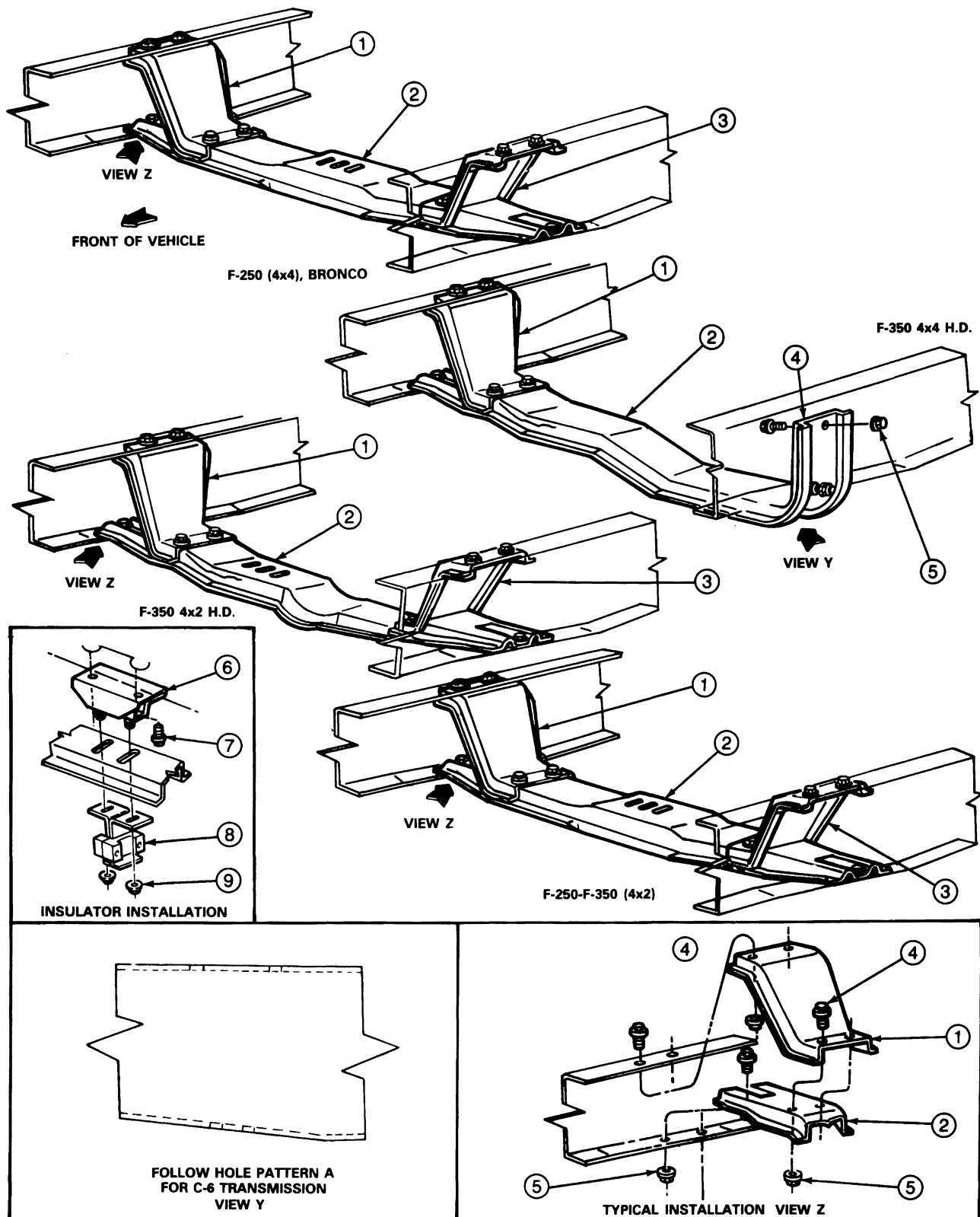
17. Install a new O-ring on the lower end of the transmission filler tube and insert the tube in the case.
18. Secure the converter-to-flywheel attaching nuts and tighten them to 28-45 N-m (20-34 ft-lb).
19. Install the converter housing access cover and secure it with the attaching bolts.
20. Connect the driveshaft.
21. Fill the transmission to the proper level with the specified fluid.
22. Adjust the shift linkage as required. Refer to Section 07-05. Connect park neutral position switch electrical connector.

23. Remove safety stands and lower vehicle.
24. Connect the battery negative cable.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM)(12A650) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

REMOVAL AND INSTALLATION (Continued)

Crossmember Installation F-250-350 4x2 and 4x4



D7421-D

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	7R314	Gusset (RH)
2	5060	Crossmember
3	7F468	Gusset (LH)
4	802114	Bolt
5	800937	Nut 58-77 N·m (43-57 Ft·Lb)

(Continued)

Item	Part Number	Description
6	6D091	Insulator; Rear Support
7	388824	Bolt 81-108 N·m (60-80 Ft·Lb)
8	4A263	Damper
9	—	Nut 96-128 N·m (70-94 Ft·Lb)

Transmission, E-150-250-350**Removal**

1. Disconnect the battery negative cable.
2. Working from inside the vehicle, remove the engine compartment cover.
3. Disconnect the park neutral position switch electrical connector.
4. If the vehicle is equipped with a V-8 engine, remove the flex hose from the air cleaner heat tube.
5. Remove the bolt securing the oil fill tube to the engine.
6. Raise the vehicle on a hoist and position safety stands under vehicle.
7. Place the drain pan under the transmission fluid pan. Carefully loosen the bolts holding the transmission pan to drain the fluid from the transmission.
8. Remove the converter drain plug access cover from the lower end of the converter housing.
9. Remove the converter-to-flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the nuts.
10. With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to the converter drain plug. Place a drain pan under the converter to catch the fluid. Then, remove the plug. With fluid drained, re-install the plug.
11. Disconnect the driveshaft from the rear axle flange and remove from the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original positions.
12. Remove transmission fluid filler tube.
13. Disconnect the starter cable at the starter. Remove the starter-to-converter housing attaching bolts and remove the starter.
14. Position an appropriate engine support bar to the frame and engine oil pan flanges.
15. Disconnect the cooler lines from the transmission. Disconnect the vacuum line from the vacuum diaphragm unit. Remove the vacuum line from the retaining clip at the transmission.

16. Disconnect the manual and downshift linkage rods or cable controls from the transmission control levers.
17. Position Rotunda Transmission Jack 077-00019 or equivalent to support the transmission. Install the safety chain to hold the transmission.
18. Remove the nuts securing the rear support and insulator assembly to the crossmember. Remove the six bolts retaining the crossmember to the side rails and remove the two support gussets. Raise the transmission with the jack and remove the crossmember.
19. Remove the converter housing-to-engine attaching bolts. Lower the jack and remove the converter and transmission assembly from under the vehicle.
20. Remove the converter and mount the transmission in a holding fixture.

Installation

1. Tighten the converter drain plug to 11-37 N·m (8-27 ft·lb).
2. Position the converter on the transmission making sure the converter drive flats are fully engaged in the pump gear.
3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with the safety chain.
4. Rotate the converter until the studs and drain plug are in alignment with their holes in the flywheel.
5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot.

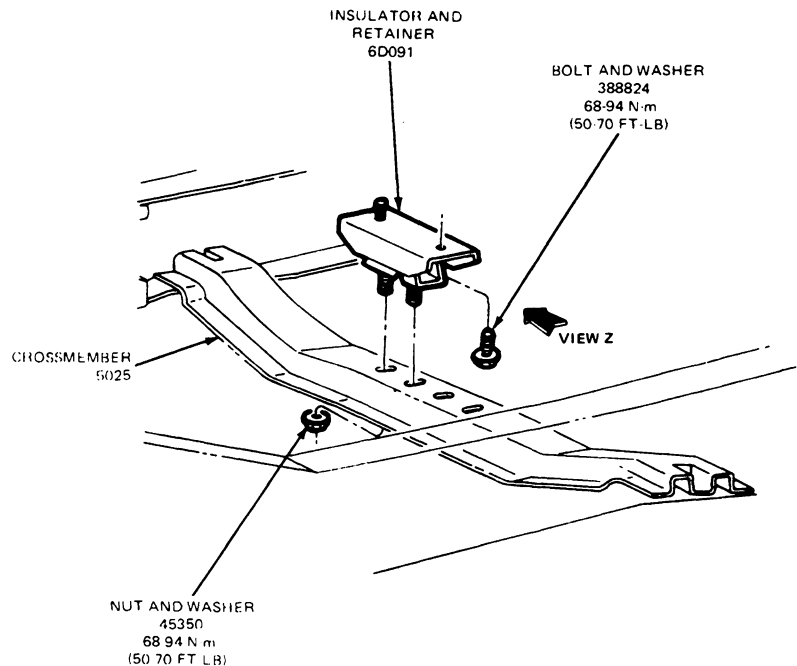
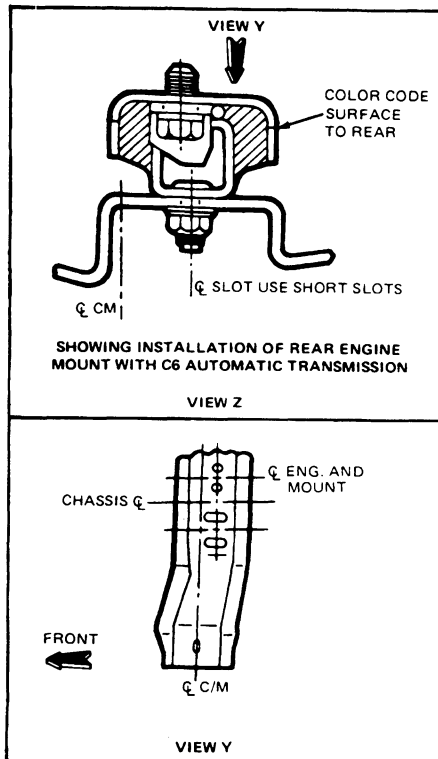
The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft. Do not allow converter drive flats to disengage from pump gear.

6. Install the converter housing-to-engine attaching bolts. Tighten the bolts to 55-67 N·m (40-50 ft·lb) on gasoline engines and 67-87 N·m (50-65 ft·lb) on diesel engines. Install the converter-to-flywheel attaching nuts. Tighten the nuts to 28-40 N·m (20-30 ft·lb).
7. Install the crossmember. Install the rear support and insulator assembly-to-crossmember attaching bolts and nuts. Tighten the bolts to specifications as listed at the end of this section.

REMOVAL AND INSTALLATION (Continued)

8. Remove the safety chain and remove the jack from under the vehicle. Remove the engine support bar.
9. Install a new O-ring on the lower end of the transmission filler tube and insert the tube and dipstick in the case.
10. Connect the vacuum line hose to the vacuum diaphragm making sure the steel vacuum line is secured in the retaining clip.
11. Connect the cooler lines to the transmission.
12. Connect the transmission shift cable to the transmission control levers. When making transmission control attachments new retaining ring and grommet should always be used (see Removal and Installation in Section 07-05). Note precautions necessary to prevent grommet damage. Perform a linkage adjustment as outlined in Section 07-05.
13. Install the converter housing access cover and tighten the attaching bolts to 17-21 N·m (12-16 ft·lb) for all except 7.5L engine application. Tighten to 4-7 N·m (35-54 in·lb) for 7.5L engine applications.
14. Position the starter into the converter housing and install the attaching bolts. Tighten the bolts to 54-68 N·m (40-50 ft·lb) on gasoline engines and 68-88 N·m (50-65 ft·lb) on diesel engines. Install the starter cable.
15. Install the driveshaft.
16. Remove safety stands and lower vehicle.
17. On V-8 engines, install the flex hose to the air cleaner heat tube. Install the bolt that retains the filler tube to the cylinder block.
18. Connect the park neutral position switch electrical connector.
19. Fill the transmission to the proper level with the specified fluid.
20. Raise the vehicle and check for transmission fluid leakage. Make sure the transmission fluid pan is securely attached. Lower the vehicle and adjust the downshift and manual linkage. Refer to Section 07-05.
21. Connect the battery negative cable.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
22. Install the engine compartment cover.

Crossmember Installation, E-150-250-350



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REMOVAL AND INSTALLATION (Continued)

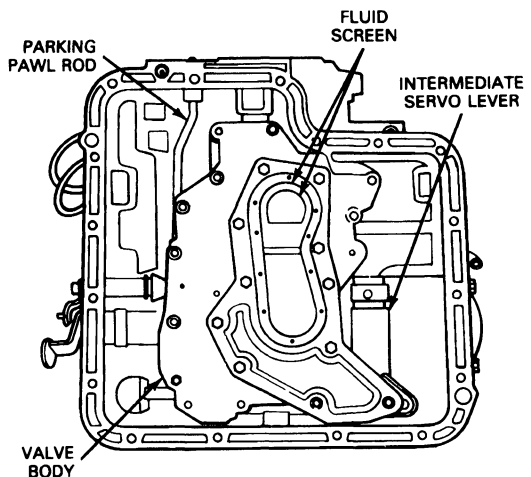
Control Valve Body

Removal

1. Raise the vehicle on a hoist and position safety stands under vehicle.
2. Place a drain pan under the transmission and loosen the bolts holding the transmission pan to drain the fluid from the transmission.
3. Remove the attaching bolts, the pan and gasket. Remove and discard the nylon shipping plug from the pan. This plug is used to retain transmission fluid within the transmission during shipment and should be discarded when the oil pan is removed.
4. Remove the valve body attaching bolts and remove the valve body from the case.

Installation

1. Position the valve body to the case making sure that the selector and downshift levers are engaged. Install and tighten the attaching bolts to 11-14 N·m (95-125 in·lb).
2. Clean the transmission pan and gasket surfaces thoroughly.
NOTE: Do not grind or sand surfaces. Use a gasket scraper or wire brush to clean old gasket material from pan and transmission gasket surfaces.
3. Using a new pan gasket, install attaching bolts securing the pan to the transmission case. Tighten the attaching bolts to 11-16 N·m (8-12 ft·lb).
4. Remove safety stands and lower the vehicle and fill the transmission to the correct level with the specified fluid.

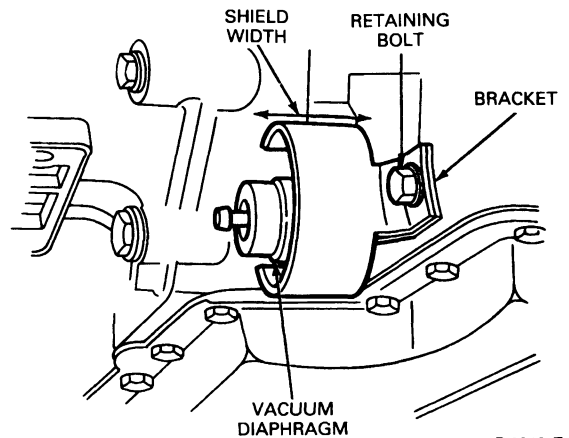


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Vacuum Diaphragm

Removal and Installation

1. Disconnect the hose from the vacuum unit.
2. Remove the vacuum unit retaining bracket bolt, heat shield and bracket. **Do not pry or bend the bracket.** Pull the vacuum unit from the transmission case.



D4819-E

3. Remove the vacuum unit control rod from transmission case.
4. Install the vacuum unit control rod in transmission case.
5. Push the vacuum unit into the case and position retaining bracket. Install heat shield and tighten the bolt to 16-22 N·m (12-16 ft·lb).
6. Install the vacuum unit hose to the diaphragm connector.

Intermediate Servo

Removal

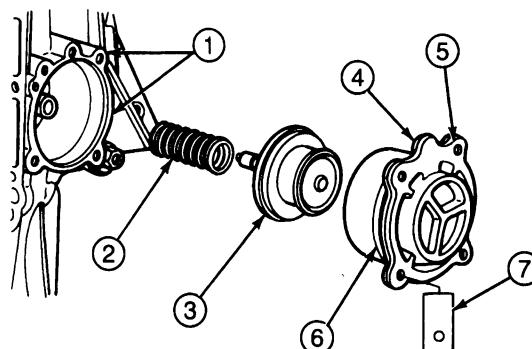
1. Raise the vehicle on a hoist and position safety stands under vehicle.
2. Remove the bolts that secure the engine rear support to the transmission extension rear support and insulator assembly to the crossmember. Refer to the illustration that accompanies the transmission removal and installation procedure for the vehicle being serviced.
3. Remove the two crossmember-to-frame attaching bolts, and the bolts attaching the gussets to the crossmember if so equipped.
4. Using Rotunda Transmission Jack 077-00019 or equivalent raise the transmission high enough to remove the weight from the crossmember and remove the crossmember.
5. Disconnect the muffler inlet pipe from the exhaust manifolds and allow the pipe to hang.

REMOVAL AND INSTALLATION (Continued)

6. Place a drain pan under the servo. Remove the bolts that attach the servo cover and identification tag to the transmission case.
7. Remove the cover, piston, spring and gasket from the case, screwing the band adjusting screw inward as the piston is removed. This places enough tension on the band to keep the struts properly engaged in the band end notches while the piston is removed.
8. Apply air pressure to the port in the servo cover, if necessary, to remove the piston and rod assembly.
9. Replace the complete piston and rod assembly if the piston, piston shaft or piston sealing lips are damaged.
10. Remove the seal from the cover.

Installation

1. Dip the new cover seal in transmission fluid.
2. Install the new seal on the cover.
3. Coat new gasket with petroleum jelly, and position on the servo cover.
4. Dip the piston in transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX E4AZ-19582-B or equivalent and install it in the cover.
5. Position the servo spring on the piston rod.
6. Insert the servo piston and cover in the case and secure the cover to the case with the attaching bolts, taking care to back off the band adjusting screw as the cover bolts are tightened 19-27 N·m (14-20 ft·lb). **Make sure that the service identification tag is in place.**
7. Connect the muffler inlet pipe to the exhaust manifolds.
8. Raise the transmission high enough to install the crossmember. Secure the crossmember to the rear support with the attaching bolts. Lower the transmission as required to install the crossmember to frame and gussets attaching bolts. Tighten the attaching bolts to specifications as listed at the end of this section.
9. Remove the jack from the transmission. Adjust the band as detailed in the Adjustments portion of this section.
10. Remove safety stands and lower the vehicle and replenish the fluid as outlined in this section.

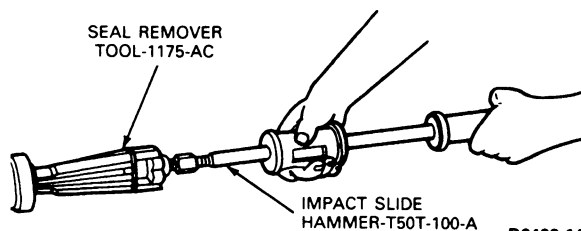


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Item	Part Number	Description
1	7005	Transmission Case
2	7D028	Spring
3	7D021	Piston and Rod Assembly
4	7D026	Gasket
5	7D027	Cover
6	7D024	Seal
7	7B148	Identification Tag

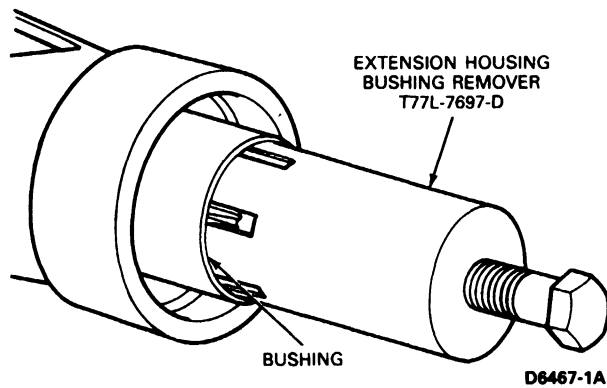
Extension Housing Bushing and Rear Seal
E-150-250-350, F-150-250-350 4x2
Removal

1. Raise the vehicle and position safety stands under vehicle. Disconnect the driveshaft at the transmission.
2. When only the rear seal needs replacing, carefully remove it with a tapered chisel or Slide Hammer T50T-100-A and Seal Remover TOOL-1175-AC. When removing the bushing, use Extension Housing Bushing Remover T77L-7697-D after removing the rear seal. **Use the bushing remover carefully so that the spline seal is not damaged.**

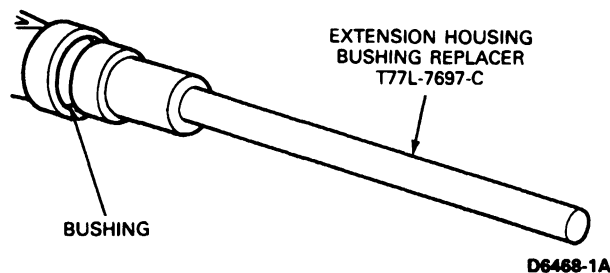


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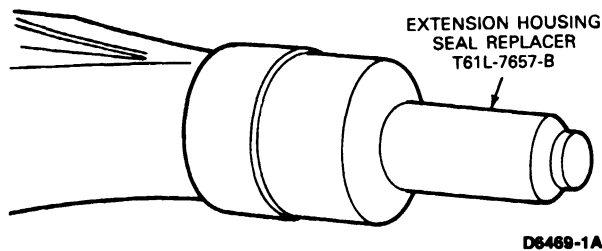
REMOVAL AND INSTALLATION (Continued)

**Installation**

1. When installing a new bushing use Extension Housing Bushing Replacer T77L-7697-C.



2. Before installing a new seal, inspect the sealing surface of the universal joint yoke for scores. If scores are found, replace the yoke.
3. Inspect the counterbore of the housing for burrs. Remove burrs with crocus cloth.
4. Install the seal into the housing using Extension Housing Seal Replacer T61L-7657-B. The seal should be firmly seated in the bore. Coat the inside diameter of the end of the seal with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or an equivalent lubricant.



5. Coat the front universal joint spline with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or an equivalent lubricant and install the driveshaft.
6. Remove safety stands and lower vehicle.

Extension Housing**Removal**

1. Raise the vehicle on a hoist and position safety stands under vehicle.
2. Disconnect the driveshaft from the rear axle flange and remove it from the transmission. On 4x4 vehicles, remove the transfer case. Refer to Sections 07-07A and 07-07B.
3. Remove the engine rear support and insulator assembly-to-extension housing attaching bolts.
4. Place Rotunda Transmission Jack 077-00019 or equivalent under the transmission and raise it just enough to remove the weight from the engine rear support.
5. Remove the bolts that secure the engine rear support to the crossmember and remove the support.
6. Place a drain pan under the rear of the transmission case.
7. Lower the transmission and remove the extension housing attaching bolts. Slide the extension housing off the output shaft and allow the fluid to drain.

Installation

1. Clean the mounting surface on the transmission case and on the extension housing. Position a new gasket on the transmission case.

CAUTION: Do not use a die grinder or similar tool to clean gasket surfaces.

2. Hold the extension housing in place and secure it with the attaching bolts. Tighten bolts to specifications.
3. Raise the transmission high enough to position the engine rear support on the crossmember.
4. Secure the support to the crossmember with the attaching bolts and nuts. Tighten the bolts to specification as listed at the end of this section.
5. Lower the transmission and remove the jack. Install the engine rear support-to-extension housing attaching bolts. Tighten bolts to specification as listed at the end of this section. On 4x4 vehicles, install the transfer case. Refer to Sections 07-07A and 07-07B.
6. Install the driveshaft. Remove safety stands and lower the vehicle to the floor.
7. Fill the transmission to the correct level with the specified fluid.

Governor**Removal**

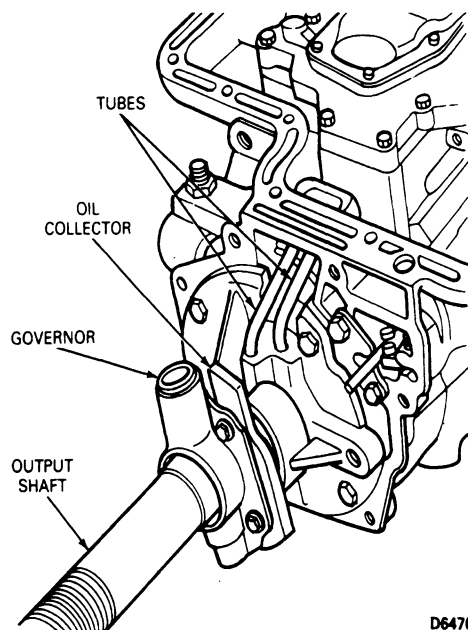
1. Remove the extension housing as outlined in this section.
2. Remove the four governor body-to-oil-collector attaching bolts.

REMOVAL AND INSTALLATION (Continued)

3. Remove the governor from the collector body flange.
4. Refer to the Disassembly and Assembly portion of this section for governor repair operations.

Installation

1. Secure the governor to the oil collector flange with the attaching bolts. Tighten the bolts to 11-13 N·m (97-115 in-lb).
2. Re-install the extension housing as outlined in this section.



D6470-1A

DISASSEMBLY AND ASSEMBLY**Transmission**

Before removing any of the subassemblies, thoroughly clean the outside of the transmission to prevent dirt from entering the mechanical parts.

During the repair of the subassemblies, certain general instructions which apply to all units of the transmission must be followed. Following these instructions will avoid unnecessary repetition.

Handle all transmission parts carefully to avoid nicking or burring the bearing or mating surfaces. Lubricate all internal parts of the transmission with clean automatic transmission fluid before assembly.

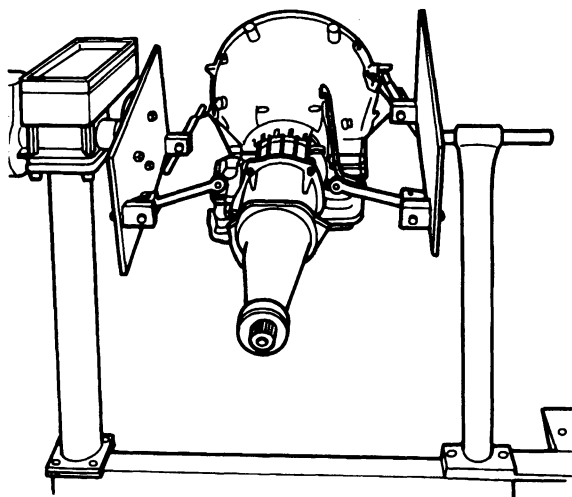
Do not use any other lubricants except on gaskets and thrust washers. These may be coated with petroleum jelly to facilitate assembly. Always use new gaskets and seals when assembling a transmission. Refer to the Cleaning and Inspection portion of this section.

Tighten all bolts and screws to the recommended torque as outlined in Specifications at end of this section.

Disassembly

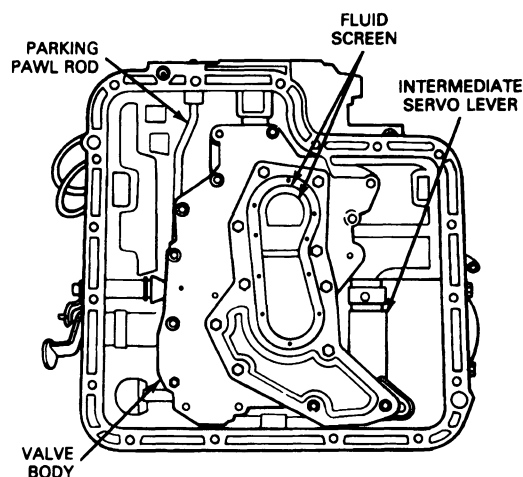
1. Remove the converter, and mount the transmission in holding fixture Rotunda Model 014-00106 or equivalent.

NOTE: If equipped, remove and discard the nylon shipping plug from the pan. This plug is used to retain transmission fluid within the transmission during shipping. It should be discarded when the oil pan is removed.



D6471-B

2. Remove the 17 fluid pan attaching bolts. Remove the pan and gasket.
3. Remove the eight valve body attaching bolts. Lift the valve body from the transmission case.

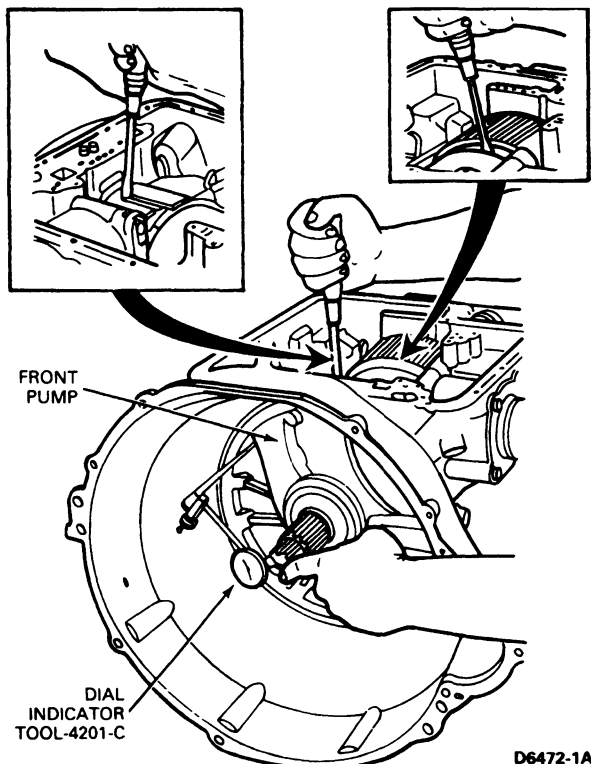


D9291-A

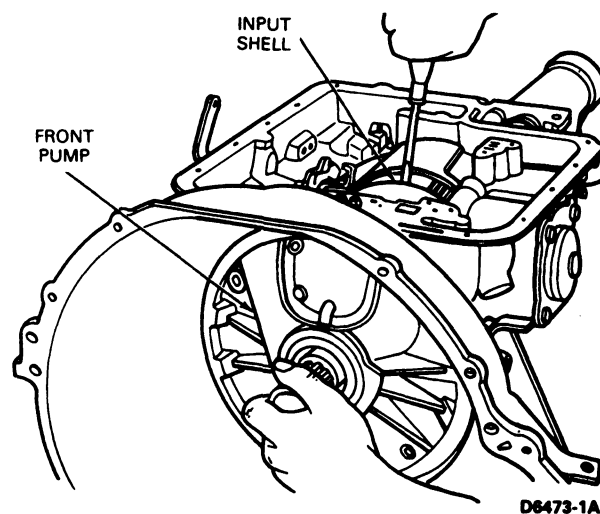
DISASSEMBLY AND ASSEMBLY (Continued)

4. Attach a dial indicator TOOL-4201-C to the front pump. Install Extension Housing Seal Replacer T61L-7657-B in the extension housing to center the output shaft.
5. Pry the gear train to the rear of the case and at the same time, press the input shaft inward until it bottoms. Set the dial indicator to read zero.
6. Pry the gear train forward, and note the amount of gear train end play on the dial indicator. Record the end play to facilitate assembling the transmission. Remove the dial indicator from the pump and the tool from the extension housing.

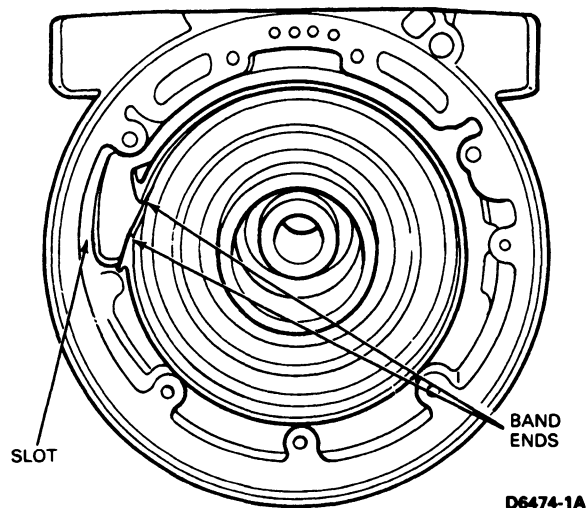
NOTE: Transmission end play should be within 0.203-1.117mm (0.008-0.044 inch).



7. Remove the vacuum diaphragm, valve rod and the throttle valve from the bore in the rear of the case. Slip the input shaft out of the front pump.
8. Remove the front pump attaching bolts. Pry the gear train forward to remove the pump.

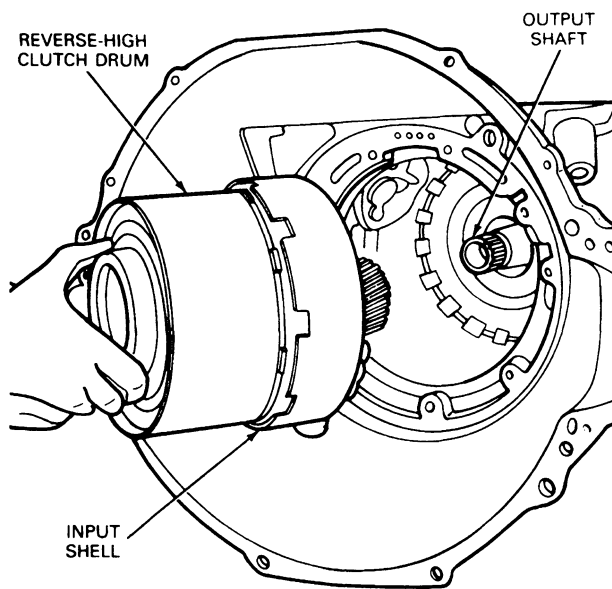


9. Loosen the band adjustment screw and remove the two struts.
10. Rotate the band 90 degrees counterclockwise to align the ends with the slot in the case. Slide the band off the reverse-high clutch drum.



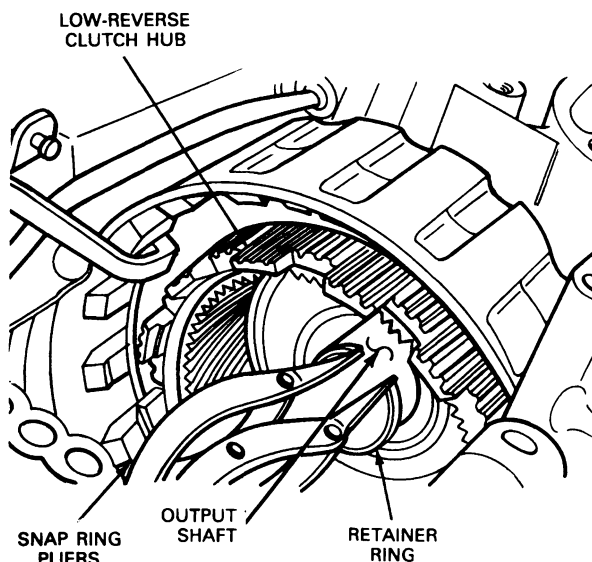
DISASSEMBLY AND ASSEMBLY (Continued)

11. Remove the forward part of the gear train as an assembly.



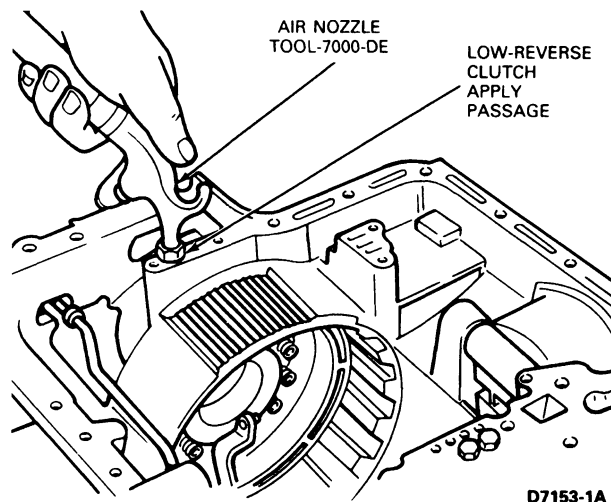
D6475-1A

12. Remove the bolts that attach the servo cover to the transmission case.
13. Remove the cover, piston, spring and gasket from the case.
14. Remove the large retaining ring that secures the reverse planet carrier in the low-reverse clutch hub. Lift the thrust washers and planet carrier from the drum.
15. Remove the retaining ring that secures the reverse ring gear and hub on the output shaft. Slide the ring gear and hub off the shaft. Remove the thrust washer.



D7151-B

16. Rotate the low-reverse clutch hub in a clockwise direction and at the same time, withdraw it from the case.
17. Remove the reverse clutch retaining ring from the case, then remove the clutch discs, plates and pressure plate from the case.
18. Remove the extension housing attaching bolts from the case. Remove the extension housing and gasket.
19. Slide the output shaft (with governor and oil collector) assembly from the transmission case.
20. Remove the distributor sleeve attaching bolts and remove the sleeve, parking pawl gear and the thrust washer.
- If the thrust washer is staked in place, use a sharp chisel and cut off the metal from behind the thrust washer. Be sure to clean the rear of the case with air pressure or a suitable solvent to remove any metal particles.
21. Remove the one-way clutch inner race attaching bolts from the rear of the case. Remove the inner race and reverse clutch spring retainer assembly from inside of the case.
22. Remove the low-reverse clutch piston from the case using TOOL-7000-DE.



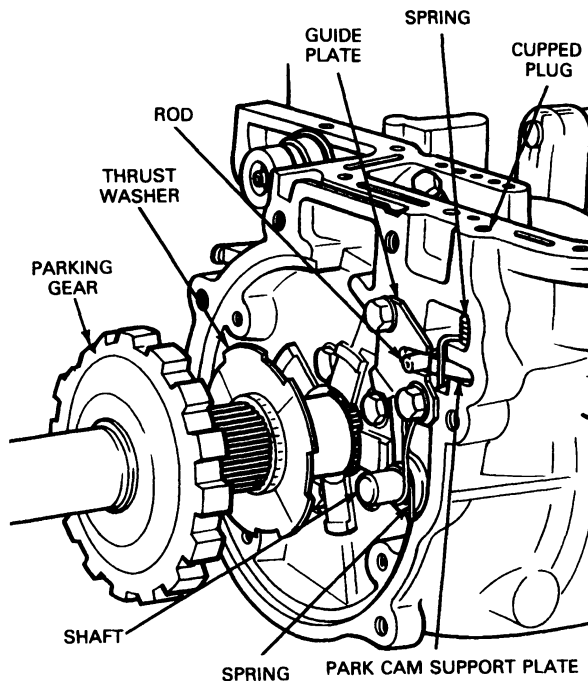
D7153-1A

Assembly

1. Place the transmission case in a holding fixture.
2. Tap the low-reverse piston into place in the case with a clean rubber hammer.
3. Install the low-reverse clutch spring retainer assembly in the clutch piston.
4. Hold the overrunning clutch inner race in position and install the attaching bolts. Tighten bolts to 25-33 N·m (18-25 ft·lb).
5. Position the transmission case with the front end facing downward.

DISASSEMBLY AND ASSEMBLY (Continued)

6. Position the parking gear thrust washer and the gear on the case. **Do not re-stake the thrust washer.**



D7157-B

7. Position the collector and tubes in place on the rear of the case. Install the attaching bolts and tighten to 16-22 N·m (12-16 ft-lb).
8. Install the output shaft and governor as an assembly.
9. Place a new gasket on the rear of the transmission case. Position the extension housing on the case and install the attaching bolts. Tighten the attaching bolts to 34-47 N·m (25-35 ft-lb).
10. Coat new gasket with petroleum jelly and position on the servo cover.
11. Position the servo spring on the piston rod.
12. Insert the servo piston rod in the case. Install the servo cover with the attaching bolts, making sure that the identification tag is in place. Tighten the attaching bolts to 19-27 N·m (14-20 ft-lb).
13. Align the low-reverse clutch hub and one-way clutch with the inner race at the rear of the case. Rotate the low-reverse clutch hub clockwise while applying pressure to seat it on the inner race.

14. Install the low-reverse clutch plates, starting with the wave plate next to the piston and following with steel and friction plates alternately. Retain them with petroleum jelly. If new composition plates are being used, soak them in clean transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent for fifteen minutes before installation. Install the pressure plate and the retaining ring. Test the operation of the low-reverse clutch by applying air pressure at the clutch pressure apply hole in the case.

NOTE: The number of steel and friction plates for the low-reverse clutch assembly will vary depending on engine application.

15. Install the reverse planet ring gear thrust washer and the ring gear and hub assembly. Insert the retaining ring in the groove on the output shaft.
16. Assemble the front and rear thrust washers onto the reverse planet assembly; retain with petroleum jelly. Insert the assembly into the ring gear and install the retaining ring.
17. Set the reverse-high clutch assembly on the bench, with the front end facing down. Install the thrust washer on the rear end of the reverse-high clutch assembly. Retain the thrust washer with petroleum jelly and insert the splined end of forward clutch into the open end of the reverse-high clutch with splines engaging the direct clutch friction plates.
18. Install the forward planet bearing assembly into the open end of the forward clutch.
19. Install thrust washer and retain with petroleum jelly on the front end of the forward planet ring gear and hub. Insert the ring gear into the forward clutch.
20. Install the thrust washer on the front end of the forward planet assembly. Retain the washer with petroleum jelly and insert the assembly into the ring gear. Install the input shell and sun gear assembly.
21. Install the reverse-high clutch assembly, forward clutch assembly, forward planet assembly and drive input shell, and sun gear as an assembly into the transmission case.
22. Insert the intermediate band into the case around the reverse-high clutch drum. Install the struts and tighten the band adjusting screw sufficiently to retain the band.

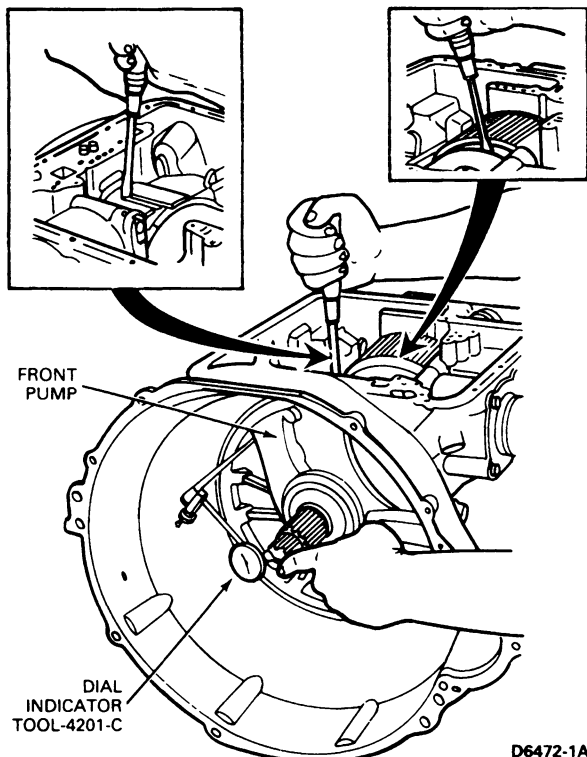
DISASSEMBLY AND ASSEMBLY (Continued)

23. Place a selective thickness bronze thrust washer (7DB 14) on the rear shoulder of the stator support (front pump support) and retain it with petroleum jelly. If the end play was not within specification when checked prior to disassembly, replace the washer with one of proper thickness. Refer to specifications at the end of this section for selective thrust washer thicknesses.

Using two 5/16-inch bolts three inches long, make two alignment studs. Cut the heads from the bolts and grind a taper on the cut end. Temporarily install the two studs opposite each other in the mounting holes of the case. Slide a new gasket onto the studs. Position pump on case, being careful not to damage the large seal on the outside diameter of the pump housing. Remove the aligning studs.

Install six of the seven mounting bolts and tighten to 22-40 N·m (16-30 ft·lb).

24. Adjust the intermediate band as detailed under Adjustments and install the input shaft with the long splined end inserted into the forward clutch assembly.
25. Install Dial Indicator TOOL-4201-C at the seventh pump mounting bolt and check the transmission end play as in Steps 4, 5 and 6 of Disassembly. (See Specifications at the end of this section.) Remove the tool.
- Install the seventh pump mounting bolt and tighten to 22-40 N·m (16-30 ft·lb).



26. Install the main control valve body on the case, making sure that the levers engage the valves properly and tighten the attaching bolts to 11-14 N·m (95-125 in·lb). Install the primary throttle valve, rod, and the vacuum diaphragm in the case. Position heat shield over vacuum diaphragm and install attaching bolt. Tighten bolt to 17-21 N·m (12-16 ft·lb).
27. Install a new pan gasket and the pan. Tighten the bolts to 11-16 N·m (8-12 ft·lb).
28. Install the converter assembly.
29. Install the transmission in the vehicle as detailed under Removal and Installation in this section.

Control Valve Body**Disassembly**

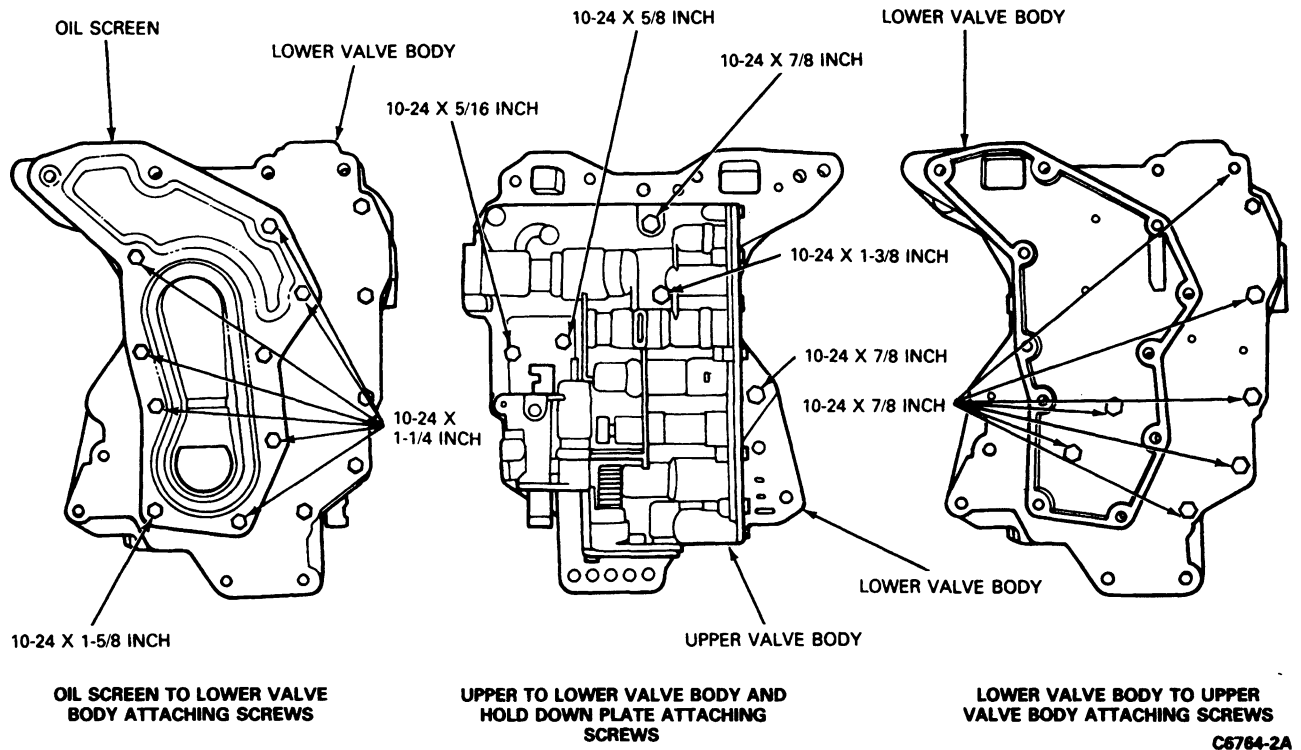
CAUTION: Extreme care should be taken to avoid dropping, nicking or in any way damaging a valve. If a valve is damaged or dropped, do not reuse it.

The valve body-to-screen gasket should **not** be reused. Use new gaskets and screen when servicing the transmission.

1. Remove the nine screws that attach the screen to the lower valve body and remove screen and gasket.

DISASSEMBLY AND ASSEMBLY (Continued)

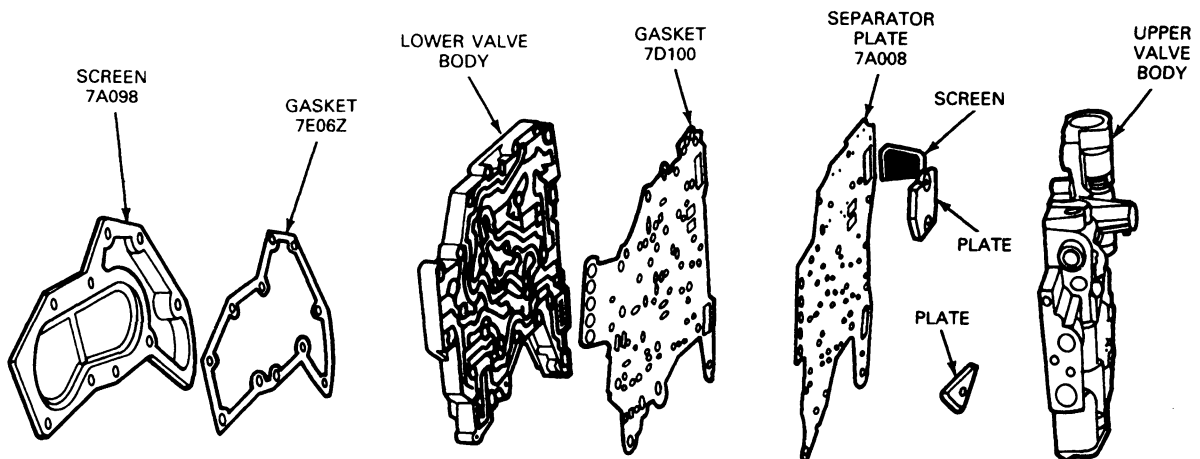
Valve Body Assembly Attaching Screws



- Remove the five upper-to-lower valve body and hold-down plate attaching screws. Remove the seven attaching screws from the underside of the lower valve body.

- Separate the bodies and remove the separator plate and gasket. **Be careful not to lose the check valves and springs.** Remove and clean the separator plate screen if necessary.

Valve Body Assembly, Separated



D5041-2A

- Remove the manual valve retaining pin from the upper valve body.
- Slide the manual valve out of the valve body.

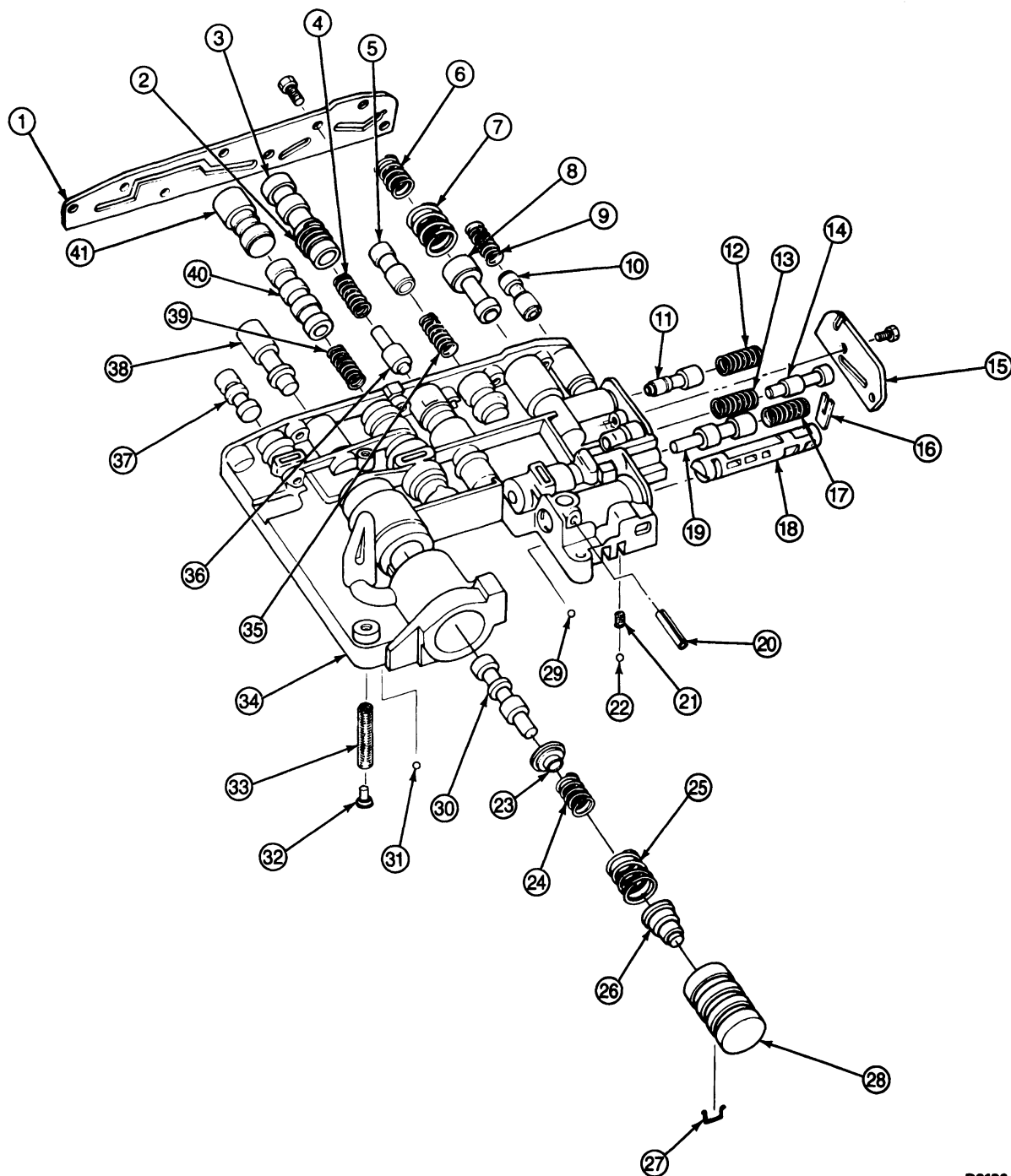
- Cover the downshift valve bore with a finger, then working from the underside of the body remove the downshift valve retainer. Remove the spring and downshift valve.

DISASSEMBLY AND ASSEMBLY (Continued)

7. Apply hand pressure on the pressure boost valve sleeve end and remove the sleeve retaining clip from the under side of the body. Slowly release hand pressure and remove the sleeve and the pressure boost valve. Remove the two springs, the spring and the main regulator valve from the bore.
8. Apply pressure on the throttle boost valve retaining plate and remove the two attaching screws. Slowly release the pressure and remove plate, throttle pressure boost valve and spring, and the manual low 2-1 scheduling valve and spring from the body.
9. Apply pressure on the remaining valve retaining plate and remove the eight attaching screws.
10. Hold the valve body so that the plate is facing upward. Slowly release the pressure and remove the plate.
11. Remove the spring and the intermediate servo modulator valve from the valve body.
12. Remove the intermediate servo accumulator valve and springs.
13. Remove the 2-3 back-out valve and spring.
14. Remove the 2-3 shift valve, spring and the throttle modulator valve and spring.
15. Remove the 1-2 shift valve, DR-2 shift valve and the spring from the valve body.
16. Remove the line pressure coasting regulator valve from the body.
17. Remove the cutback control valve to complete the disassembly of the control valve.

DISASSEMBLY AND ASSEMBLY (Continued)

Upper Valve Body



D3136-E

Item	Part Number	Description
1	7D058	Shift Valve Plate
2	7A320	2-3 Shift Spring (7.3L Diesel Only)

(Continued)

Item	Part Number	Description
3	7D053	2-3 Shift Valve
4	7A286	Throttle Modulating Valve Spring
5	7D229	2-3 Backout Valve

(Continued)

DISASSEMBLY AND ASSEMBLY (Continued)

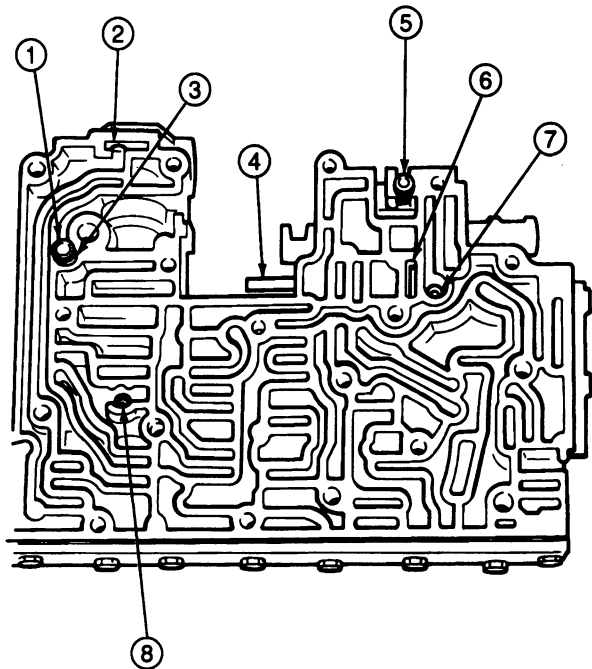
Item	Part Number	Description
6	7D435	Inner Intermediate Servo Accumulator Spring
7	7D371	Outer Intermediate Servo Accumulator Spring
8	7D370	Intermediate Servo Accumulator Valve
9	7D434	Intermediate Servo Modulator Valve Spring
10	7D436	Intermediate Servo Modulator Valve
11	7E060	2-1 Scheduling Valve
12	7E061	2-1 Scheduling Valve Spring
13	7A331	Throttle Pressure Boost Spring
14	7A327	Throttle Pressure Boost Valve
15	7D094	Throttle Boost Plate
16	7D227	Retainer
17	7A289	Downshift Valve Spring
18	7340	Manual Valve
19	7B424	Throttle Downshift Valve
20	388932	Manual Valve Retaining Pin
21	7D017	Throttle Pressure Relief Spring

(Continued)

Item	Part Number	Description
22	353078	Throttle Pressure Relief Ball, 1/4 inch Diameter
23	7E337	Spring Seat
24	7D367	Boost Valve Spring
25	7A270	Pressure Regulator Spring
26	7D003	Booster Valve
27	7E335	Retainer
28	7D002	Main Oil Pressure Boost Valve Sleeve
29	353078	Reverse Clutch Check Ball
30	7C388	Main Regulator Valve
31	353078	2-3 Shift Valve Check Ball
32	7E217	Converter Pressure Relief Valve
33	7D017	Converter Pressure Relief Spring
34	7A092	Upper Valve Body
35	7D230	2-3 Backout Valve Spring
36	7D057	Throttle Modulator Valve
37	7A318	Cutback Control Valve
38	7E104	Line Pressure Coast Valve
39	7A288	1-2 Shift Valve Spring
40	7D368	DR-2 Shift Valve
41	7A334	1-2 Shift Valve

Assembly

1. Place the downshift valve and spring in the valve body. Compress the spring and install the retainer from the underside of the body.
2. Place the valve body on a clean surface with the passage side facing up. Place the converter relief valve spring in its bore. Coat the converter pressure relief valve with petroleum jelly and place it on top of the spring. Place the 2-3 shift valve check ball in its cavity. Place the throttle pressure relief valve spring in its bore. Coat the throttle pressure relief valve check ball with petroleum jelly and place it on top of the spring. Place the reverse clutch check ball in its cavity.



D7154-B

DISASSEMBLY AND ASSEMBLY (Continued)

Item	Description
1	Converter Pressure Relief Valve
2	Pressure Boost Valve Sleeve
3	Converter Pressure Relief Spring
4	Downshift Valve — 7B424 and Spring 7A289
5	Throttle Pressure Relief Ball (1/4 inch Diameter) and Spring
6	Downshift Valve Retainer
7	Reverse Clutch Check Ball
8	2-3 Check Valve

3. Install the small separator screen in the separator plate if it was previously removed. **Be sure the screen tabs are flush with the separator plate surface.** Carefully position the separator plate and new gasket on the lower valve body. Place the two hold-down plates on the separator plate and install the attaching screws finger tight.
4. Place the lower body and plate assembly on the upper valve body and install the attaching screws finger tight.
5. Install the oil screen screws loosely, without the screen, to properly align the upper and lower valve bodies, gasket and separator plate.
6. Tighten the two bolts that are covered by the screen to 5-7 N·m (44-62 in·lb).
7. Remove the oil screen attaching screws and place the screen gasket and oil screen in position on the lower valve body. Re-install the screen attaching screws.
8. Tighten all the valve body and screen attaching screws to 5-6 N·m (44-53 in·lb).
9. Place the cutback control valve and the line pressure coasting regulator valve in the valve body.
10. Place the one spring, DR-2 shift valve and the 1-2 shift valve in the body.
11. Place the throttle modulator valve and spring and the 2-3 shift valve (and spring on 7.3L Diesel) in the valve body.
12. Place the spring and the 2-3 backout valve in the valve body.
13. Place the two springs and the intermediate servo accumulator valve in the valve body.
14. Place the intermediate servo modulator valve and spring in the body.
15. Carefully place the valve retaining plate on the body and secure it with the eight attaching screws. Tighten the two hex head screws to 3-5 N·m (27-35 in·lb). Tighten the remaining six screws to 3-4 N·m (27-35 in·lb).
16. Place the throttle pressure boost valve and spring in the valve body. Place the manual low 2-1 scheduling valve and spring in the valve body and install the retaining plate. Tighten the attaching screws to 3.0-5.0 N·m (27-44 in·lb).

17. Place the spring seat on the stem of the main regulator valve so that the retainer flange is next to the valve shoulder. Place the main regulator valve, spring seat, two springs, pressure boost valve and sleeve in the bore. Apply hand pressure on the end of the pressure boost valve sleeve and install the spring clip retainer in the groove on the under side of the body so that the clip is inserted into the end groove in the sleeve. Be sure that the pressure boost valve sleeve is free in its bore.
18. Place the manual valve in the valve body and install the retaining pin in the body.

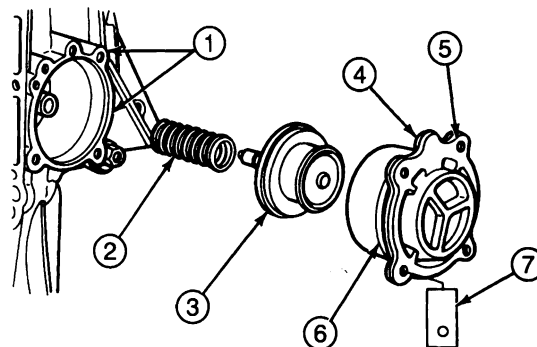
Intermediate Servo

Disassembly

1. Apply air pressure to the port in the servo cover, if necessary, to remove the piston and rod.
2. Replace the complete piston and rod assembly if the piston or piston sealing lips are unserviceable or damaged.
3. Remove the seal and gasket from the cover.

Assembly

1. Dip the new seal in clean transmission fluid.
2. Install new seal and gasket on the cover. Coat the new gasket with petroleum jelly, if necessary, to hold it in place.
3. Dip the piston in transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent and install it in the cover.
4. Position the servo spring on the piston rod.
5. Insert the servo piston and cover in the case and secure the cover to the case with the attaching bolts, taking care to back off the band adjusting screw as the cover bolts are tightened 19-27 N·m (14-20 ft·lb). **Make sure that the service identification tag is in place.**



D6465-B

DISASSEMBLY AND ASSEMBLY (Continued)

Item	Part Number	Description
1	7005	Transmission Case
2	7D028	Spring
3	7D021	Piston and Rod Assembly

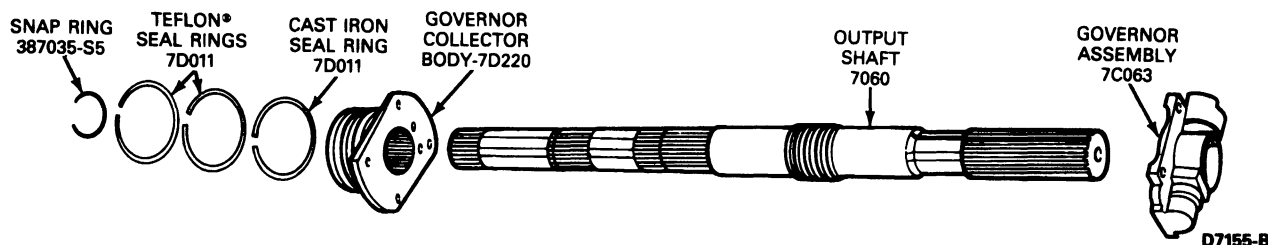
(Continued)

Item	Part Number	Description
4	7D026	Gasket
5	7D027	Cover
6	7D024	Seal
7	7B148	Identification Tag

Governor**Disassembly**

1. Remove the governor body attaching bolts and remove the governor.
2. Remove and discard the retaining ring that secures the governor oil collector body on the output shaft and slide the governor off the front of the shaft.
3. Remove the seal rings from the oil collector body.

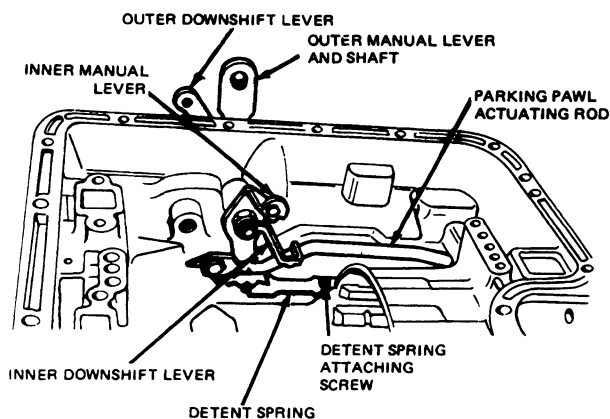
NOTE: Make note of the position of the cast iron seal ring versus the two Teflon® seal rings so the new rings will be installed in the correct location.

Output Shaft and Governor Assembly**Assembly**

1. Carefully install new seal rings on the oil collector body.
2. Working from the front end of the output shaft, slide the governor oil collector body into place on the shaft. Install a new retaining ring to secure it. Make sure that the retaining ring is seated in the groove.
3. Position the governor assembly on the oil collector body and secure with the attaching screws. Tighten screws to 11-13 N-m (97-115 in-lb).

Downshift and Manual Linkage**Disassembly**

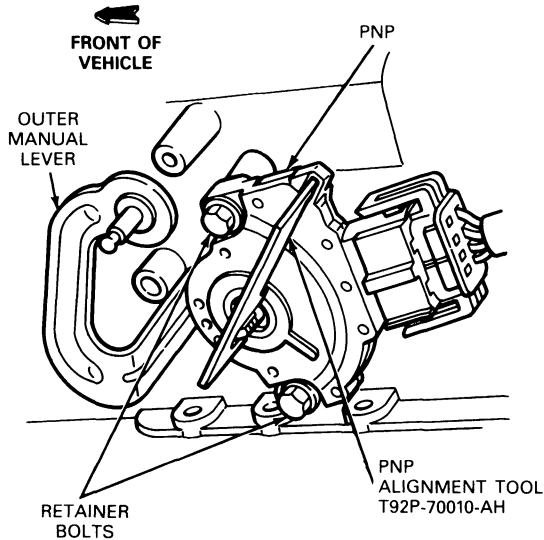
1. Remove the nut and lockwasher that secures the outer downshift lever to the transmission and remove the lever.
2. Slide the inner downshift lever assembly out from the inside of the case. Remove the seal from the recess in the manual lever shaft.



3. Remove the two bolts retaining the park neutral position switch and remove the switch.
4. Remove the nut securing the inner manual lever to the shaft. Remove the inner lever from the shaft. Remove the inner lever and parking pawl actuating rod assembly from the case. Slide the outer lever and shaft from the case.

DISASSEMBLY AND ASSEMBLY (Continued)

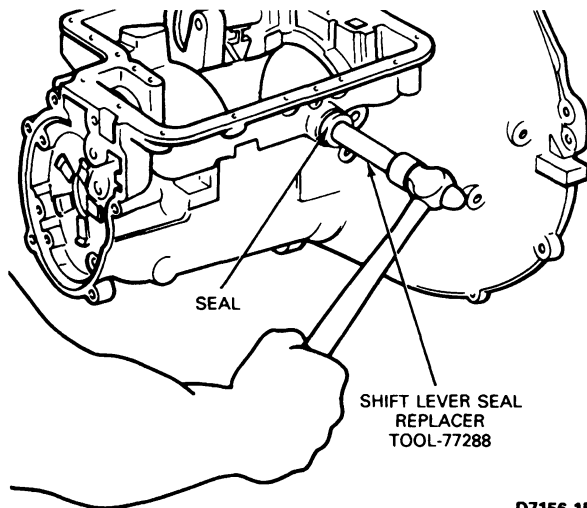
5. Remove the seal from the case with Slide Hammer T59L-100-B and Puller Attachment T58L-101-B.



D4823-D

Assembly

1. Dip the new seal in transmission fluid Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent and install it in the case using shift lever seal replacer TOOL-77288.



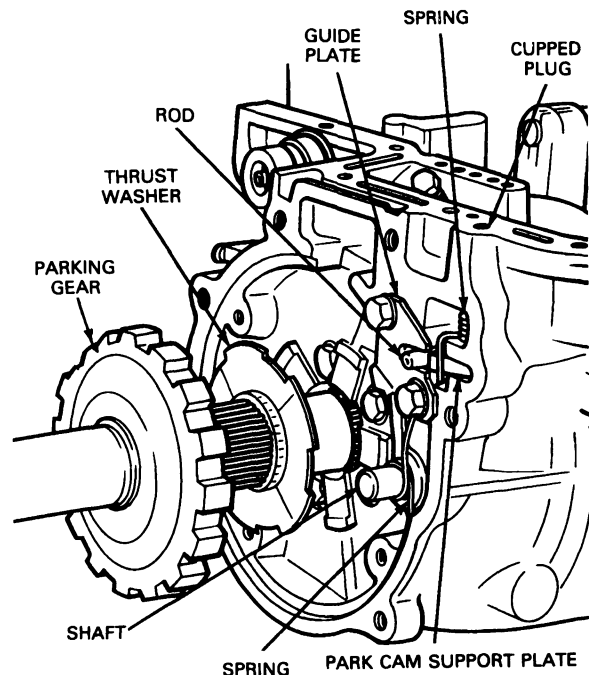
D7156-1B

2. Slide the outer manual lever and shaft in the transmission case.

3. Simultaneously position the parking pawl actuating rod into the case and the inner lever on the shaft, making sure the leaf spring roller is positioned in the inner manual lever detent. Install the attaching nut. Tighten the nut to 41-54 N-m (30-40 ft-lb).
4. Install park neutral position switch and adjust following procedures under Adjustments in this section.
5. Install a new downshift lever seal in the recess of the outer lever shaft. Slide the downshift lever and shaft into position.
6. Place the outer downshift lever on the shaft and secure it with a lockwasher and nut. Tighten nut to 17-21 N-m (12-16 ft-lb).

Parking Pawl Linkage**Disassembly**

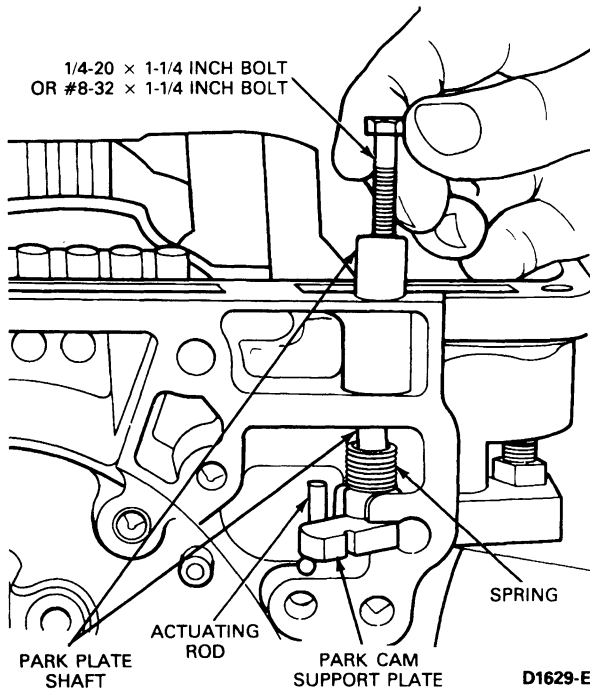
1. Remove the bolts securing the parking pawl guide plate to the case. Remove the plate.
2. Remove the spring, parking pawl and shaft from the case.
3. Working from the pan mounting surface, drill a 1/8-inch diameter hole through the center of the cupped plug. Pull the plug from the case with a wire hook.
4. Unhook the end of the spring from the park plate slot to relieve the tension.



D7157-B

DISASSEMBLY AND ASSEMBLY (Continued)

- Thread a 1/4-20 inch or 8-32 x 1-1/4 inch screw into the park plate shaft. Pull the shaft from the case with the screw. Remove the spring and park cam support plate.

**Assembly**

- Position the spring and park cam support plate in the case and install the shaft. Place the end of the spring into the slot of the park plate.
- Install a new cupped plug (6572) to retain the shaft.
- Install the parking pawl shaft in the case. Slip the parking pawl and spring into place on the shaft.
- Position the guide plate on the case, making sure that the actuating rod is seated in the slot of the plate. Secure the plate with two bolts and lockwashers. Tighten bolts to 17-21 N·m (12-16 ft-lb).

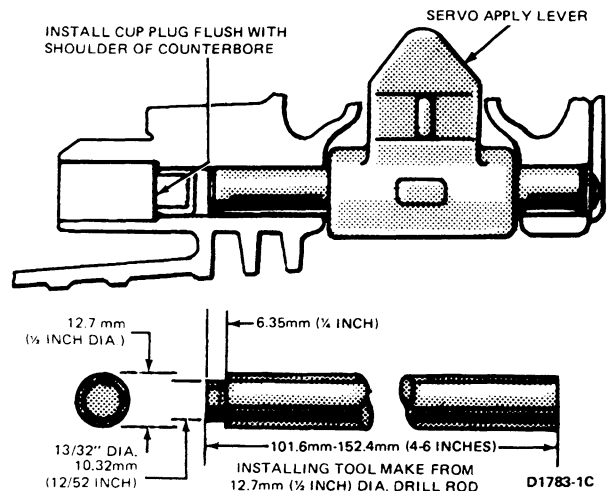
Servo Apply Lever**Disassembly**

- Working from the inside of the transmission case, carefully drive on the servo apply lever shaft to remove the cup plug. The shaft can be withdrawn from the case by hand.

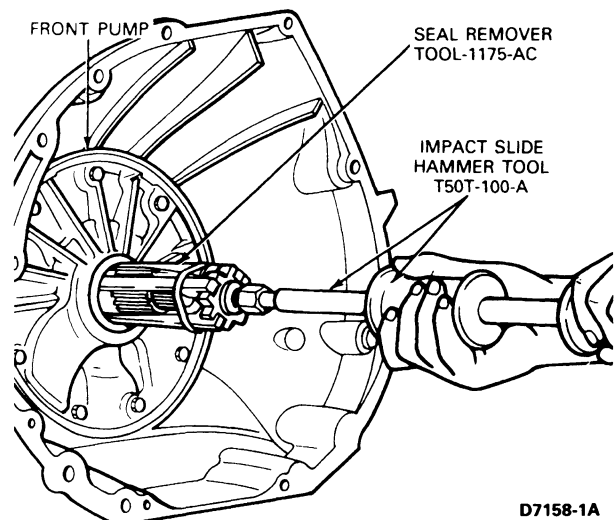
Assembly

- Hold the servo apply lever in position and install the new shaft.

- Using the fabricated tool, drive the cup plug into position in the case. Be sure the plug is flush with the shoulder of the counterbore. The cup plug must be coated with Threadlock and Sealer EOAZ-19554-AA (ESE-M4G204-A) or equivalent before installation.

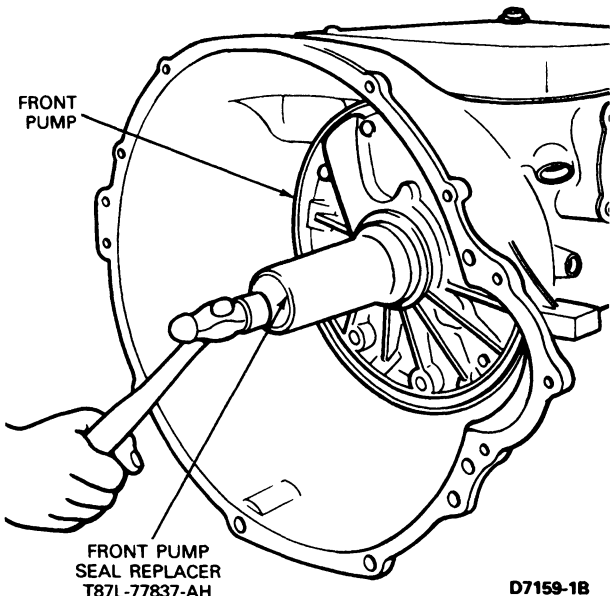
**Front Pump**

The front seal can be replaced after the pump has been installed on the transmission using Slide Hammer T50T-100-A and Seal Remover TOOL-1175-AC for removal, and Front Pump Seal Replacer T87L-77837-AH for installation.

Removing Front Pump Seal

DISASSEMBLY AND ASSEMBLY (Continued)

Installing Front Pump Seal

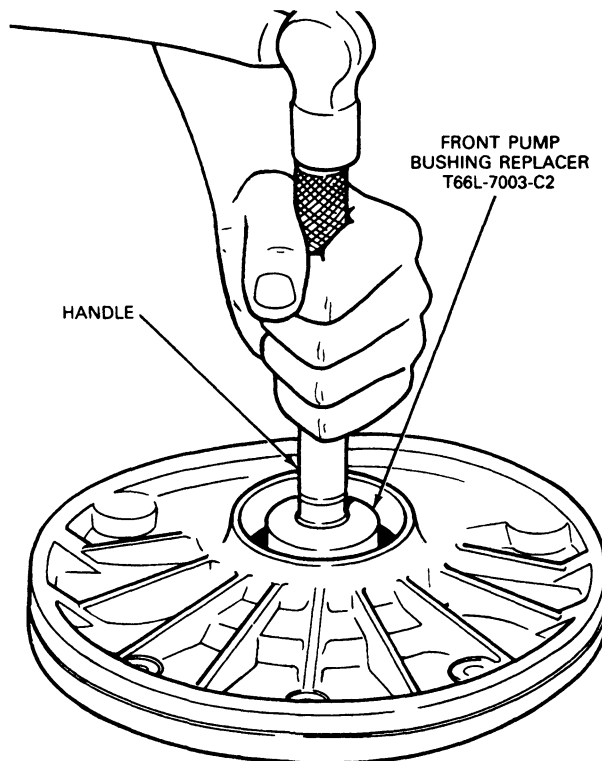


D7159-1B

Disassembly

1. Remove the two seal rings and the selective thrust washer.
2. Remove the large square-cut seal from the outside diameter of the pump housing.
3. Remove the five bolts that secure the stator support to the pump housing. Lift the support from the housing.
4. Remove the drive and the driven gear from the housing.
5. If the pump housing bushing is worn or damaged, replace it using the handle and Front Pump Bushing Replacer T66L-7003-C2.

Place the new bushing in position, making sure the half moon slot in the bushing is on top and in line with the oil lube hole near the seal bore. Press the bushing in 1.52-2.03mm (0.060-0.080 inch) below the front face of the bushing bore. Use Front Pump Bushing Replacer T66L-7003-C2 and handle to seat the bushing properly. After assembly, the half moon slot must be in past the lube hole to provide proper lubrication.



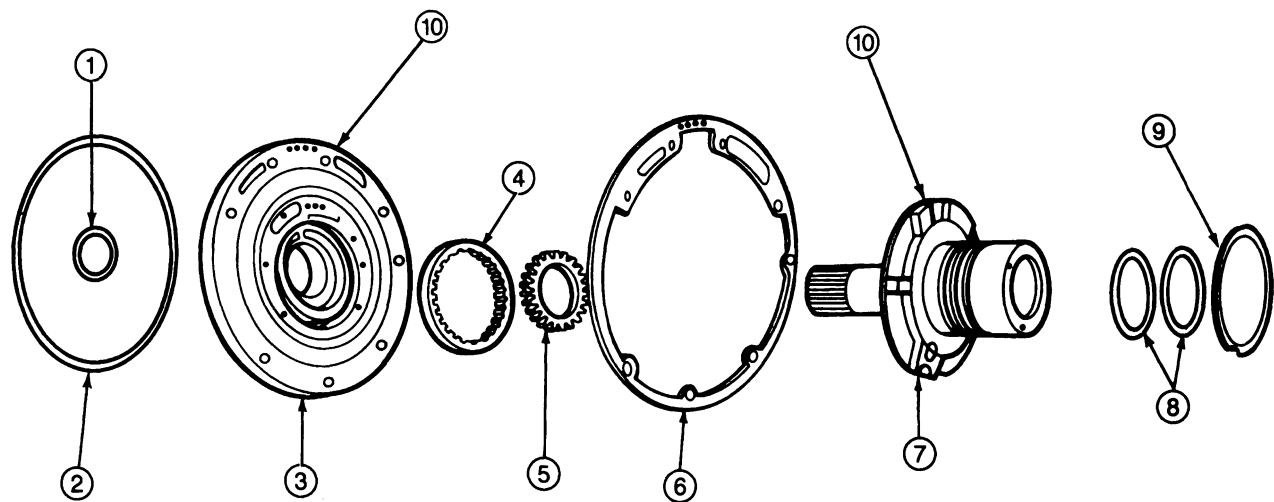
D7161-1A

Assembly

1. Install the drive and driven gears in the pump housing. **Each gear has either an identification mark or chamfered teeth on one face. The identification mark or the chamfered surface on each gear must be installed toward the front bushing / seal end of the pump housing.**
2. Position the stator support in the pump housing and install the five attaching bolts. Tighten bolts to 17-21 N·m (12-16 ft·lb).
3. Carefully install two new seal rings on the stator support. Make sure that the ends of the rings are engaged to lock them in place. Install a new square-cut seal on the outside diameter of the pump housing.
4. Install the selective thrust washer. **Make sure that the correct thickness selective washer is being used to obtain the specified end play.** Refer to Specifications at end of this section.
5. Place the pump on the converter, making sure that the drive gear engages the converter hub. Rotate the pump to make sure that the gears rotate freely.

DISASSEMBLY AND ASSEMBLY (Continued)

Front Pump



D7160-C

Item	Part Number	Description
1	7A248	Front Pump Seal
2	7A248	Seal Ring
3	7A106	Front Pump Body Assembly
4	7C011	Driven Gear

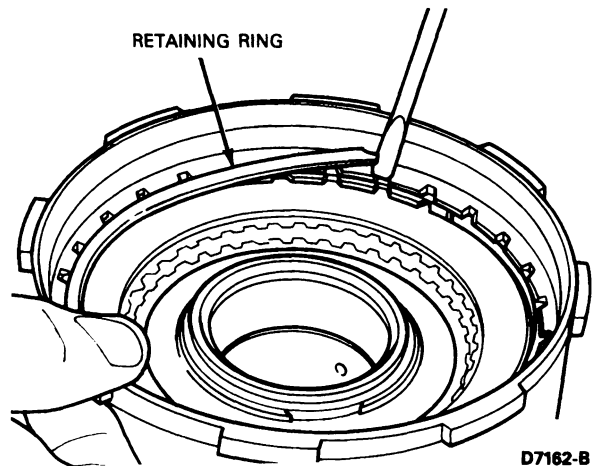
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Item	Part Number	Description
5	7C010	Drive Gear
6	7A136	Gasket
7	7A108	Stator Support
8	7D025	Seal Rings, Teflon
9	7D014	Selective Thrust Washer
10	7A103	Front Pump Assembly

Reverse-High Clutch

Disassembly

1. Separate the drive train. Remove the pressure plate retaining ring.

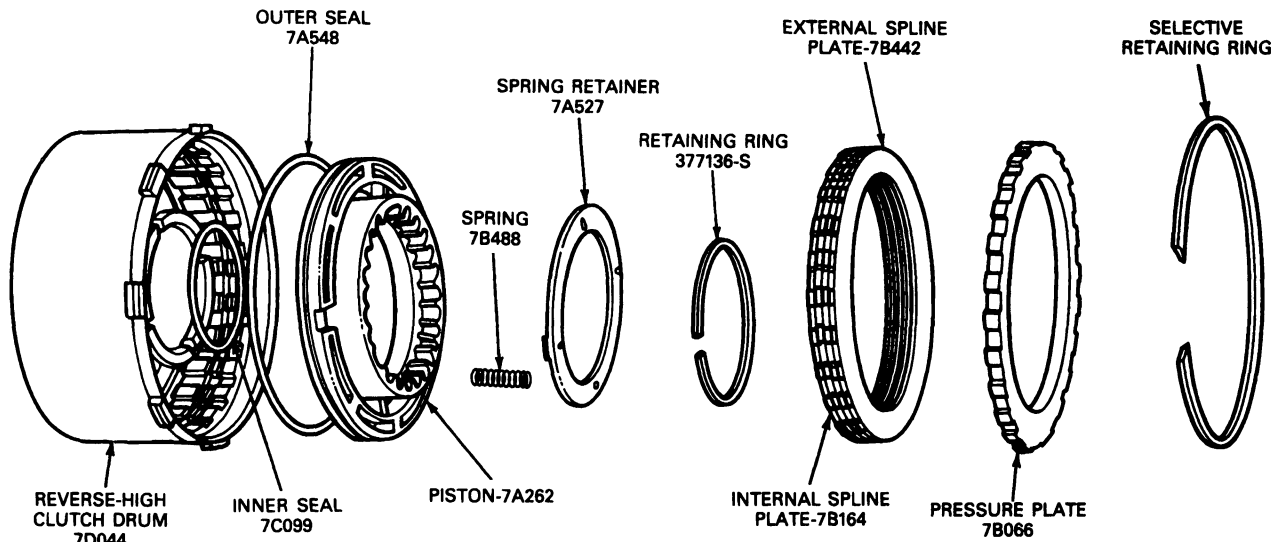


D7162-B

2. Remove the pressure plate and the drive and driven (internal and external spline) clutch plates.

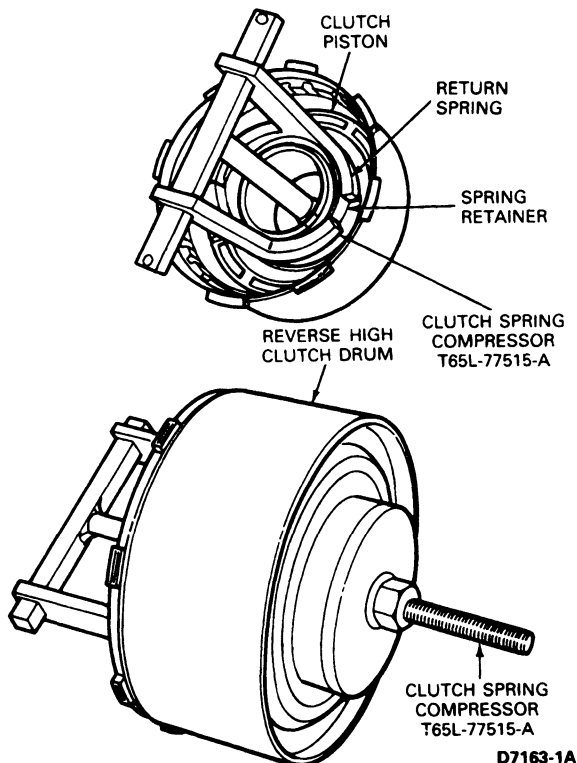
DISASSEMBLY AND ASSEMBLY (Continued)

Reverse-High Clutch

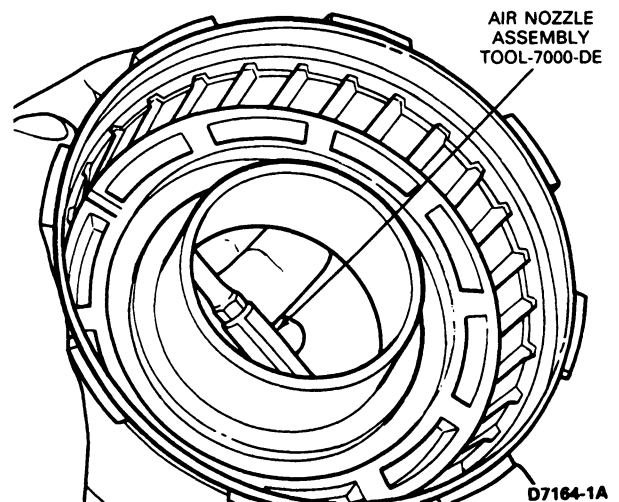


D6457-B

3. Install Clutch Spring Compressor T65L-77515-A on the reverse-high clutch drum. Make sure that the legs clear the retaining ring enough to remove it. Remove the retaining ring and remove the tool.
4. Remove the spring retainer and the piston return springs.



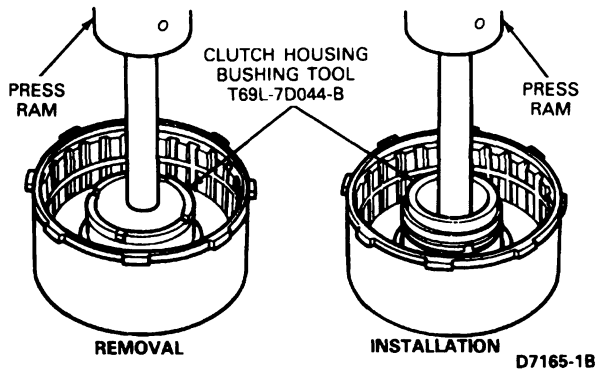
5. Apply air pressure to the piston apply hole in the clutch hub using Air Nozzle Assembly TOOL-7000-DE and remove the piston.



6. Remove the piston outer seal from the piston and the inner seal from the clutch drum.

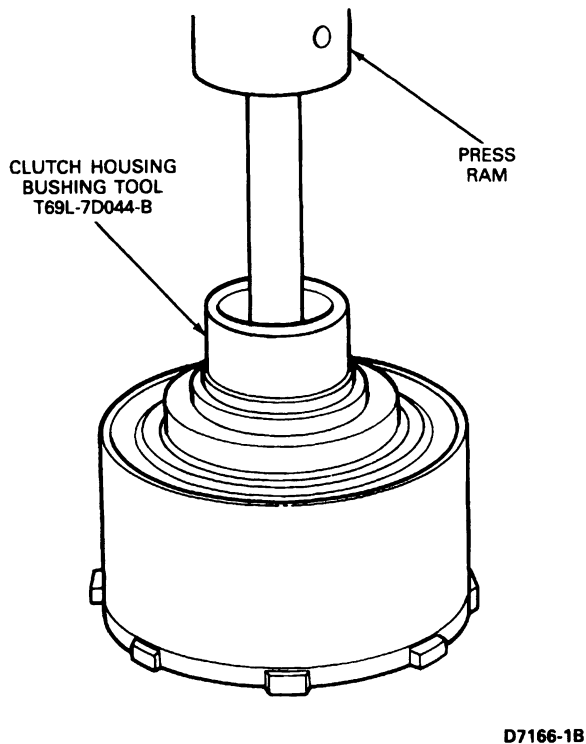
DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove the front and rear bushings from the clutch drum if they are worn or damaged. To remove the front bushing, use a cape chisel and cut along the bushing seam until the chisel breaks through the bushing wall. Pry the loose ends of the bushing up with an awl and remove the bushing. To remove the rear bushing, use Clutch Housing Bushing Tool T69L-7D044-B and press the bushing from the drum.



Assembly

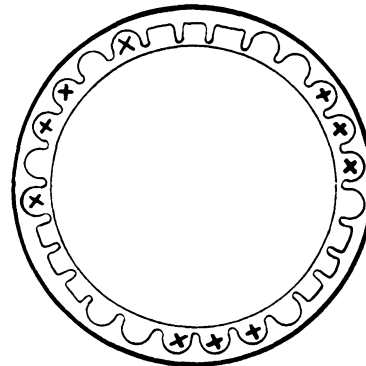
1. If the clutch drum bushings were removed, position the drum in a press and press new bushings into the drum with the Clutch Housing Bushing Tool T69L-7D044-B.



2. Dip the new seals in transmission fluid and install one on the drum and one on the piston.
3. Install the piston in the clutch drum.
4. Position the piston return springs in the piston sockets. Place the spring retainer on the springs.

Reverse-High Clutch Piston Return Spring Locations

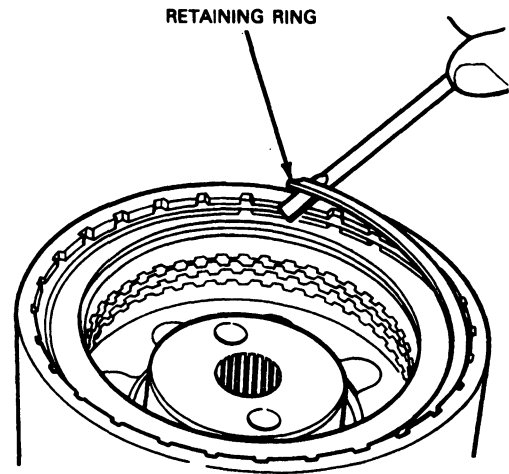
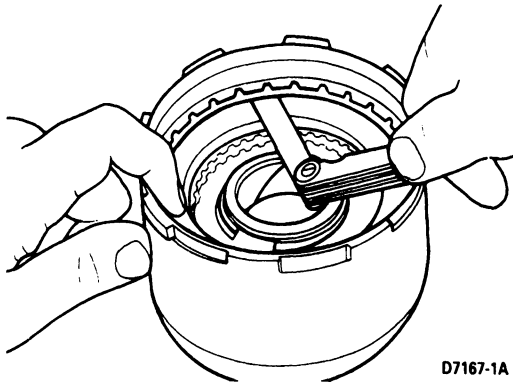
SPRINGS MUST BE INSTALLED
IN POCKETS MARKED X ONLY



5. Install Clutch Spring Compressor T65L-77515-A and compress the springs. Make certain that the spring retainer is centered while compressing the springs. Install the retaining ring. **Before releasing the pressure on the tool, make certain that the retaining ring is positioned inside of the four retaining ring guides on the spring retainer.**
6. Clutch plate usage varies with each model, refer to the Specifications at end of this section for the number of plates required. Dip the clutch plates in clean transmission fluid. Install the clutch plates alternately starting with a steel drive (internal) plate. When new composition clutch plates are used, soak the plates in automatic transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent for 15 minutes before they are assembled.
7. After all clutch plates have been installed, position the pressure plate in the clutch drum. Install the pressure plate (selective) retaining ring.
8. With a feeler gauge, check the clearance between the pressure plate and retaining ring.

DISASSEMBLY AND ASSEMBLY (Continued)

9. The pressure plate should be held downward as the clearance is checked. The clearance should be 0.558-0.914mm (0.022-0.036 inch). If the clearance is not within specifications, selective thickness retaining rings are available in the following thicknesses: 1.42-1.52mm (0.056-0.060 inch), 1.65-1.75mm (0.065-0.069 inch), 1.87-1.98mm (0.074-0.078 inch), 2.10-2.20mm (0.083-0.087 inch), 2.33-2.43mm (0.092-0.096 inch), 2.79-2.89mm (0.110-0.114 inch) and 3.25-3.35mm (0.128-0.132 inch). Install the correct size retaining ring and re-check the clearance.



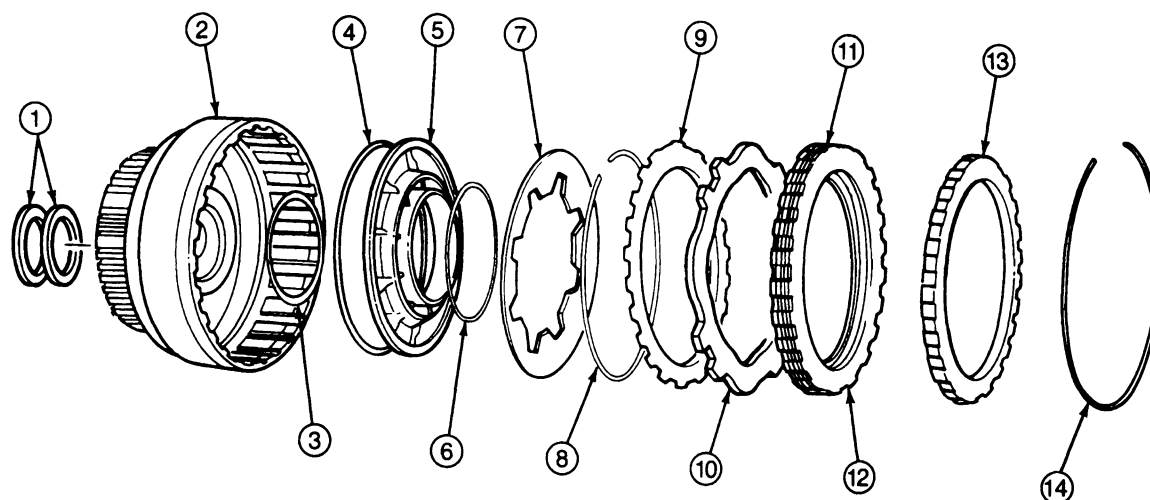
2. Remove the rear pressure plate, the drive and driven plates, wave plate, and the forward pressure plate from the clutch cylinder.

Forward Clutch**Disassembly**

1. Remove the clutch pressure plate retaining ring.

DISASSEMBLY AND ASSEMBLY (Continued)

Forward Clutch



D7169-C

Item	Part Number	Description
1	7D019	Forward Clutch Cylinder Seal (2 Req.)
2	7A360	Forward Clutch Cylinder
3	7C099	Inner Seal
4	7A548	Outer Seal
5	7A262	Piston
6	7D256	Steel Ring
7	7B070	Disc Spring
8	377127-S	Retaining Ring
9	7B066	Forward Pressure Plate

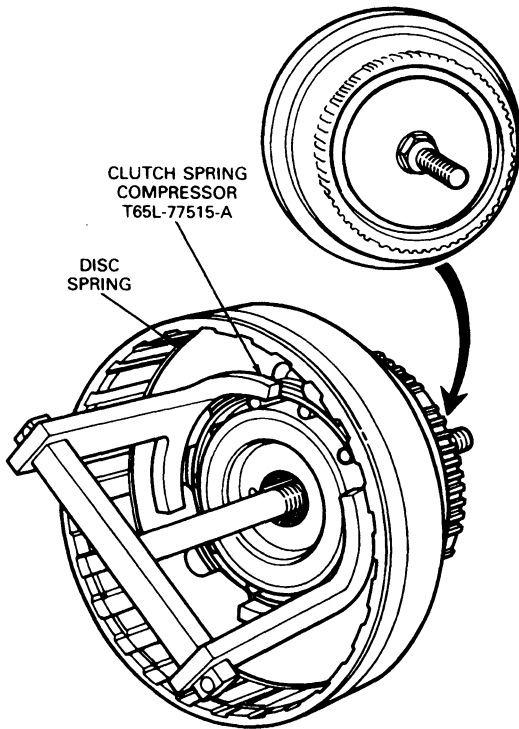
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Item	Part Number	Description
10	7E085	Forward Clutch Pressure Spring
11	7B164	Internal Plates
12	7B442	External Plates
13	7B066	Rear Pressure Plate
14	377127-S	Retaining Ring, Selective Fit
14	377437-S	Retaining Ring, Selective Fit
14	377444-S	Retaining Ring, Selective Fit
14	386841-2-S	Retaining Ring, Selective Fit

TD7169A

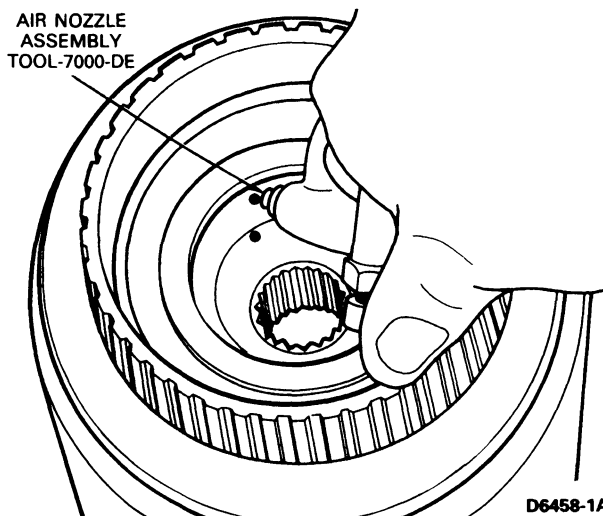
DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove the retaining ring that secures the disc spring in the clutch cylinder. Remove the disc spring and steel ring using Clutch Spring Compressor T65L-77515-A.



D7170-1A

4. Apply air pressure to the clutch cylinder using Air Nozzle Assembly TOOL-7000-DE to remove the piston.

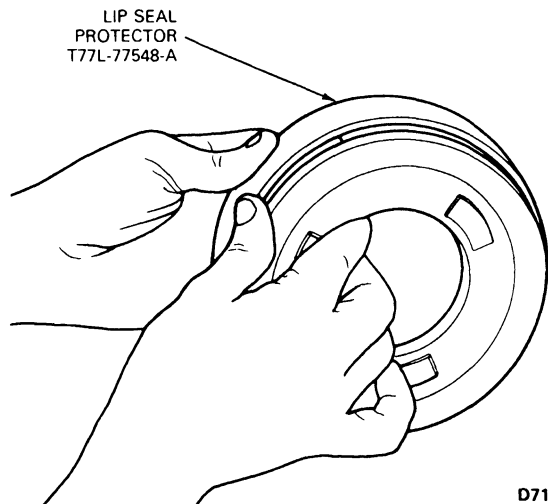


D6458-1A

5. Remove the seal from the piston and the seal from the clutch hub.

Assembly

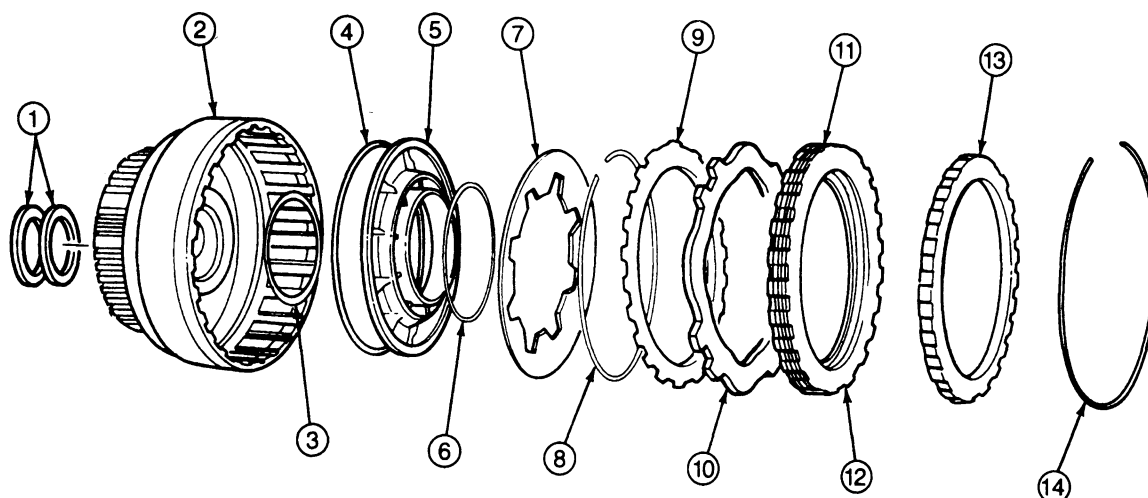
1. Dip two new seals in transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent. Install the smaller seal on the clutch cylinder and the lip seal on the clutch piston.
2. Install the clutch piston and lip seal with Lip Seal Protector T77L-77548-A.



D7171-1A

3. Position the installation tool with the piston into the forward clutch cylinder, so that the bore of the tool is aligned with the piston bore in the cylinder. Press the piston into the cylinder until it bottoms in the bore. Remove the installation tool.
4. Make sure that the steel pressure ring is in the groove on the piston. **Position the disc spring in the cylinder with the dished face downward.** Install the spring so that the pressure ring and spring are in contact. Secure the disc with the retaining ring.
5. Install the forward pressure plate with the flat side up and the beveled side downward. Dip the clutch plates in clean transmission fluid, Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent. Next, install the wave plate, then a steel plate and a composition driven plate. Install the remaining plates in this sequence.

Refer to Specifications at end of this section for the number of plates required. The last plate installed will be the rear pressure plate. Install the retaining ring and make certain that it seats fully in the groove.

DISASSEMBLY AND ASSEMBLY (Continued)**Forward Clutch**

D7169-C

Item	Part Number	Description
1	7D019	Forward Clutch Cylinder Seal (2 Req.)
2	7A360	Forward Clutch Cylinder
3	7C099	Inner Seal
4	7A548	Outer Seal
5	7A262	Piston
6	7D256	Steel Ring
7	7B070	Disc Spring
8	377 127-S	Retaining Ring
9	7B066	Forward Pressure Plate

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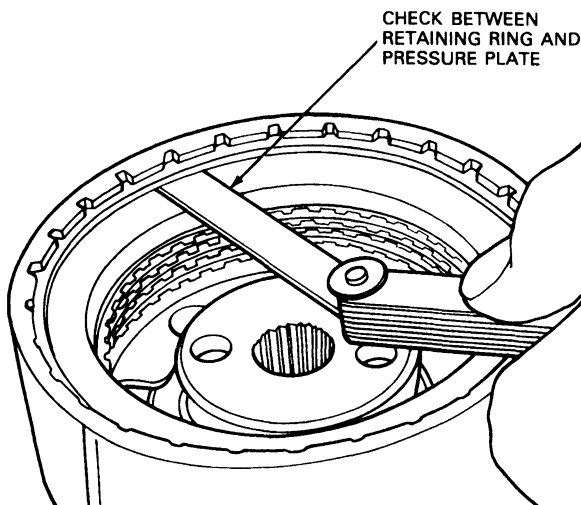
Item	Part Number	Description
10	7E085	Forward Clutch Pressure Spring
11	7B164	Internal Plates
12	7B442	External Plates
13	7B066	Rear Pressure Plate
14	377 127-S	Retaining Ring, Selective Fit
14	377 437-S	Retaining Ring, Selective Fit
14	377 444-S	Retaining Ring, Selective Fit
14	386841-2-S	Retaining Ring, Selective Fit

TD7 169A

6. With a feeler gauge, check the clearance between the retaining ring and the pressure plate. Downward pressure on the plate should be maintained when making this check. Clearance should be 0.533-1.168mm (0.021-0.046 inch).

DISASSEMBLY AND ASSEMBLY (Continued)

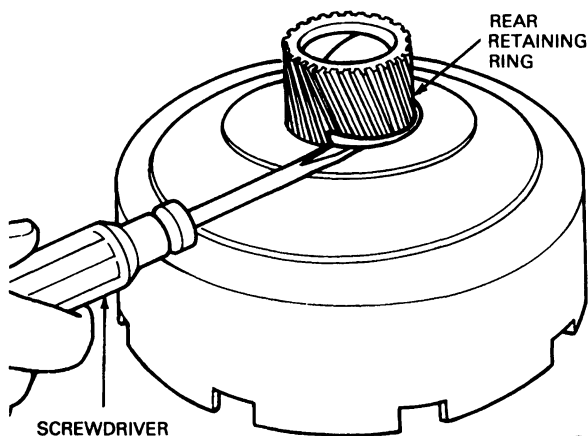
7. If the clearance is not within specifications, selective retaining rings are available in the following thicknesses: 1.42-1.52mm (0.056-0.060 inch), 1.65-1.75mm (0.065-0.069 inch), 1.87-1.98mm (0.074-0.078 inch), 2.10-2.20mm (0.083-0.087 inch), 2.33-2.43mm (0.092-0.096 inch), 2.79-2.89mm (0.110-0.114 inch) and 3.25-3.35mm (0.128-0.132 inch). Insert the correct size retaining ring and recheck the clearance.



D7172-B

Input Shell and Sun Gear**Disassembly**

1. Remove the rear retaining ring from the sun gear.

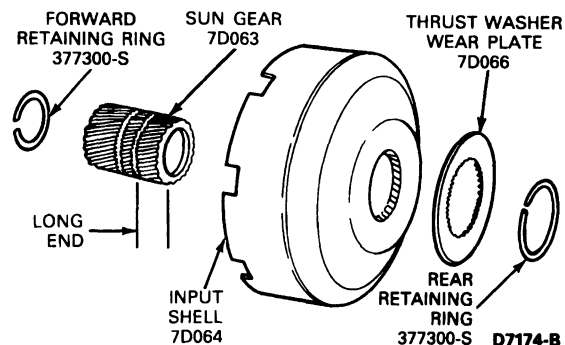


D7173-B

2. Remove the thrust washer wear plate from the input shell and sun gear.
3. Working from inside the input shell remove the sun gear. Remove the retaining ring from the gear.

Assembly

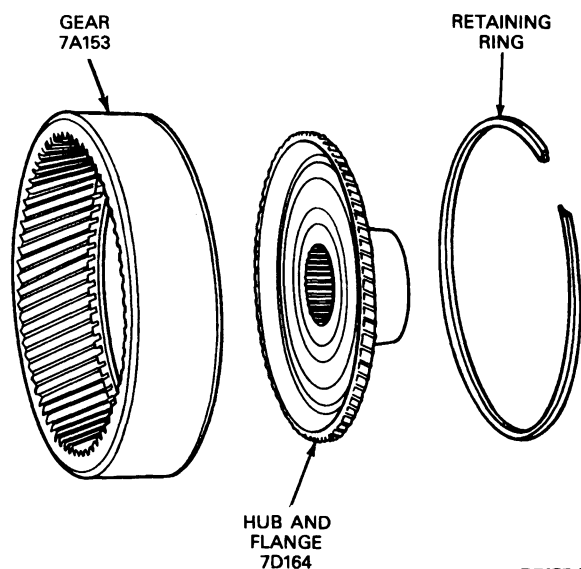
1. Install the forward retaining ring on the forward end (short end) of the sun gear. Working from inside the input shell, slide the sun gear and retaining ring into place making sure that the longer end is at the rear.
2. Place the thrust washer wear plate on the sun gear and install the rear retaining ring.

**Output Shaft Hub and Ring Gear****Disassembly**

1. Remove the hub retaining ring from the ring gear.
2. Lift the hub from the ring gear.

Assembly

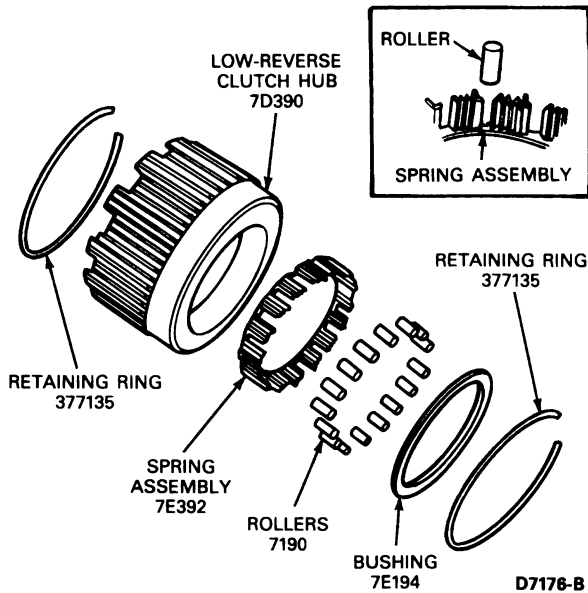
1. Position the hub in the ring gear.
2. Secure the hub with the retaining ring. Make certain that the snap ring is fully engaged with the groove.



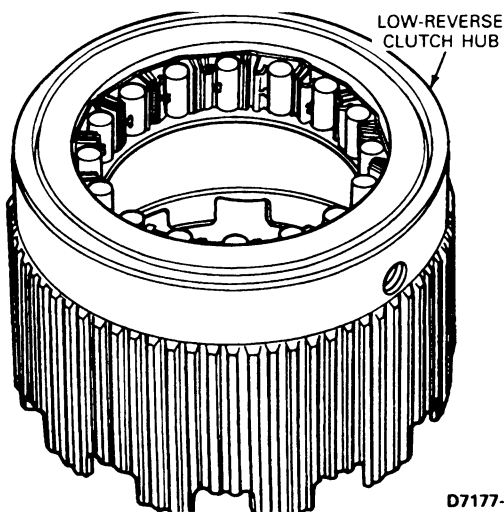
D7175-B

DISASSEMBLY AND ASSEMBLY (Continued)**One-Way Clutch****Disassembly**

1. Remove the retaining ring and bushing from the rear of the low-reverse clutch hub.
2. Remove the rollers from the spring assembly and lift the spring assembly from the hub.
3. Remove the remaining retaining ring from the hub.

**Assembly**

1. Install a retaining ring in the forward retaining ring groove of the low-reverse clutch hub.
2. Place the low-reverse clutch hub on the bench with the forward end down.



3. Install the one-way clutch spring assembly on top of the retaining ring.
4. Install a roller into each of the spring assembly compartments.

5. Install the bushing on top of the spring assembly.
6. Install the remaining retaining ring at the rear of the low-reverse clutch hub to secure the assembly.

Low-Reverse Clutch Piston**Disassembly**

1. Remove the inner and the outer seal from the low-reverse clutch piston.

Assembly

1. Dip the two new seals in clean transmission fluid.
2. Install the seals on the piston.

CLEANING AND INSPECTION**Transmission**

It is important to completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches, and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. The cleaning of debris from the direct clutch piston and forward clutch piston check balls are often omitted. This omission can lead to a repeat servicing of the transmission.

During overhaul, inspect all hardware for evidence of overheating. Any overheating will be indicated by heat stained blue surfaces. Replace any parts that show evidence of overheating.

Clean the parts with suitable solvent and use moisture-free air to dry off all the parts and clean out fluid passages.

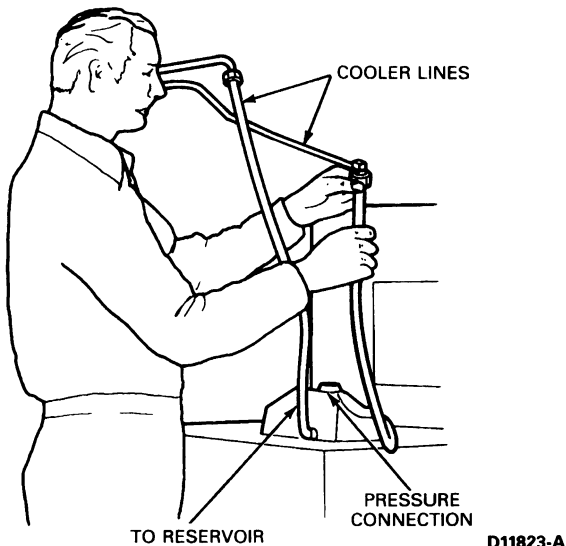
The composition clutch plates, bands and synthetic seals should not be cleaned in a vapor degreaser or with any type of detergent solution. To clean these parts, wipe them off with a lint-free cloth. New clutch plates or bands should be soaked in transmission fluid specified for that transmission type for fifteen minutes before being assembled.

Backflushing and Cleaning Transmission Cooler and Lines

1. Conduct backflushing with a Rotunda Model 14-0028 Torque Converter Cleaner or equivalent. Test your equipment to make sure that a vigorous fluid flow is present before proceeding. Replace the system filter if flow is weak or contaminated.

CLEANING AND INSPECTION (Continued)

2. To aid in attaching the cleaner to the transmission steel cooler lines, connect two additional rubber hoses to the transmission end of the steel transmission cooler lines as described below.
 - Connect the cleaner tank pressure line to the steel transmission cooler **return** line (longest line).
 - Connect a tank return hose to the steel transmission cooler **pressure** line (shorter line). Place the outlet end of this hose in the solvent tank reservoir.
3. Turn on solvent pump and allow the solvent to circulate a minimum of 5 minutes (cycling switch on and off will help dislodge contaminants in cooler system).
4. Switch off the solvent pump and disconnect the solvent pressure hose from the transmission cooler return line.
5. Use compressed air to blow out the cooler(s) and lines (blow air into the transmission cooler return line) until all solvent is removed.
6. Remove the rubber return hose from the remaining steel cooler line.



2. Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs or distortion. Inspect all plugs and valves for burrs or scores. Use crocus cloth to polish valves and plugs. Avoid rounding the sharp edges of the valves and plugs with the cloth.
3. Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight in their respective bores.
4. Inspect the separator plate screen for obstructions. The screen must be clean and free of foreign material. If contaminated, remove it from separator plate, clean in a suitable solvent, and thoroughly blow clean with compressed air.
5. Roll the manual valve on a flat surface to check for bent condition.

Intermediate Servo

1. Inspect the servo bore for cracks and the servo piston for damage, and the piston bore and the servo piston stem for scores. Check fluid passages for obstructions. Replace damaged seals.
2. Check the servo spring and servo band strut(s) for distortion.
3. Inspect the cover seal and gasket cover sealing surface for damage.

Extension Housing

1. Inspect the housing for cracks. Inspect the gasket surface for burrs or warpage.
2. Inspect the bushing for scores or wear. Replace if required.
3. Inspect the rear seal for hardness, cracks, or wear. If the seal shows wear or deterioration, replace the seal.
4. Inspect the seal counterbore and remove all burrs and scores with crocus cloth.

Control Valve Body

1. Clean all parts thoroughly in clean solvent, and blow dry with moisture-free compressed air. **If the valve body-to-screen gasket is removed, the gasket should not be cleaned in a degreaser, solvent or any type of detergent solution. To clean the gasket, wipe it off with a lint-free cloth.**

Governor

1. Inspect the governor valves and bores for scores. Minor scores may be removed from the valves with crocus cloth. Replace the governor if the bores are scored or if the valves are scored beyond the point of being able to be cleaned.
2. Check for free movement of the valves in the bores. The valves should slide freely of their own weight in the bores when dry. Inspect fluid passages in the valve body and counterweight for obstructions. **All fluid passages must be clean.**

CLEANING AND INSPECTION (Continued)

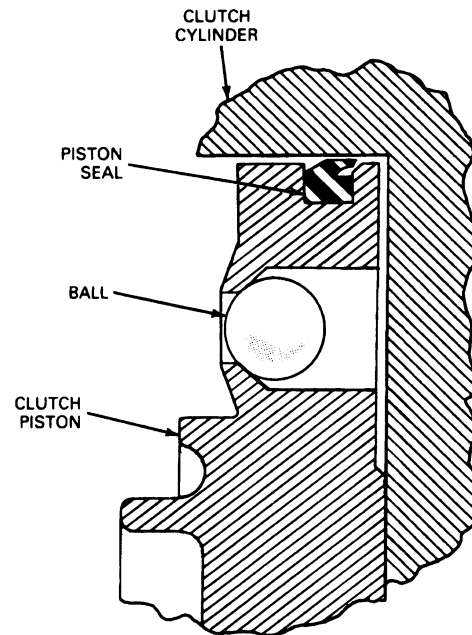
3. Inspect the mating surfaces of the governor body and governor distributor for burrs and distortion. Mating surfaces must be smooth and flat.

Front Pump

1. Inspect the mating surfaces of the pump body and case for burrs.
2. Inspect the drive and driven gear bearing surface for scores and check gear teeth for burrs.
3. Inspect the front pump seal for cuts or nicks, and the pump bushing for scoring.
4. Check the fluid passages for obstructions.
5. If any parts are found damaged or worn, replace the pump as a unit. Minor burrs and scores may be removed with crocus cloth.
6. Check the large seal ring groove of the pump body for damage. Check the gasket mating surface of the pump body for damage.

Reverse-High Clutch

1. Inspect the drum band surface, the bushing, and thrust surfaces for scores. Minor scores may be removed with crocus cloth. **Badly scored parts must be replaced.**
2. Inspect the clutch piston bore and the piston inner and outer bearing surfaces for scores. Check the air bleed ball valve in the clutch piston for free movement. Check the orifice to make sure it is not plugged.
3. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.
4. Inspect the clutch plates for wear, scoring and fit on the clutch hub serrations. Replace all plates that are badly scored, worn or do not fit freely in the hub serrations.
5. Inspect the clutch pressure plate for scores on the clutch plate bearing surface. Check the clutch release spring(s) for distortion.
6. The clutch piston has a check ball similar to that shown. Inspect the check ball for freedom of movement and proper seating.



D2945-1C

Forward Clutch

1. Inspect the clutch cylinder thrust surfaces, piston bore and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.
2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating.
3. Check the clutch release spring for distortion and cracks. Replace the spring if distorted or cracked.
4. Inspect the composition clutch plates, steel clutch plates and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.
5. Check the clutch cylinder thrust surfaces for scores and the clutch cylinder splines for wear.
6. Check the splines on the stator support for wear. Inspect the bushing in the stator support for scores. Check the input shaft for damaged or worn splines. Replace shaft if the splines are excessively worn.

CLEANING AND INSPECTION (Continued)**Low-Reverse Clutch**

1. Inspect the clutch piston bore in the case and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the case if it is badly scored or damaged.
2. Check the fluid passage in the case for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary.
3. Check the piston return springs for distortion. Check the piston return spring retainer for flatness.
4. Inspect the composition clutch plates, steel clutch plates and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.
5. Check the clutch hub splines.

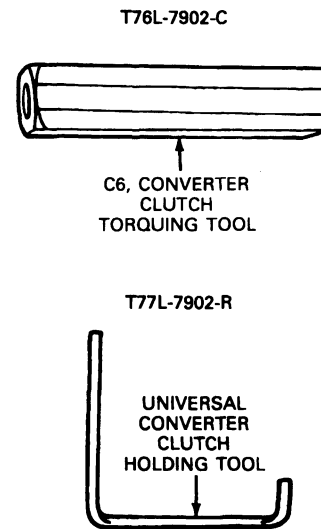
Converter and Fluid Cooler

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and **MUST** be removed from the system before the transmission is put back into service.

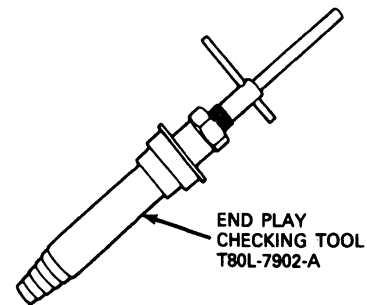
Whenever a transmission has been disassembled to replace worn or damaged parts, or because the valve body valves stick due to foreign material, the converter and oil cooler **MUST** be cleaned by using the Rotunda Torque Converter Cleaner model 014-00028 or equivalent. Under **NO** circumstances should an attempt be made to clean converters by hand agitation with solvent.

Converter End Play and One-Way Clutch Check

Converter Clutch Torquing Tool T76L-7902-C and Converter Clutch Holding Tool T77L-7902-R shown are used to check the converter one-way clutch. Also shown is End Play Checking Tool T80L-7902-A.



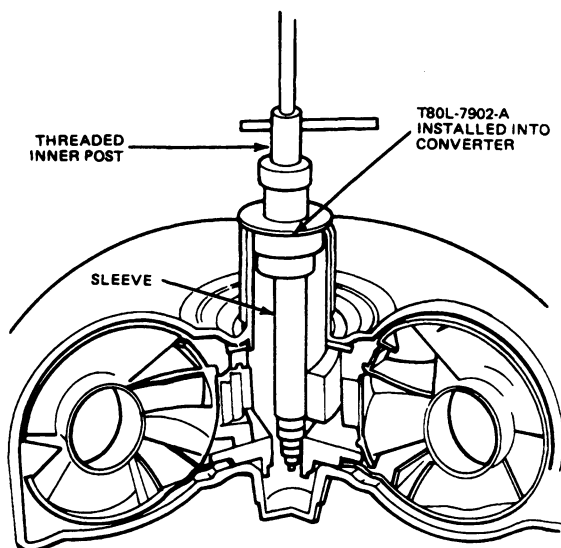
D2946-E



D10721-A

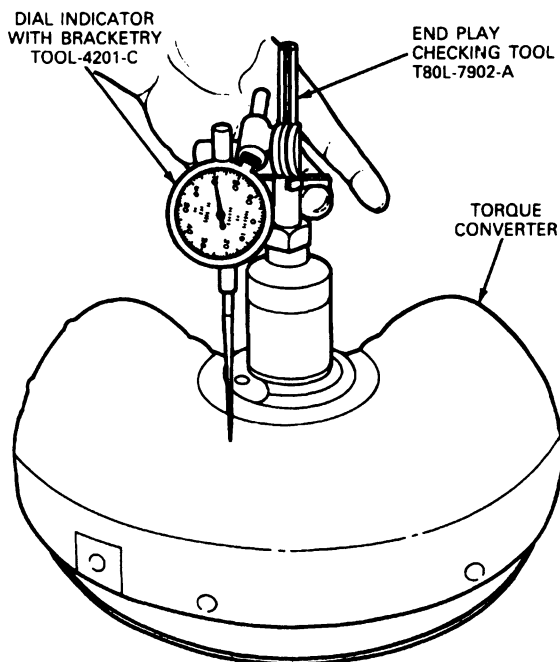
CLEANING AND INSPECTION (Continued)**End Play Check**

1. Insert End Play Checking Tool T80L-7902-A into the converter pump drive hub until it bottoms.



D2878-1C

2. Expand the sleeve in the turbine spline by tightening the threaded inner post, until the tool is securely locked into the spline.
3. Attach a Dial Indicator with Bracketry TOOL-4201-C to the tool. Position the indicator button on the converter pump drive hub, and set the dial face at 0 (zero).

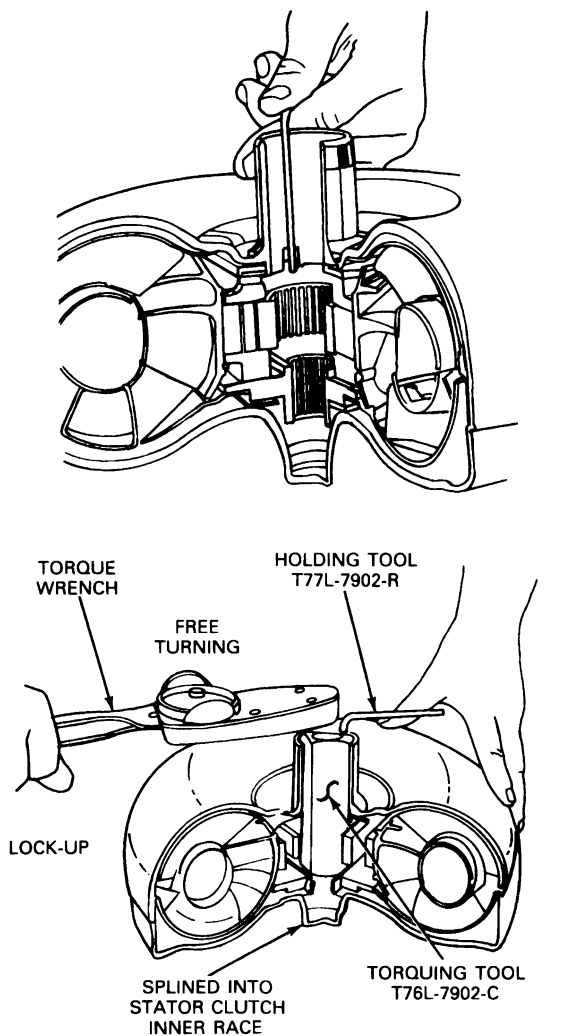


D5723-1A

4. Lift the tool upward as far as it will go and note the indicator reading. The indicator reading is the total end play which the turbine and stator share. Replace the converter unit if the total end play exceeds the limits. End play specifications are listed at the end in the specifications section of this section.
5. Loosen the threaded inner post to free the tool, and then remove the tool from the converter.

Converter One-Way Clutch Check

1. Insert the Converter Clutch Holding Tool T77L-7902-R in one of the grooves in the stator thrust washer.
2. Insert the Converter Clutch Torquing Tool T77L-7902-C in the converter pump drive hub so as to engage the one way clutch inner race.

CLEANING AND INSPECTION (Continued)**Converter One-Way Clutch Check**

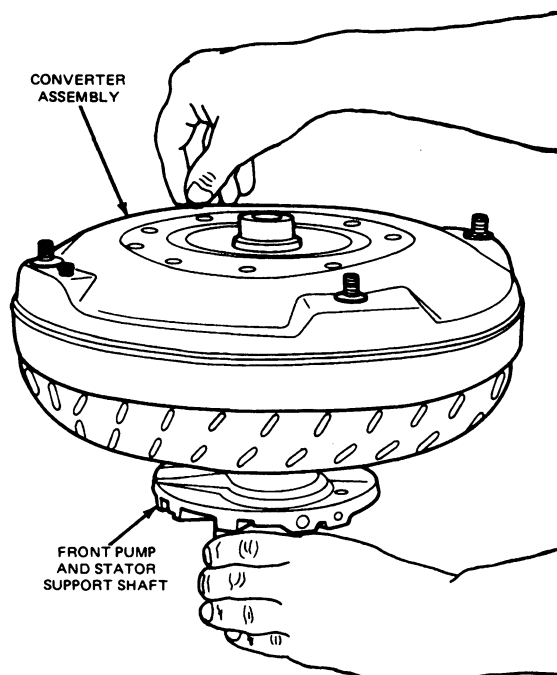
D7394-D

3. Attach a torque wrench to the Converter Clutch Torquing tool. With the one way clutch holding tool held stationary, turn the torque wrench counterclockwise. The converter one way clutch should lockup and hold a 14 N·m (10 ft-lb) force. The converter one way clutch should rotate freely in a clockwise direction. Try the clutch for lockup and hold in at least five different locations around the converter.
4. If the clutch fails to lock up and hold at 14 N·m (10 ft-lb) torque, replace the torque converter.

Stator to Impeller Interference Check

1. Position the front pump assembly on a bench with the spline end of the stator shaft pointing up.
2. Mount a converter on the pump with the splines on the one-way clutch inner race engaging the mating splines of the stator support. The converter hub will then engage the pump drive gear.

3. Hold the pump stationary and try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.
4. If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the converter.



D4821-1A

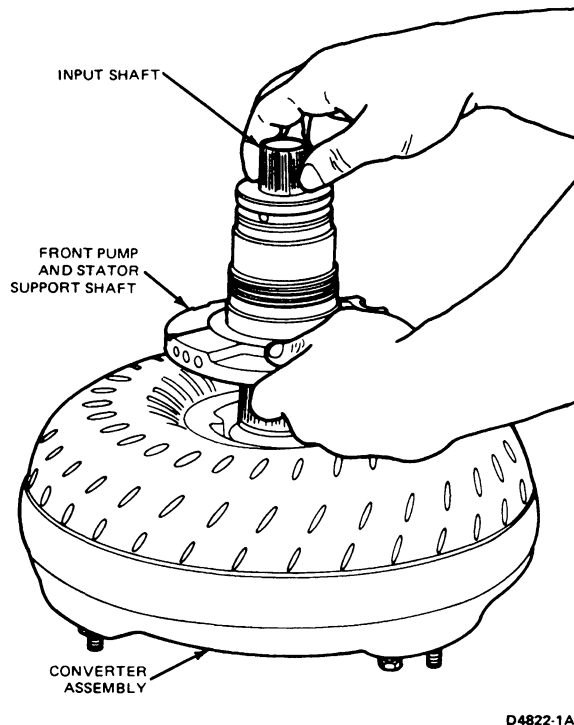
Stator-to-Turbine Interference Check

1. Position the converter on the bench front side down.
2. Install a front pump assembly to engage the mating splines of the stator support and stator, and pump drive gear lugs.
3. Install the input shaft, engaging the splines with the turbine hub.
4. Hold the pump stationary and attempt to rotate the turbine with the input shaft. The turbine should rotate freely in both directions without any signs of interference or scraping noise.

CLEANING AND INSPECTION (Continued)

5. If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. In such cases, the converter must be replaced.

Check the converter crankshaft pilot for nicks or damaged surfaces that could cause interference when installing the converter into the crankshaft. Check the converter front pump drive hub for nicks or sharp edges that would damage the pump seal.



Pinion Carriers

Individual parts of the planet carriers are not serviceable.

1. Check the pins and shafts in the planet assemblies for loose fit and/or complete disengagement. Use a new planet assembly if either condition exists. Before installing a planet assembly, the shaft retaining pins should be checked for adequate staking. If necessary, restake the pins before installation. When restaking, the retaining pins must not be driven into the carrier any further than 1.01mm (0.040 inch) below the surface of the carrier.
2. Inspect the pinion gears for damaged or excessively worn teeth.
3. Check for free rotation of the pinion gears.

Stator Support

1. Inspect the stator support splines for burrs and wear.
2. Check the oil ring grooves in the stator support for nicks, burrs or damaged edges.
3. Check the front and rear bushings of the stator support for wear or scoring. If worn the forward clutch cylinder will wear into or score the stator support. Replace stator support assembly if worn.

Case

1. Inspect the case for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions, and check all fluid passages for obstructions and leakage.
2. Inspect the case bushing for scores. Check all parking linkage parts for wear or damage.
If a transmission case thread is damaged, service kits may be purchased from local jobbers. To repair a damaged thread, the following procedures should be carefully followed.
3. Drill out the damaged threads **using the same drill size as the thread outside diameter**. For example, use a 5/16-inch drill for a 5/16-18 thread.
4. Select the proper special tap and tap the drilled hole. The tap is marked for the size of the thread being repaired. Thus, the special tap marked 5/16-18 will not cut the same thread as a standard 5/16-18 tap. The tap cuts a thread large enough to accommodate the insert, and after the insert is installed, the original thread size (5/16-18) is restored.
5. Select the proper coil inserting tool. These tools are marked with the thread size being repaired. Place the insert on the tool and adjust the sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is 1/2 turn below the face.
6. Working through the insert, bend the insert tang straight up and down until it breaks off at the notch.
7. Improperly installed inserts can be removed with the extractor tool. Place the extractor tool in the insert with the blade resting against the top coil 1/4 to 1/2 turn away from the end of the coil. Tap the tool sharply with a hammer until the blade cuts into the insert. Exert downward pressure on the tool and turn counterclockwise until the insert is removed.

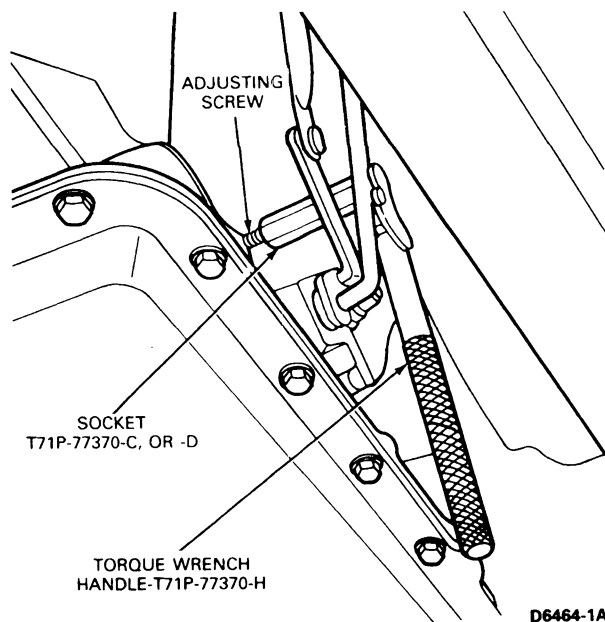
ADJUSTMENTS

The only adjustments on the transmission are the intermediate band and the park neutral position switch switch.

To prevent damage to the transmission and to assure proper band adjustment, it is essential that the tools and procedures described here are used whenever the band is adjusted.

Intermediate Band Adjustment

1. Raise the vehicle on a hoist and position safety stands under vehicle.
2. Clean all the dirt from the band adjusting screw. Remove and discard locknut.
3. Install a new locknut and tighten the adjusting screw to 14 N·m (10 ft-lb) torque.
4. **Back off the adjusting screw exactly 1-1/2 turns.**
5. Hold the adjusting screw from turning and tighten the new locknut to 48-61 N·m (35-40 ft-lb).
6. Remove safety stands and lower the vehicle.

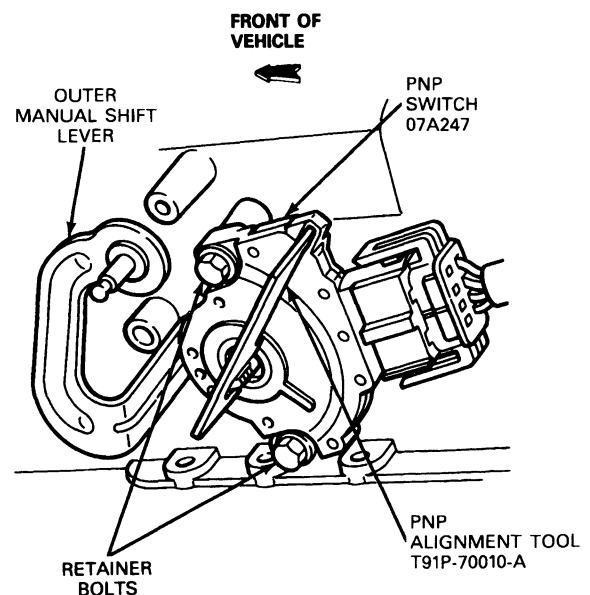


Park/Neutral Position (PNP) Switch

1. Set the vehicle parking brake.
2. Set the transmission in the NEUTRAL position.
3. With the manual shift cable properly adjusted, loosen the switch attaching bolts.
4. Insert park neutral position switch Alignment Tool T91P-70010-A onto the park neutral position switch into the three slots provided on the switch actuator and terminal plate.

NOTE: Check to make sure that each leg of the tool is seated in its slot.

5. Leaving the alignment tool in place, tighten the attaching bolts to 7-8 N·m (55-75 in-lb).
6. Remove the alignment tool at this time. Adjustment can be confirmed visually by making sure the line etched in the actuator and the line etched in the housing are in a straight line when the switch is centered in neutral.
7. Check the operation of the switch. The backup lamps should operate only with the transmission selector lever in REVERSE. The vehicle should start only with the transmission selector lever in PARK or NEUTRAL.



SPECIFICATIONS

Refer to the following charts for transmission specifications.

TRANSMISSION REFILL CAPACITY — (Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid E4AZ-19582-B or equivalent)

Vehicle	U.S. Quarts	Capacity Imperial Quarts	Liters
F-150-250-350 (4x2), E-150-250-350	11-3/4	9.4	11.2
F-250-350 (4x4)	13-1/2	10.8	12.7

TD10987A

SPECIFICATIONS (Continued)

SELECTIVE THRUST WASHERS (FRONT PUMP SUPPORT)

Identification Color	Thickness	
	mm	Inch
Blue	1.42-1.52	0.056-0.060
Natural (White)	1.85-1.95	0.073-0.077
Red	2.23-2.33	0.088-0.092

TD 10988A

TRANSMISSION CLUTCH PLATE USAGE

Transmission Clutch	4.9L	5.0L	5.8L	7.3L	7.5L	Clearance	
						mm	Inch
Forward Clutch							
Steel	3 ^a	3 ^a	4 ^a	4 ^a	4 ^a		
Friction	3	3	4	4	4	0.533-1.168	0.021-0.046
High Clutch							
Steel	3 ^a	3 ^a	4 ^a	4 ^a	4 ^a		
Friction	3	3	4	4	4	0.558-0.914	0.022-0.036
Reverse Clutch							
Steel	4 ^b	4 ^b	5 ^b	5 ^b	6 ^b		
Friction	4	4	5	5	6	—	—

a Plus a waved plate (7E457) next to inner pressure plate

b Plus a waved plate next to the piston

TD 10989A

CLUTCH RETAINING RINGS

Part Number	Thickness		Forward	High
	mm	inch		
377434	1.52-1.42	0.060-0.056	X	X
377126	1.75-1.62	0.069-0.064		X
377127	1.98-1.87	0.078-0.074	X	X
377128	2.20-2.10	0.087-0.083		X
377444	2.43-2.33	0.096-0.092	X	X
386841	2.89-2.79	0.114-0.110	X	
386842	3.35-3.25	0.132-0.128	X	

TD 10990A

CHECKS AND ADJUSTMENTS

Operation	Specification
Transmission End Play	0.203-1.117mm (0.008-0.044 inch) (Selective Thrust Washers Available)
Torque Converter End Play	New or rebuilt 0.533mm (0.021 inch) max. Used 1.016mm (0.040 inch) max. To check end play, exert force on checking tool to compress turbine to cover thrust washer wear plate. Set indicator at zero.
Intermediate Band Adjustment	Remove and discard locknut. Install new locknut. Adjust screw to 14 N·m (10 ft·lb) torque, then back off 1-1/2 turns. Hold screw and tighten locknut to 54 N·m (40 ft·lb)

(Continued)

CHECKS AND ADJUSTMENTS (Cont'd)

Operation	Specification
Forward Clutch Pressure Plate-to-Retaining Ring Clearance	0.533-1.168mm (0.021-0.046 inch)
Selection Retaining Ring Thickness	1.42-1.52mm (0.056-0.060 inch) 1.62-1.75mm (0.064-0.069 inch) 1.87-1.98mm (0.074-0.078 inch) 2.10-2.20mm (0.083-0.087 inch) 2.33-2.43mm (0.092-0.096 inch) 2.79-2.89mm (0.110-0.114 inch) 3.25-3.35mm (0.128-0.132 inch)
Reverse-High Clutch Pressure Plate-to-Retaining Ring Clearance	0.558-0.914mm (0.022-0.036 inch)

(Continued)

SPECIFICATIONS (Continued)

CHECKS AND ADJUSTMENTS (Cont'd)

Operation	Specification
Selective Retaining Ring Thickness	1.42-1.52mm (0.056-0.060 inch)
	1.62-1.75mm (0.064-0.069 inch)
	1.87-1.98mm (0.074-0.078 inch)
	2.10-2.20mm (0.083-0.087 inch)
	2.33-2.43mm (0.092-0.097 inch)

TD2845A

AUTOMATIC TRANSMISSION REFILL CAPACITY — C6 AND AOD AUTOMATIC TRANSMISSION

Vehicle	Transmission Type	Engine	Approximate Refill Capacity ^a		
			U.S. Quarts	Imperial Quarts	Liters
E-150 — E-250 — E-350	C6 ^b	4.9L (300 CID) I-6 5.8L (351 CID) V-8 7.5L (460 CID) V-8 7.3L Diesel	12	9.6	11.4
F-250 — F-350 (4x2)	C6 ^b	4.9L (300 CID) I-6 5.0L (302 CID) V-8 5.8L (351 CID) V-8 7.5L (460 CID) V-8 7.3L Diesel	12	9.6	11.4
F-250 — F-350 (4x4)	C6 ^b	5.8L (351 CID) V-8 7.5L (460 CID) V-8	13.5	10.8	12.8

a Approximate dry capacity, includes cooler and lines. Fluid level indicator should be used to determine actual fluid requirements and fluid specifications. Check level at normal operating temperature. DO NOT OVERFILL.

b Use Motorcraft MERCON® Multi-Purpose Transmission Fluid E4AZ-19582-B (ESP-M2C166-H).

If it is necessary to add or replace fluids, use fluids which have been certified by the supplier as meeting one of the Ford Motor Company specifications shown below:

TORQUE CONVERTER END PLAY — C6

Converter End Play			
New or Rebuilt Converter		Used Converter	
mm	Inch	mm	Inch
0.533 Max.	0.021 Max.	1.01 Max.	0.040 Max.

TD2950A

STALL SPEED SPECIFICATIONS — C6

Vehicle Application	Engine Disp.	Converter Size	Stall Speed	
			Min.	Max.
F-150/250/350 E-150/250/350	4.9L	12 inch	1560	1870
F-250/350	5.8L	12 inch	2240	2640
F-250/350 E-250/350	7.3L	12 inch	1700	1960
F-250/350 E-250/350	7.5L	12 inch	1950	2300

TD4824A

SPECIFICATIONS (Continued)

VACUUM DIAPHRAGM ASSEMBLY SPECIFICATION

Transmission Type	Diaphragm Type	Diaphragm Part No.	Identification	Throttle Valve Rod #		
				Part No. (7A380)	Length	Identification
C6	HAD	D7AP-7A337-AA	Part No. Stamped	C4AP-A	1.677-1.667	No Color
	SAD	D70P-7A377-BA	1 Green Stripe	D1AP-BA	1.727-1.717	Purple Daub
	SAD	D4TP-7A377-BA	1 Black Stripe	D3AP-DA	1.611-1.601	Yellow Daub
	SAD	D5AP-7A377-AA	1 Purple Stripe	D3AP-EA	1.644-1.634	Blue Daub
				D3AP-FA	1.660-1.650	Green Daub
				D3AP-GA	1.710-1.700	White Daub
				D8AP-AA	1.694-1.684	Brown Daub

Selective fit rods

SAD — Single Area Diaphragm

HAD — High Altitude Diaphragm

CD2948-2F

TORQUE LIMITS

Item	N-m	(Ft-Lb)
Converter to Flywheel	28-45	20-34
Converter Drain Plug	11-37	8-27
Front Pump to Transmission Case	22-40	16-30
Overrunning Clutch Race to Case	25-33	18-25
Oil Pan to Case	11-16	8-12
Stator Support to Pump	17-21	12-16
Converter Cover to Converter Housing (all except 7.5L)	17-21	12-16
Guide Plate to Case	17-21	12-16
Intermediate Servo Cover to Case	10-16	14-22
Distributor Sleeve to Case	17-21	12-16
Extension Assembly to Transmission Case	34-47	25-35
Plug — Case Front Pump or Line Pressure	8.5-16	6-12
Pressure Gauge Tap	8.5-16	6-12
Band Adjusting Screw Locknut to Case	48-61	35-45
Converter Drain Plug	11-37	8-28
Manual Valve Inner Lever to Shaft	51-54	30-40
Downshift Lever to Shaft	17-21	12-16
Filler Tube to Engine (Econoline 5.8L)	54-67	40-50
Filler Tube to Engine (Econoline 4.9L)	44-56	33-42
Filler Tube to Engine (Econoline 7.3L)	32-47	24-35
Transmission to Engine (Gas Engines)	55-67	40-50
Plug Case — Throttle Pressure	8.5-16	6-12
5 / 16 inch Fitting — Cooler Line Connector to Case — Front and Rear (Case Fitting)	25-32	18-23
5 / 16 inch Tube Nut — Cooler Line to Transfer Case Fitting	17-24	12-18
Transmission-to-Engine (Diesel Engine)	68-88	50-65
Starter Bolts (Gas Engines)	54-68	40-50

(Continued)

TORQUE LIMITS (Cont'd)

Item	N-m	(Ft-Lb)
Starter Bolts (Diesel Engines)	68-88	50-65
Transmission Insulator-to-Frame Nuts, F-Series	96-128	70-94
Transmission Insulator-to-Extension Housing Bolts, F-Series	81-108	60-80
Transmission Insulator-to-Frame Nuts, E-Series	68-94	50-70
Transmission Insulator-to-Extension Housing Bolts, E-Series	68-94	50-70
Vacuum Diaphragm / Heat Shield-to-Case Bolt	16-22	12-16
Governor Collector-to-Case Bolts	16-22	12-16

TD4721A

TORQUE LIMITS

Item	N-m	(In-Lb)
Shift Valve Plate to Body (2)	3-5	27-44
Boost Valve Plate to Body (6)	3-4	27-35
Inner Downshift Lever Stop	2.5-5	20-45
Reinforcement Plate to Body	2.5-5	20-45
Screen and Lower to Upper Valve Body	5-6.2	40-55
Shift Valve Plate to Upper Body	2.5-5	20-45
Upper to Lower Body	5-6.2	40-55
Reinforcing Right Side Plate to Lower Body	3-5	27-44
Converter Housing Cover to Converter Housing (7.5L)	4-7	35-54
Control Assembly to Case	11-14	95-125
Governor Body to Collector Body	11-13	97-115
Detent Spring to Case	9.5-13.5	80-120
Park / Neutral Position Switch to Case	6.5-8	55-75




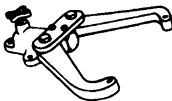
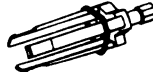

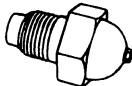

TD11824A

SPECIFICATIONS (Continued)**CLUTCH AND BAND APPLICATION CHART**







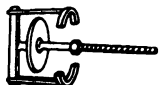
Gear	Forward Clutch	One Way Clutch	Low Reverse Clutch	Intermediate Band	Reverse High Clutch
1st Gear — Manual Low	Applied		Applied		
2nd Gear — 2	Applied			Applied	
1st Gear — D	Applied	Holding			
2nd Gear — D	Applied			Applied	
3rd Gear — D	Applied				Applied
Reverse (R)			Applied		Applied

TD7744A

SPECIAL SERVICE TOOLS/EQUIPMENT


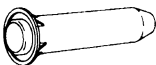


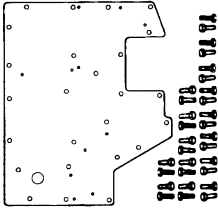



Tool Number/ Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T59L-100-B Impact Slide Hammer	 T59L-100-B
T58L-101-B Puller Attachment	 T58L-101-B
T57L-500-B Bench Mounted Holding Fixture	 T57L-500-B
TOOL-1175-AC Seal Remover	 TOOL-1175-AC
TOOL-4201-C Dial Indicator With Bracketry	 TOOL-4201-C
TOOL-7000-DD Rubber Tip For Air Nozzle	 TOOL-7000-DD
TOOL-7000-DE Air Nozzle Assembly	 TOOL-7000-DE

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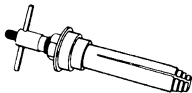
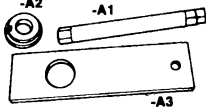
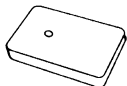

Tool Number/ Description	Illustration
T66L-7003-C2 Front Pump Bushing Replacer	 T66L-7003-C2
T61L-7657-B Extension Housing Seal Replacer	 T61L-7657-B
T77L-7697-C Extension Housing Bushing Replacer	 T77L-7697-C
T77L-7697-D Extension Housing Bushing Remover	 T77L-7697-D
TOOL-77288 Shift Lever Seal Replacer	 TOOL-77288
T71P-77370-A Band Adjustment Torque Wrench Set	 T71P-77370-A
T65L-77515-A Clutch Spring Compressor	 T65L-77515-A

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

Tool Number/ Description	Illustration
T77L-77548-A Lip Seal Protector	 T77L-77548-A
T87L-77837-AH Front Pump Seal Replacer	 T87L-77837-AH
T69L-7D044-B Clutch Housing Bushing Tool	 T69L-7D044-B
T91P-70010-A MLPS Alignment Tool	 T91P-70010-A
T82L-7006-A Air Pressure Check Plate	 T82L-7006-A
T82P-7006-C Cap Screws for Air Pressure Check Plate	 T82P-7006-C
T76L-7902-C Converter Clutch Torquing Tool	 T76L-7902-C
T77L-7902-R Converter Clutch Holding Tool	 T77L-7902-R

(Continued)

Tool Number/ Description	Illustration
T80L-7902-A Torque Converter End Play Checking Tool	 T80L-7902-A
T83L-7902-A Converter Checking Tool Kit	 T83L-7902-A
T80L-77030-B Servo Piston Remover	 T80L-77030-B
T83T-7B200-AH VRV (Vacuum Regulator Valve)	 T83T-7B200-AH

ROTUNDA EQUIPMENT

Tool Number	Description
014-00106	Engine / Transmission Stand
077-00019	Transmission Jack
014-00028	Torque Converter Cleaner
021-00054	Torque Converter Leak Tester
014-00737	Automatic Transmission Tester
021-00014	Vacuum Tester
059-00008	Vacuum and Pressure Tester

SECTION 07-01C Transmission, Automatic, AOD

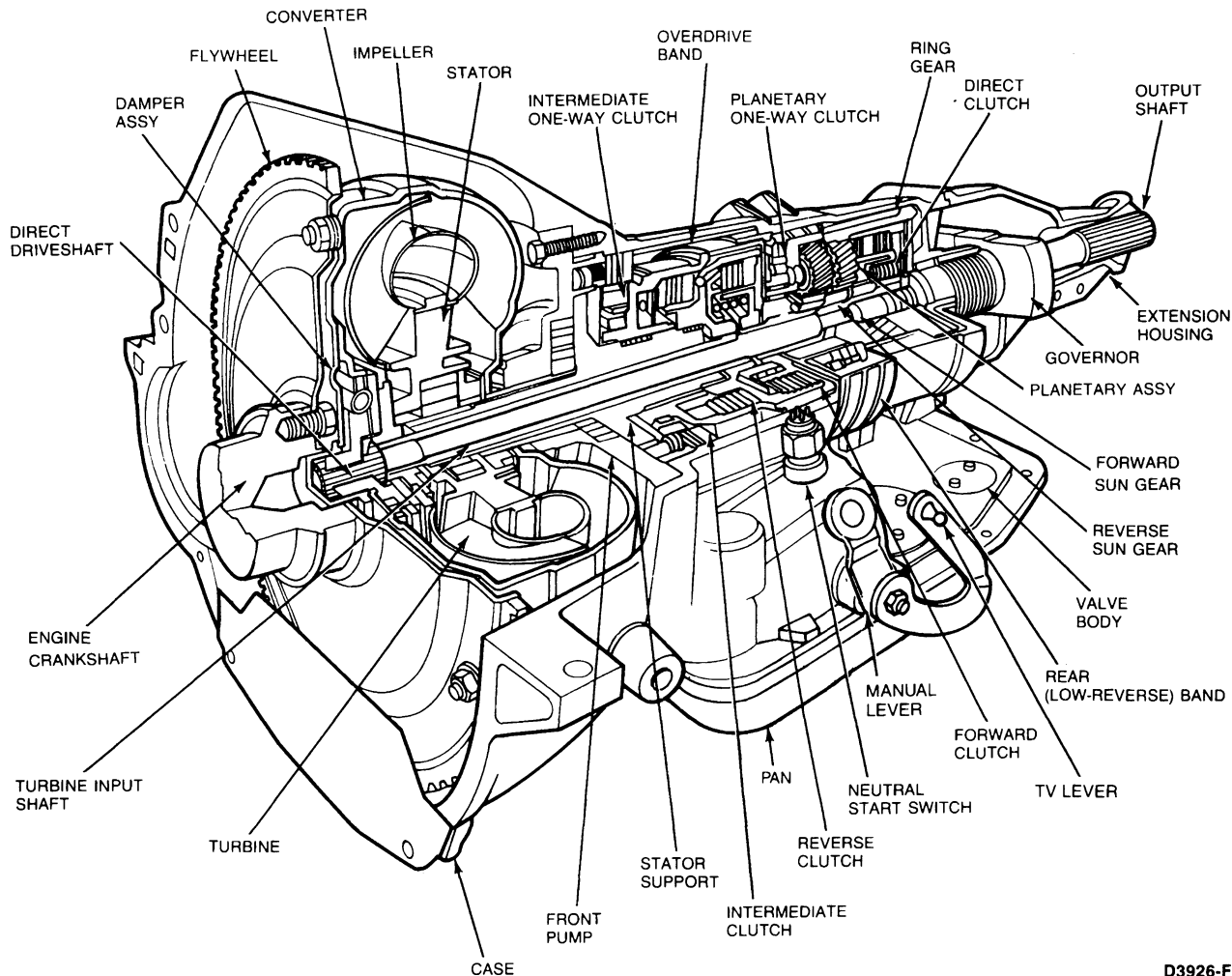
SUBJECT	PAGE	SUBJECT	PAGE
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VEHICLE APPLICATION

E-150, F150, Bronco Vehicles Under 8500 GVW
Equipped with 5.0L Engines and Automatic Overdrive
(AOD) Transmissions

DESCRIPTION

The following illustration shows the location of the converter, front pump, clutches, gear train and most of the internal parts used in the Automatic Overdrive (AOD) Transmission.



D3926-F

The Automatic Overdrive Transmission provides fully automatic operation in either the **Ⓓ** (OVERDRIVE) or **D** (3-OVERDRIVE LOCK OUT) positions.

NOTE: A 2 (SECOND) selector position replaces the 1 (LOW) selector position in vehicles equipped with the low gear lock out position.

Ⓓ (OVERDRIVE)—This is the normal driving position for an automatic overdrive transmission. In this position the transmission starts in first gear and as the vehicle accelerates, automatically upshifts to second, third and fourth (overdrive) gear. The transmission will automatically downshift as vehicle speed decreases.

NOTE: The transmission will not shift into or remain in overdrive gear when the accelerator is pushed to the floor.

The Automatic Overdrive Transmission differs from the conventional 3-speed automatic transmission in that the planetary gear set operates in fourth gear. Some noise may be heard while in fourth gear (overdrive). This noise may be described as a light whine, and should be considered normal. During diagnosis, care should be taken not to mistake other audible abnormal noises as normal.

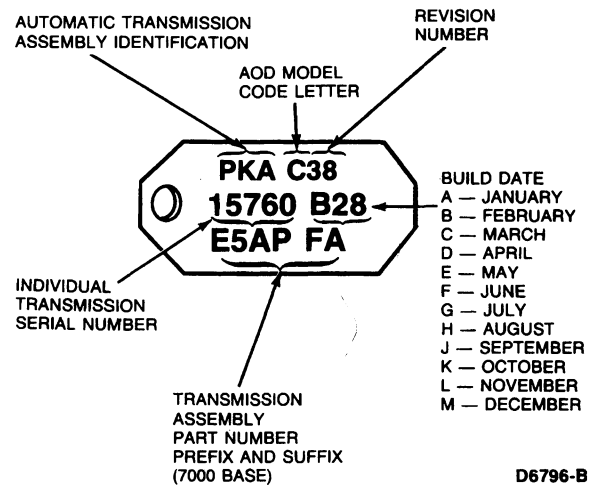
D (OVERDRIVE LOCK OUT)—In this position the transmission operates as in **Ⓓ** (OVERDRIVE) except there will be no shift into the overdrive gear. This position may be used when driving up or down mountainous roads to provide better performance and greater engine braking than the overdrive position. The transmission may be shifted from **Ⓓ** to D or D to **Ⓓ** at any vehicle speed.

DESCRIPTION (Continued)

1 (LOW)—This position can be used when maximum engine braking is desired. To help brake the vehicle on hilly roads where D (OVERDRIVE LOCK OUT) does not provide enough braking, shift the selector lever to 1 (LOW). At vehicle speeds above approximately 40 km/h (25 mph), the transmission will shift to second gear and remain in second gear. When vehicle speed drops below 40 km/h (25 mph), the transmission will downshift to first gear and remain in first gear. Upshifts from 1 (LOW) can be made by manually shifting to \odot (OVERDRIVE) or D (OVERDRIVE LOCK OUT). When 1 (LOW) is used for starting up, the transmission starts in first gear and stays in first gear.

FORCED DOWNSHIFTS—At vehicle speeds from 89-40 km/h (55-25 mph), in \odot (OVERDRIVE) or D (OVERDRIVE LOCK OUT), the transmission will downshift to second gear when the accelerator is pushed to the floor. At vehicle speeds below 40 km/h (25 mph), the transmission will downshift to first gear when the accelerator is pushed to the floor.

At most vehicle speeds in \odot (OVERDRIVE), the transmission will downshift from fourth gear to third gear when the accelerator is pushed for moderate to heavy acceleration.

AOD TRANSMISSION IDENTIFICATION TAG — TYPICAL**Transmission Identification**

All vehicles are equipped with a Vehicle Certification Label, affixed to the LH (driver's) side door lock post.

Refer to the code in the space marked TR on the Vehicle Certification Label for proper transmission identification.

1FABP43F2FZ100001								
VEHICLE IDENTIFICATION NUMBER								
MFD. BY FORD MOTOR CO. IN U.S.A.								
DATE: 09/87	GVWR: 5347 LB - 2425 KG							
FRONT GAWR: 2714 LB	REAR GAWR: 2683 LB							
1231 KG	1216 KG							
THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY AND BUMPER STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.								
VEH. IDENT. NO. 1FABP43MZGX100001								
TYPE PASSENGER								
2A								
EXTERIOR PAINT COLORS								
BODY	VR	MLDG.	INT. TRIM	A/C	R	S	AX	TR
54K	YP	S9P	GG	A	2	8	8	T8888

TRANSMISSION CODE

TRANSMISSION TYPE	TRANSMISSION CODE
T	AUTOMATIC

D2116-U

DESCRIPTION (Continued)

For additional information such as: model, service ID level or build date, refer to the transmission ID tag which is attached to the transmission case.

AUTOMATIC TRANSMISSION MODEL IDENTIFICATION		
MODELS ARE IDENTIFIED BY A SERVICE IDENTIFICATION TAG AFFIXED TO THE ASSEMBLY. TAGS ARE LOCATED AND CONTAIN INFORMATION AS FOLLOWS:		
<u>BASIC MODEL</u>	<u>TAG LOCATION</u>	<u>INFORMATION (TYPICAL)</u>
AOD	MIDDLE LH EXTENSION TO CASE ATTACHING BOLT, (NO. 6 POSITION).	<div> <div>TRANSMISSION MODEL</div> <div>BUILD DATE CODE</div> <div>ASSEMBLY PART NO. PREFIX AND SUFFIX</div> <div>SERIAL NO.</div> </div>

CD7290-A

DIAGNOSIS AND TESTING

Troubleshooting the automatic transmission is simplified by using the proven method of diagnosis. One of the most important things to remember is that there is a definite procedure to follow. Do not take short cuts or assume that critical checks or adjustments have already been made.

The following procedures are recommended for checking and /or verifying that the various components are adjusted and operating properly. Use Rotunda Automatic Transmission Tester 014-00737 or equivalent. Follow the manufacturer's instructions.

Diagnosis Charts

The following diagnosis charts can be used as an aid in diagnosing the Automatic Overdrive Transmission.

AUTOMATIC TRANSMISSION DIAGNOSIS


CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> Slow Initial Engagement 	<ul style="list-style-type: none"> Improper fluid level. Damaged or improperly adjusted linkage. Contaminated fluid. Improper clutch and band application, or low main control pressure. 	<ul style="list-style-type: none"> Perform fluid level check. Service or adjust linkage. Perform fluid condition check. Perform control pressure test.
<ul style="list-style-type: none"> Rough Initial Engagement 	<ul style="list-style-type: none"> Improper fluid level. High engine idle. Looseness in the driveshaft, U-joints or engine mounts. Improper clutch or band application, or oil control pressure. Sticking or dirty valve body. 	<ul style="list-style-type: none"> Perform fluid level check. Adjust idle to specifications. Service as required. Perform control pressure test. Clean, service or replace valve body.

DIAGNOSIS AND TESTING (Continued)**AUTOMATIC TRANSMISSION DIAGNOSIS (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> ● Harsh Engagements—(Warm Engine) 	<ul style="list-style-type: none"> ● Improper fluid level. ● TV linkage misadjusted (high TV), disconnected / sticking / damaged return spring disconnected. ● Engine curb idle too high. ● Valve body bolts—loose / too tight. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Adjust or service TV linkage. ● Check engine curb idle. ● Tighten to 9-11 N-m (80-97 lb-in).
<ul style="list-style-type: none"> ● No or Delayed Forward Engagement (Reverse OK) 	<ul style="list-style-type: none"> ● Improper fluid level. ● Manual linkage—misadjusted / damaged ● Low main control pressure (leakage). ● Forward clutch stator support seal rings leaking (No. 3 and No. 4). ● Forward clutch assembly burnt / damaged. ● Forward clutch cylinder check ball leaking / leaking piston seal rings. ● Valve body bolts—loose / too tight. ● Valve body dirty / sticking valves. ● Transmission filter plugged. ● Pump damaged / leaking. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Check and adjust or service as required. ● Control pressure test, note results. ● Perform air pressure test or visually inspect especially if forward clutch plates are burnt. ● Perform air pressure test or visually inspect especially if forward clutch plates are burnt. ● Perform air pressure test or visually inspect especially if forward clutch plates are burnt. ● Tighten to 9-11 N-m (80-97 lb-in). ● Determine source of contamination. Service as required. ● Replace filter. ● Visually inspect pump gears. Replace pump if necessary.
<ul style="list-style-type: none"> ● No or Delayed Reverse Engagement (Forward OK) 	<ul style="list-style-type: none"> ● Improper fluid level. ● Manual linkage misadjusted / damaged. ● Low main control pressure in reverse. ● Reverse clutch or reverse clutch stator support seal rings leaking (No. 1 and No. 2). ● Reverse clutch assembly burnt / worn. ● Reverse clutch piston check ball leaking / leaking piston seal rings. ● Valve body bolts loose / too tight. ● Valve body dirty / sticking valves. ● Transmission filter plugged. ● Pump damaged. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Check and adjust or service as required. ● Control pressure test. ● Air pressure test or visually inspect, especially if reverse clutch plates are burnt. ● Air pressure test or visually inspect, especially if reverse clutch plates are burnt. ● Air pressure test or visually inspect, especially if reverse clutch plates are burnt. ● Tighten to 9-11 N-m (80-97 lb-in). ● Determine source of contamination. Service as required. ● Replace filter. ● Visually inspect pump gears. Replace if necessary.
<ul style="list-style-type: none"> ● No or Delayed Reverse Engagement and / or No Engine Braking in Manual Low (1) 	<ul style="list-style-type: none"> ● Improper fluid level. ● Low reverse band burnt / worn. ● Low reverse servo piston seal leaking. ● Planetary low one-way roller clutch damaged. ● End-play clearance too tight. 	<ul style="list-style-type: none"> ● Perform fluid level check. ● Perform air pressure test. ● Air pressure test or visually inspect especially if low reverse band is burnt. ● Replace. ● Check transmission end play clearance.
<ul style="list-style-type: none"> ● No Engine Braking in Manual Second Gear 	<ul style="list-style-type: none"> ● Improper band or clutch application, or oil pressure control system. ● Overdrive servo leaking. ● Polished or glazed band or drum. 	<ul style="list-style-type: none"> ● Perform control pressure test. ● Perform air pressure test of overdrive servo for leakage. Service as required. ● Service or replace as required.

DIAGNOSIS AND TESTING (Continued)

AUTOMATIC TRANSMISSION DIAGNOSIS (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> Forward Engagement Slips/Shudders/Chatters 	<ul style="list-style-type: none"> Improper fluid level. Manual linkage misadjusted/damaged. Low main control pressure. Valve body bolts—loose/too tight. Valve body dirty/sticking valves. Forward clutch piston ball check not seating/leaking. Forward clutch piston seal cut/worn. Forward clutch stator support seal rings leaking (No. 3 and No. 4). Low one-way roller clutch (planetary) damaged. 	<ul style="list-style-type: none"> Perform fluid level check. Check and adjust or service as required. Control pressure test. Tighten to 9-11 N·m (80-97 lb-in). Determine source of contamination. Service as required. Replace forward clutch cylinder. Service transmission as required. Replace seal and service clutch as required. Air pressure test especially if forward clutch plates are burnt. Determine cause of condition. Service as required.
<ul style="list-style-type: none"> Reverse Shudders/Chatters/Slips 	<ul style="list-style-type: none"> Improper fluid level. Low main control pressure in reverse. Low reverse servo leaking. Low (planetary) one-way roller clutch damaged. Reverse clutch drum bushing damaged. Reverse clutch stator support seal rings, ring grooves worn/damaged. Reverse clutch piston seal cut/worn. Reverse band damaged or incorrect servo piston. Looseness in the driveshaft. U-joints or engine mounts. 	<ul style="list-style-type: none"> Perform fluid level check. Control pressure test. Air pressure test; visually inspect seal rings and piston bore. Determine cause of condition. Service as required. Determine cause of condition. Service as required. Determine cause of condition. Service as required. Determine cause of condition. Service as required. Service as required.
<ul style="list-style-type: none"> No Drive, Slips or Chatters in First Gear in D. All Other Gears Normal. First Gear in  Automatic Overdrive Transmission 	<ul style="list-style-type: none"> Damaged or worn (planetary) one-way roller clutch. 	<ul style="list-style-type: none"> Service or replace planetary one-way roller clutch.
<ul style="list-style-type: none"> No Drive, Slips or Chatters in Second Gear 	<ul style="list-style-type: none"> Intermediate friction clutch or one-way roller clutch. Intermediate clutch piston bleed hole blocked or not positioned at 12 o'clock. Improper band or clutch application, or control pressure. Intermediate clutch stackup incorrect. Dirty or sticking valve body. 	<ul style="list-style-type: none"> Service as required. Clean and install bleed hole at 12 o'clock position. Perform control pressure test. Check intermediate clutch pack clearance. Clean, service or replace valve body.
<ul style="list-style-type: none"> Initial Drive in Second or Third 	<ul style="list-style-type: none"> Improper band and/or clutch application, or oil pressure control system. Intermediate clutch pack clearance too tight. Damaged or worn governor. Sticking governor. Valve body loose. Dirty or sticking valve body. Cross leaks between valve body and case mating surface. 	<ul style="list-style-type: none"> Perform control pressure test. Check intermediate clutch pack clearance. Perform governor check. Replace or service governor, clean screen. Tighten to 9-11 N·m (80-97 lb-in). Clean, service or replace valve body. Service or replace valve body and/or case as required.

DIAGNOSIS AND TESTING (Continued)**AUTOMATIC TRANSMISSION DIAGNOSIS (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> Shift Points Incorrect 	<ul style="list-style-type: none"> Improper fluid level. TV linkage out of adjustment. Improper speedometer gear installed. Improper clutch or band application, or oil pressure control system. Damaged or worn governor. Dirty or sticking valve body. 	<ul style="list-style-type: none"> Perform fluid level check. Service or adjust linkage. Replace gear. Perform shift test and control pressure test. Service or replace governor—clean screen. Clean, service or replace valve body.
<ul style="list-style-type: none"> All Upshifts Harsh or Delayed or No Upshifts 	<ul style="list-style-type: none"> Improper fluid level. Throttle linkage—misadjusted (high TV) / disconnected / sticking / damaged / return spring disconnected. Manual linkage—misadjusted damaged. Governor sticking. Main control pressure too high. Valve body bolts—loose / too tight. Valve body dirty / sticking valves. 	<ul style="list-style-type: none"> Perform fluid level check. Adjust throttle linkage. Service as required, Check and adjust or service as required. Perform governor test. Service as required. Control pressure test. Service as required. Tighten to 9-11 N-m (80-97 lb-in). Determine source of contamination. Service as required.
<ul style="list-style-type: none"> Mushy / Early All Upshifts Pile Up / Upshifts 	<ul style="list-style-type: none"> Improper fluid level. TV throttle linkage misadjusted (low TV) sticking / damaged. Low main control pressure. Valve body bolts loose / too tight. Valve body valve or throttle control valve sticking. Governor valve sticking. 	<ul style="list-style-type: none"> Perform fluid level check. Adjust throttle linkage. Service as required. Control pressure test. Note results. Tighten to 9-11 N-m (80-97 lb-in). Determine source of contamination. Service as required. Perform governor test. Service as required.
<ul style="list-style-type: none"> No 1-2 Upshift 	<ul style="list-style-type: none"> Improper fluid level. Manual linkage—misadjusted / damaged. Low main control pressure to intermediate friction clutch. Valve body bolts—loose / too tight. Valve body dirty / sticking valves. 	<ul style="list-style-type: none"> Perform fluid level check. Check and adjust or service as required. Control pressure test. Note results. Tighten to 9-11 N-m (80-97 lb-in). Determine source of contamination. Service as required.
<ul style="list-style-type: none"> Rough / Harsh / Delayed 1-2 Upshift 	<ul style="list-style-type: none"> Improper fluid level. Poor engine performance. TV linkage—misadjusted (high TV) / damaged. All shifts will be harsh / delayed. Main control pressure too high. Governor valve sticking. Valve body bolts—loose / too tight. Valve body dirty / sticking valves. 	<ul style="list-style-type: none"> Perform fluid level check. Tune engine. Adjust linkage. Service as required. Control pressure test. Note results. Perform governor test. Service as required. Tighten to 9-11 N-m (80-97 lb-in) Determine source of contamination. Service as required.

DIAGNOSIS AND TESTING (Continued)

AUTOMATIC TRANSMISSION DIAGNOSIS (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> Mushy / Early / Soft / Slipping 1-2 Upshift 	<ul style="list-style-type: none"> Improper fluid level. Incorrect engine performance. TV linkage misadjusted (low TV) / sticking / damaged. All shifts will be affected. Low main control pressure. Valve body bolts loose / too tight. Valve body dirty / sticking valves. Intermediate friction clutch burnt / worn. Governor valve sticking. 	<ul style="list-style-type: none"> Perform fluid level check. Tune adjust engine idle as required. Adjust throttle linkage. Service as required. Control pressure test. Note results. Tighten to 9-11 N-m (80-97 lb-in). Determine source of contamination. Service as required. Determine cause of condition. Service as required. Perform governor test. Service as required.
<ul style="list-style-type: none"> No 2-3 Upshift 	<ul style="list-style-type: none"> Improper fluid level. Low main control pressure to direct clutch. Valve body bolts—loose / too tight. Valve body dirty / sticking valves. Direct clutch or assembly burnt / worn. Converter damper hub / weld broken. 	<ul style="list-style-type: none"> Perform fluid level check. Control pressure test. Note results. Tighten to 9-11 N-m (80-97 lb-in). Determine source of contamination, then service as required. Stall test. Determine cause of condition. Service as required. Perform converter damper hub weld check. Replace torque converter if required.
<ul style="list-style-type: none"> Harsh / Delayed 2-3 Upshift 	<ul style="list-style-type: none"> Incorrect engine performance. Throttle linkage misadjusted (high TV) / sticking / damaged. All shifts will be harsh / delayed. 2-3 accumulator piston—apply passage plugged / omitted. 2-3 accumulator piston seals cut / worn. Damaged 2-3 accumulator. Valve body bolts—loose / too tight. Valve body dirty / sticking valves. 2-3 capacity modulator valve. TV control cable bent, sticking. 	<ul style="list-style-type: none"> Check engine tune-up. Adjust linkage. Service as required. Remove 2-3 accumulator piston and visually inspect or air test for plugging condition or omission. Replace seals, determine cause of condition. Service as required. Service as required. Tighten to 9-11 N-m (80-97 lb-in). Determine source of condition. Service as required. Check cable. Replace as necessary.
<ul style="list-style-type: none"> Soft / Early / Mushy 2-3 Upshift 	<ul style="list-style-type: none"> TV linkage: misadjusted (low TV) / bent / sticking. All shifts will be soft / early. Valve body bolts loose / too tight. Valve body dirty / sticking valves. Direct clutch assembly burned / worn. TV control cable bent, sticking. 	<ul style="list-style-type: none"> Adjust linkage. Service as required. Tighten to 9-11 N-m (80-97 lb-in). Determine source of contamination. Service as required. Stall test. Determine cause of condition. Service as required. Check cable. Replace as necessary.

DIAGNOSIS AND TESTING (Continued)

AUTOMATIC TRANSMISSION DIAGNOSIS (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> No 3-4 Upshift (Stays in Third Gear) 	<ul style="list-style-type: none"> Throttle linkage —misadjusted / bent / sticking. Valve body bolts loose / too tight. Direct clutch circuit leakage—Perform Direct Clutch Pressure Test to confirm. <p>NOTE: Burnt direct clutch plates will help to confirm leakage in the direct clutch circuit. Replacing only the plates and not finding the cause will require repeat service.</p>	<ul style="list-style-type: none"> Adjust throttle linkage. Service as required. Check torque on valve body bolts. Tighten to 9-11 N·m (80-97 lb-in). Check for nicks or porosity in the case passages. (Valve body to case mating surface). Replace case for the above. Direct clutch piston check ball leaking. Perform check ball leakage procedure; found in cleaning and inspection portion. Replace piston if leakage confirmed. Direct clutch piston seal rings (inner and outer) leaking. Replace. Check the direct clutch output shaft seal rings (No. 5, No. 6). They should move freely on the output shaft. Check for metal shaving contamination or burrs between the seal and the output shaft. Replace as necessary. Check the large seal rings on the output shaft for freedom of movement. Check for contamination such as metal shavings on the output shaft. Replace as necessary. <p>NOTE: The four large seal rings are numbered 7, 8, 9 and 10. Seal rings 7 and 8 (closest to the output shaft hub) are for the direct clutch. Seal rings 9 and 10 (closest to the governor) are for the governor.</p> <ul style="list-style-type: none"> Inspect the output shaft feed passages and the cup plug for leakage.

DIAGNOSIS AND TESTING (Continued)

AUTOMATIC TRANSMISSION DIAGNOSIS (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> No 3-4 Upshift (Stays in Third Gear) Continued 	<ul style="list-style-type: none"> Valve body contamination / sticking valves. Main control gasket distortion. Case out-of-flat can cause sticking valve. Governor leakage. 	<ul style="list-style-type: none"> Clean the valve body. Check for sticking valves as follows: Overdrive servo regulator valve; 3-4 shift valve; 3-4 TV modulator valve; orifice control valve. If any valves are sticking and they cannot be freed, replace valve body. Check if main control gasket is blocking an orifice. Replace gasket. Reduce valve body bolt torque, tighten to minimum side of specification 9 N·m (80 lb-in). Check last two large seal rings on the output shaft (No. 9 and No. 10). They should move freely. Check for metal shaving contamination or burrs between the seal and output shaft. Replace as necessary. Check the seal ring bore at the rear of case for scoring. Light scoring is permissible. Deep grooving indicates case wear. Replace case for deep grooving. Check the governor to output shaft retaining ring to make sure it is properly seated on the output shaft. Service as necessary. Check the fit of the governor counterweight on the output shaft. If the fit is sloppy, replace the counterweight.
<ul style="list-style-type: none"> Harsh / Delayed 3-4 Upshift 	<ul style="list-style-type: none"> TV linkage—misadjusted / high TV / cable bent / sticking. All shifts will be harsh / delayed. Valve body bolts—loose / too tight. Valve body dirty / sticking valves. Incorrect engine performance. 	<ul style="list-style-type: none"> Adjust linkage. Service as required. Tighten to 9-11 N·m (80-97 lb-in). Determine source of contamination. Service as required. Tune / adjust engine as required.

DIAGNOSIS AND TESTING (Continued)

AUTOMATIC TRANSMISSION DIAGNOSIS (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> Slipping Fourth Gear (Engine Flare-Up / No Fourth Gear Drive Capability) 	<ul style="list-style-type: none"> Overdrive circuit leakage or blocked passage. NOTE: Burnt overdrive band will help to confirm leakage in the overdrive circuit. Replacing only the overdrive band without finding the cause will result in a repeat service. Overdrive servo piston not applying overdrive band / band not applying. Overdrive band mislocated. Converter damper plate and hub fracturing the weld and / or rivets fatiguing, or the damper springs breaking. Direct driveshaft splines distorted. 	<ul style="list-style-type: none"> Check valve body bolt torque. Overdrive servo cover seals leaking. Replace seals. Overdrive servo piston seal leaking. Replace seal. Overdrive servo rod excessive clearance in case. Replace inoperative / worn parts. Overdrive servo cover cracked / porous. Coat cover with fluid. Apply air to overdrive servo, apply passage using Servo Piston Remover T80L-77030-B or equivalent. Observe to see if air bubbles are present on overdrive servo cover. Replace cover if air bubbles are present. Overdrive servo case apply passage blocked. Air pressure test. Replace case if necessary. Overdrive servo piston not seated to the band end seat. Service. Overdrive band not seated to anchor pin. Service. Perform converter damper / hub assembly weld check procedure. Use Converter Checking Tool T83L-7902-A or equivalent. Replace converter if shaft turns more than two degrees or if there is a grinding noise while applying 50 lb-ft torque. Check splines on both ends of the direct driveshaft. Check splines in direct clutch cylinder. Replace direct driveshaft and hardware that splines to it for distortion.
<ul style="list-style-type: none"> Erratic Shifts 	<ul style="list-style-type: none"> Improper fluid level. Poor engine performance. TV linkage—binding / sticking. Valve body bolts—loose / too tight. Valve body dirty / sticking valves. Governor valve stuck. Output shaft collector body seal rings damaged. 	<ul style="list-style-type: none"> Perform fluid level check. Check engine tune-up. Inspect throttle linkage. Service as required. Tighten to 9-11 N-m (80-97 lb-in). Line pressure test, note results. Determine source of contamination. Service as required. Perform governor test. Service as required. Service as required.

DIAGNOSIS AND TESTING (Continued)

AUTOMATIC TRANSMISSION DIAGNOSIS (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> Shift 1-3 in D 	<ul style="list-style-type: none"> Intermediate friction clutch burnt / damaged. Intermediate one-way roller clutch damaged. Improper clutch application, or oil pressure control system. Dirty or sticking valve body. Governor valve stuck. 	<ul style="list-style-type: none"> Determine cause of condition. Service as required. Determine cause of condition. Replace / service as required. Perform control pressure test. Clean, service or replace valve body. Perform governor test. Service as required.
<ul style="list-style-type: none"> Engine Over-Speeds on 2-3 Shift 	<ul style="list-style-type: none"> Linkage out of adjustment. Improper clutch application, or oil pressure control system. Damaged or worn direct clutch. Dirty or sticking valve body. Converter damper / hub broke. 	<ul style="list-style-type: none"> Service or adjust linkage. Perform control pressure test. Perform air pressure test. Service as required. Clean, service or replace valve body. Perform converter damper / hub weld check. Replace converter if necessary.
<ul style="list-style-type: none"> Shift Hunting 3-4, 4-3 	<ul style="list-style-type: none"> Poor engine performance—EGR solenoid worn or damaged. Manual linkage misadjusted. 	<ul style="list-style-type: none"> Tune-up engine; replace solenoid. Check and adjust or service as required.
<ul style="list-style-type: none"> Rough Shudder 3-1 Shift at Closed Throttle in D 	<ul style="list-style-type: none"> Incorrect engine idle or performance. Improper linkage adjustment. Improper clutch or band application or oil pressure control system. Improper governor operation. Dirty or sticking valve body. 	<ul style="list-style-type: none"> Tune, and adjust engine idle. Service or adjust linkage. Perform control pressure test. Perform governor test. Service as required. Clean, service or replace valve body.
<ul style="list-style-type: none"> Rough or Mushy 4-2 or 3-1 Shift (Kickdown) 	<ul style="list-style-type: none"> Incorrect engine performance. Improper application of intermediate friction and one-way roller clutch. Dirty or sticking valve body. 	<ul style="list-style-type: none"> Tune, adjust engine idle as required. Service as required. Clean, service or replace valve body.
<ul style="list-style-type: none"> No Forced Downshifts (Kickdown) 	<ul style="list-style-type: none"> Damaged, misadjusted throttle linkage. Improper clutch or oil pressure control system. Dirty or sticking governor. Dirty or sticking valve body. 	<ul style="list-style-type: none"> Inspect and adjust throttle linkage. Perform control pressure test. Perform governor test. Service or replace governor. Clean screen. Clean, service or replace valve body.
<ul style="list-style-type: none"> Shift Efforts High 	<ul style="list-style-type: none"> Manual shift linkage damaged / misadjusted. Inner manual lever nut loose. Manual lever retainer pin damaged. 	<ul style="list-style-type: none"> Check and adjust or service as required. Tighten nut to 26-37 N·m (20-27 lb-ft). Adjust linkage and install new pin.
<ul style="list-style-type: none"> Transmission Overheats 	<ul style="list-style-type: none"> Improper fluid level. Incorrect engine idle or performance. Improper clutch or band application, or oil pressure control system. Restriction in cooler or lines. Seized converter one-way roller clutch. Dirty or sticking valve body. 	<ul style="list-style-type: none"> Perform fluid level check. Tune or adjust engine idle. Perform control pressure test. Service restriction. Replace one-way roller clutch. Clean, service or replace valve body.

DIAGNOSIS AND TESTING (Continued)**AUTOMATIC TRANSMISSION DIAGNOSIS (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
<ul style="list-style-type: none"> Transmission Clunk or Squawk During 1-2 or 2-3 Shift (AOD) 	<ul style="list-style-type: none"> Intermediate clutch piston bleed hole blocked or not positioned at 12 o'clock. Anti-clunk spring not positioned. Converter damper spring broken. 	<ul style="list-style-type: none"> Clean piston and install bleed hole at 12 o'clock position. Secure anti-clunk spring. Perform converter damper hub weld check.
<ul style="list-style-type: none"> Transmission Leaks 	<ul style="list-style-type: none"> Case breather vent. Leakage at gasket, seals, etc. 	<ul style="list-style-type: none"> Check the vent for free breathing. Service as required. Remove all traces of lube on exposed surfaces of transmission. Check the vent for free breathing. Operate transmission at normal temperatures and perform fluid leakage check. Service as required.
<ul style="list-style-type: none"> Poor Vehicle Acceleration 	<ul style="list-style-type: none"> Poor engine performance. Torque converter one-way roller clutch locked up. 	<ul style="list-style-type: none"> Check engine tune-up. Replace torque converter.
<ul style="list-style-type: none"> Transmission Noisy—Valve Resonance <p>NOTE: Gauges may aggravate any hydraulic resonance. Remove gauge and check for resonance level.</p>	<ul style="list-style-type: none"> Improper fluid level. Improper band or clutch application, or oil pressure control system. Cooler lines grounding. Dirty or sticking valve body. Internal leakage or pump cavitation. 	<ul style="list-style-type: none"> Perform fluid level check. Perform control pressure test. Free up cooler lines. Clean, service or replace valve body. Service as required.
<ul style="list-style-type: none"> Harsh Coasting Downshift Clunk 	<ul style="list-style-type: none"> Anti-clunk spring not seated properly. TV linkage misadjusted (high TV). 	<ul style="list-style-type: none"> Re-position anti-clunk spring properly. Adjust linkage, service as required.
<ul style="list-style-type: none"> Initial Engagement Clunk (Engine Warm) <p>NOTE: Refer to rough initial engagement also.</p>	<ul style="list-style-type: none"> Engine rpm's above specification. Throttle valve linkage misadjusted (high TV). Worn / damaged / loose: <ul style="list-style-type: none"> —U-joint (front / rear) —Slip yoke —Rear axle —Rear suspension Excessive transmission end play. 	<ul style="list-style-type: none"> Adjust engine rpm to specification. Adjust linkage. Service as necessary. Check transmission end play. Replace selective thrust washer if necessary.

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PINPOINT TEST A: TRANSMISSION NOISY—OTHER THAN VALVE RESONANCE

TEST STEP		RESULT	ACTION TO TAKE
A1	ROAD TEST		
	<ul style="list-style-type: none"> Drive vehicle to determine if noise level is within acceptable limits. Is noise within acceptable limits? 	Yes No	Vehicle OK. GO to A2.
A2	PERFORM LINKAGE CHECK		
	<ul style="list-style-type: none"> Check linkage adjustment as outlined. Is linkage properly adjusted? 	Yes No	GO to A3. SERVICE and/or ADJUST linkage. GO to A1.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A: TRANSMISSION NOISY — OTHER THAN VALVE RESONANCE (Continued)

TEST STEP		RESULT	ACTION TO TAKE
A3	PERFORM FLUID CHECK		
	<ul style="list-style-type: none"> Check fluid for proper level and / or contamination as outlined. 	Fluid level correct; No contamination	GO to A4.
		Fluid level low; No contamination	FILL transmission until fluid level is between ADD and FULL. GO to A1.
		Fluid contaminated	STOP! REMOVE, DISASSEMBLE, CLEAN and SERVICE transmission. FLUSH converter, cooler and cooler lines.
A4	STALL TEST		
	<ul style="list-style-type: none"> Perform Stall Test. Check for noise at initial engagement for each gear. Can noise be heard in every gear? 	Yes	GO to A5.
		No	REPLACE planetary gear set.
A5	SPEEDOMETER GEAR		
	<ul style="list-style-type: none"> Remove speedometer gear and check for noise. Does noise stop? 	Yes	REPLACE speedometer gear.
		No	CHECK extension housing bushing, seal or driveshaft. SERVICE or REPLACE as necessary. If noise still exists, REPLACE planetary gear set.

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Transmission Fluid Level Check

CAUTION: Vehicle should not be driven if fluid level is below the bottom hole.

Transmission Hot — Operating Temperature

The automatic transmission should be checked at an operating temperature of 66°C-77°C (150°F-170°F) (dipstick is hot to touch). The operating temperature may be obtained by driving 24-32 km (15-20 miles) of city-type driving with the outside temperature above 10°C (50°F).

Dipstick Reading: Fluid level at operating temperature.

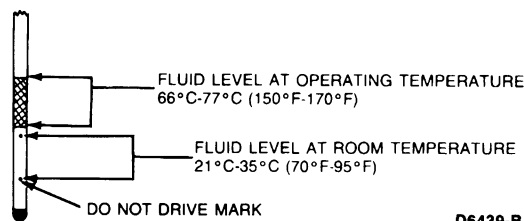
Fluid level on dipstick should be within the cross-hatched area.

Transmission Cold — Room Temperature

If the transmission is not at an operating temperature of 66°C - 77°C (150°F - 170°F) and it becomes necessary to check the fluid level (such as pre-delivery) the fluid may be checked at room temperature of 21°C - 35°C (70°F - 95°F) (dipstick cool to touch).

Dipstick Reading: Fluid level at room temperature.

Fluid level on the dipstick should read between the holes at room temperature.



Check fluid level at operating temperature or room temperature as follows:

1. With transmission in PARK, engine at curb idle rpm, foot brakes applied and vehicle on level surface, move the transmission selector lever through each range. Allow time in each range to engage transmission, return to PARK, apply parking brake and block wheels. **Do not turn off the engine during the fluid level check.**
2. Clean all dirt from the transmission fluid dipstick cap before removing the dipstick from the filler tube.
3. Pull the dipstick out of the tube, wipe it clean, and push all the way back into the tube. **Ensure it is fully seated.**

DIAGNOSIS AND TESTING (Continued)

4. Pull the dipstick out of the tube again and check the fluid level.

NOTE: The fluid level indication on the dipstick will be different at operating temperature and room temperature. For the correct fluid level reading on the dipstick, follow the appropriate instructions stated previously.

Before adding fluid, ensure that Synthetic MERCON® Multi-Purpose Automatic Transmission Fluid E6AZ-19582-B (ESR-M2C 163-A2) or equivalent will be used. Only use fluid that meets or exceeds the specification stamped on the dipstick.

CAUTION: If vehicle has been operated for an extended period at high speed, in city traffic, in hot weather, or vehicle is being used to pull a trailer, the fluid has to cool approximately 30 minutes after engine has been turned off to obtain an accurate reading.

CAUTION: Use of a fluid other than specified could result in transmission malfunction and/or failure.

If necessary, add enough fluid through the filler tube to raise the level to the correct position.

CAUTION: Do not overfill the transmission. This will result in foaming, loss of fluid through the vent and possible transmission malfunction. If overfill occurs, excess fluid must be removed.

5. Install the dipstick, making sure it is fully seated in the tube.

If the transmission fluid level is correctly established at 21°C-35°C (70°F-95°F), it will appear in the cross-hatch area on the dipstick when the transmission reaches an operating temperature of 66°C-77°C (150°F-170°F). Do not overfill or underfill.

Underfill can result in transmission loss of engagement or slipping. This condition is most evident in cold weather or when the vehicle is parked or being driven on a hill.

If the transmission fluid level is checked when the fluid is at room temperature, the dipstick could indicate that fluid should be added if the dipstick is misread. If fluid is added at this time, an overfill condition could result when the fluid reaches operating temperatures of 66°C-77°C (150°F-170°F) (dipstick hot to touch).

Transmission Fluid Condition Check

1. Make the normal fluid level check as outlined.
2. Observe color and odor of the fluid. It should be dark reddish, not brown or black. Odor can sometimes indicate that there is an overheating condition or clutch disc or band failure.
3. Use an absorbent white facial tissue to wipe the dipstick. Examine the stain for evidence of solids (specks of any kind) and for antifreeze signs (gum or varnish on dipstick).

If specks are present in the oil or there is evidence of antifreeze, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive solids in the oil pan, the transmission must be disassembled and completely cleaned and serviced. This includes cleaning the torque converter and transmission cooling system. It would be a waste of time to perform any further checks before cleaning and servicing the transmission. During disassembly and assembly, all overhaul checks and adjustments of clearances and end play must be made. After the transmission has been serviced, all diagnosis tests and adjustments listed in the Diagnosis chart must be completed to ensure the concern has been corrected.

High or Low Fluid Level

A fluid level that is too high will cause the fluid to become aerated (foamy). Aerated fluid will cause low control pressure and the aerated fluid may be forced out the vent.

A fluid level that is too low can affect the operation of the transmission. Low level may indicate fluid leaks that could cause transmission damage.

Fluid Level High Before Starting Engine, OK During Normal Check

1. Check for correct operation of drainback valve in stator support.
2. Check pump bushing.
3. Replace or service pump, if required.

DIAGNOSIS AND TESTING (Continued)**Transmission Fluid Leakage Checks**

Check the speedometer cable connection at the transmission. Replace the rubber seal, if necessary.

Check for leakage at oil pan gasket.

NOTE: Fluid from other external sources can collect between the case and pan rail and give the appearance of a pan gasket leak. If fluid is present check the following positions as outlined.

Oil Pan

Leakage at the oil pan gasket often can be stopped by tightening the retaining bolts to 8-13.5 N·m (7-11 lb-in). Do not over-tighten pan bolts. If necessary, replace the gasket.

Fluid Filler Tube

Check the fluid filler tube connection at the transmission case or oil pan. If leakage is found here, install a new O-ring and press the filler tube to the case. The filler tube bracket should align properly and be attached to the transmission or engine.

Transmission Cooler Lines

CAUTION: Do not try to stop the fluid leak by increasing the torque beyond specification. This may cause damage to the case threads.

Check the fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear or damage. When fluid is found to be leaking between the case and the cooler line fitting, tighten the fitting to 31 N·m (23 lb-ft).

If the leak continues, replace the cooler line fitting and tighten to 24-31 N·m (18-23 lb-ft). The same procedure should be followed for fluid leaks between the radiator cooler and cooler line fittings.

Transmission Case

Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the transmission cooler in the radiator is probably leaking.

The cooler can be further checked for leaks by disconnecting the lines from the cooler fittings and applying 345-517 kPa (50-75 psi) air pressure to the fittings. Remove the radiator pressure cap to relieve the pressure buildup at the exterior of the oil cooler tank. If the cooler is leaking and/or will not hold pressure, the cooler must be replaced. Refer to Section 03-03 for coolant replacement procedure.

If leakage is found at either the throttle valve lever shaft or the manual lever shaft, replace either or both seals.

Pipe Plugs

The automatic overdrive transmission (AOD) has four pipe plugs: three on the RH side of the case and one on the LH side. Inspect the plugs for leakage. Ensure they are tightened to 8-16 N·m (6-12 lb-ft). If tightening does not stop the leak, replace the plug.

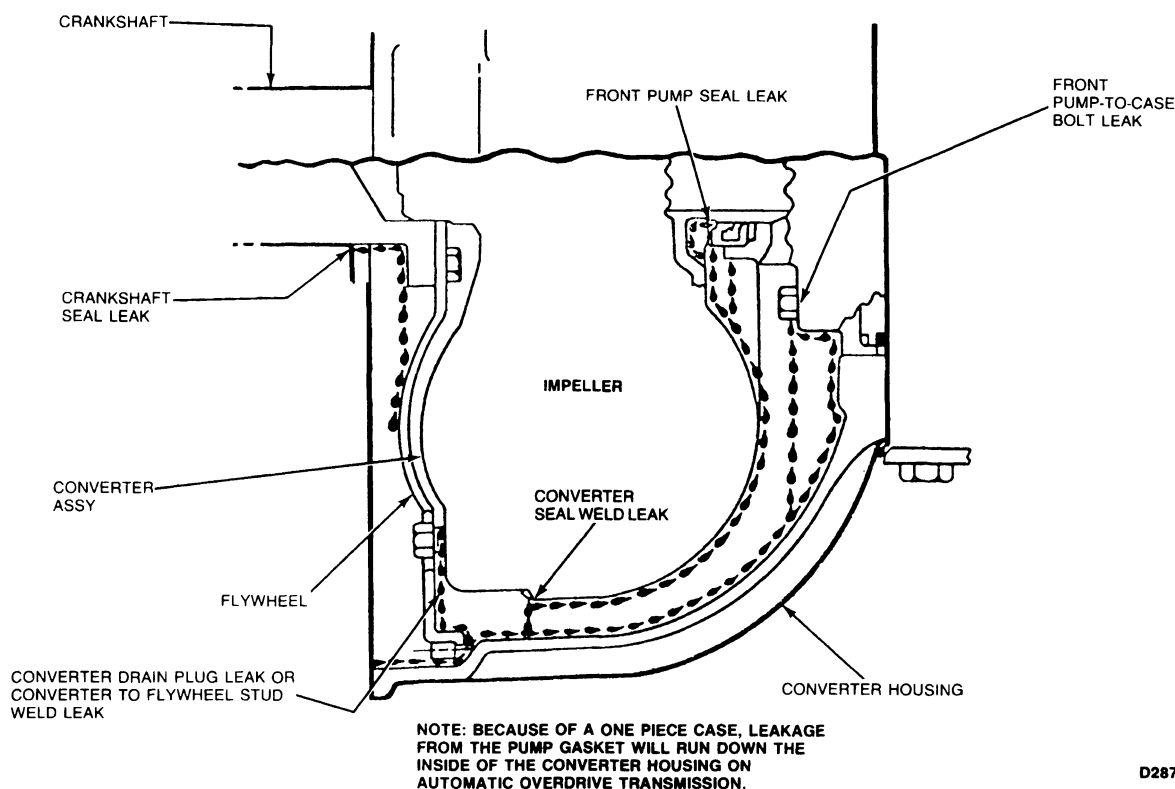
When a converter drain plug leaks, remove the drain plug with a six-point wrench. Coat the threads with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G 194-A and ESR-M18P7-A) or equivalent and install plug. Tighten the drain plug to 11-38 N·m (8-28 lb-ft). Fluid leakage from the converter housing may also be caused by engine oil leaking past the rear main bearing seal, or from oil galley plugs. Verify the exact cause of the leak before starting service procedures.

Oil soluble aniline or fluorescent dyes premixed at the rate of 2.5ml (1/2-teaspoon) of dye powder to 0.23l (1/2-pint) of transmission fluid have proved helpful in locating the source of fluid leakage. Such dyes may be used to determine whether an engine oil or transmission fluid leak is present, or if the fluid in the oil cooler leaks into the engine coolant system. A black light must be used with the fluorescent dye solution.

DIAGNOSIS AND TESTING (Continued)

Fluid Leakage in Converter Area

In diagnosing and correcting fluid leaks in the front pump and converter area, use the following procedures to locate the exact cause of the leakage. Leakage at the front of transmission, as evidenced by fluid around the converter housing, may have several sources. By careful observation, it is possible, in many instances, to pinpoint the source of leak before removing the transmission from the vehicle. The paths which the fluid takes to reach the bottom of the converter housing are shown in the following illustration.



1. Fluid leaking by the front pump seal lip will tend to move along the impeller hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the housing.
2. Fluid leakage by the outside diameter of the seal and front pump body will follow the same path which the leaks by the front pump seal follow.
3. Fluid that leaks by a front pump to case bolt will be deposited on the inside of the converter housing only. Fluid will not be deposited on the back of the converter.

4. Fluid leakage from the converter drain plugs or converter-to-flywheel stud weld, will appear at the outside diameter of the converter on the back face of the flywheel, and in the converter housing only near the flywheel. Fluid leaks from the torque converter will leave a ring of fluid around the inside of the transmission converter housing.

NOTE: White tissue paper may aid in determining the color (red is transmission fluid) and source of the leaking fluid.

DIAGNOSIS AND TESTING (Continued)

5. Engine oil leaks are sometimes improperly diagnosed as transmission front pump seal leaks. The following areas of possible leakage should also be checked to determine if engine oil leakage is causing the concern.
 - a. Leakage at the rocker arm cover may allow oil to flow over the converter housing or seep down between the converter housing and cylinder block causing oil to be present in or at the bottom of the converter housing.
 - b. Oil galley plug leaks will allow oil to flow down the rear face of the block to the bottom of the converter housing.
 - c. Leakage at the crankshaft seal will work back to the flywheel, and then into the converter housing.
 - d. Leakage at engine oil pressure sender.
6. Fluid leakage from other areas, such as the power steering system forward of the transmission, could cause fluid to be present around the converter housing due to blowback or road draft. The following procedures should be used to determine the cause of the leakage before service.
 - a. Remove the transmission dipstick and note the color of the fluid. Original factory fill fluid is dyed red to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the red color should assist in pinpointing the leak. However, a power steering leak may be mistaken for a transmission leak since the fluid color for both looks the same. Observe the power steering system for leaks that could be misidentified as a transmission leak.
 - b. Remove the converter housing cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case and rear face of the engine and engine oil pan. Clean the converter area by washing with a suitable non-flammable solvent and blow dry with compressed air.
 - c. Wash out the converter housing, the front of the flywheel and the converter drain plug. The converter housing may be washed out using cleaning solvent in a squirt-type oil can. Blow all washed areas dry with compressed air.
 - d. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist. Refer to Section 00-02. Run the engine at fast idle, then at engine idle, occasionally shifting to the DRIVE and REVERSE ranges to increase pressure within the transmission. Observe the front of the flywheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

Converter Leakage Check**Tools Required:**

- Rotunda Torque Converter Leak Detector 021-00054

If welds on the torque converter indicate leakage remove the converter and make the following check:

Assemble Rotunda Torque Converter Leak Detector 021-00054 or equivalent to the converter. Test the converter for leaks, following the directions supplied with the detector kit.

Engine Idle Speed Check

If the idle speed is too low, the engine will run rough. An idle speed that is too high will cause the vehicle to creep, have harsh engagements and harsh closed throttle downshifts.

Check and, if necessary adjust the engine idle speed with the throttle positioner (if applicable) or the injection pump linkage adjustment. Refer to the Powertrain Control/Emissions Diagnosis Manual¹ for the appropriate procedure according to throttle positioner application.

Shift Linkage Check

NOTE: Check for a misadjustment in shift linkage. Do this by matching the detents in the shift lever with those in the transmission. If they match, the misadjustment is in the indicator. Do not adjust the shift linkage. Refer to Section 13 for proper selector indicator adjustment.

This is a **CRITICAL** adjustment. Be sure the Ⓒ detent in the transmission corresponds exactly with the STOP in the steering column or console. Hydraulic leakage at the manual valve can cause delay in engagements and/or slipping while operating if the linkage is not correctly adjusted. Refer to Section 07-05.

¹ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Throttle Valve (TV) Control System**

The AOD transmission uses a Throttle Valve (TV) control self-locking system.

Shift Trouble Diagnosis**TV Control Cable System**

CAUTION: Do not drive vehicle if cable is broken or disconnected at throttle body lever.


- A. **Symptoms:** Excessively early and/or soft upshifts with or without slip-bump feel. Slip-bump feel on light throttle shift into and out of fourth gear (3-4 and/or 4-3 shifts). No forced downshift (kickdown) function at appropriate speeds.

Cause: TV control cable set too long.

Remedy: Reset cable per procedure for the TV control cable system.

Damage to friction elements in transmission may result due to excessive slipping since TV pressure will remain near zero. If it is necessary to drive vehicle before servicing or resetting cable, disconnect cable at the transmission lever. TV pressure will allow light throttle operation. However, shift will be delayed and harsh.

Remedy: Replace/reconnect cable and reset per procedure for the TV control cable system.

- A. **Symptoms:** Shift clunk when throttle is backed off after full or heavy throttle acceleration. Harsh coasting downshifts out of fourth gear (automatic 4-3 shifts in  range).

Cause: TV control cable is set too short.

Remedy: Reset cable per procedure for the TV control cable system.

Cause: Transmission lever does not return to idle (lever to rear as far as possible) although cable is correctly set.

Remedy: Check for binding due to misaligned or damaged cable brackets or damaged cable or return spring (in rubber boot). Check for binding at cable connections at throttle body or transmission. Pry off cable from the TV lever ball stud and check for free movement of the cable. Lubricate the ball stud with a small amount of Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A and ESB-M1C93-A) or equivalent and reattach the cable. Check for frozen moisture in cable due to damaged boot. Service or replace as necessary. Set cable per procedure for the TV control cable system.

Cause: Cable assembly not correctly attached to bracket at either throttle body or transmission.

Remedy: Determine reason for cable becoming detached. Replace if necessary. Set cable per procedure for the TV control cable system.

- A. **Symptoms:** Extremely delayed and harsh upshift, especially at light to moderate acceleration and harsh idle engagement.

Cause: Cable disconnect at transmission (transmission TV pressure is at maximum).

Remedy: Determine cause for cable becoming disconnected. Service or replace as necessary. Set cable per procedure for the TV control cable system.

Cause: Transmission lever stays at wide-open throttle (WOT) or part throttle although cable is correctly set.

Remedy: Check for binding conditions as detailed previously. Service or replace as necessary. Set cable per procedure for the TV control cable system.

Control Pressures Test

Line pressure and throttle pressure on the Automatic Overdrive transmission are tested in the idle position (zero TV) and wide-open throttle position. In each of the two modes, the reverse specifications will be higher than the others.

Control pressure specifications can be found in the Special Specifications booklet.

1. Be sure the TV linkage is properly adjusted.

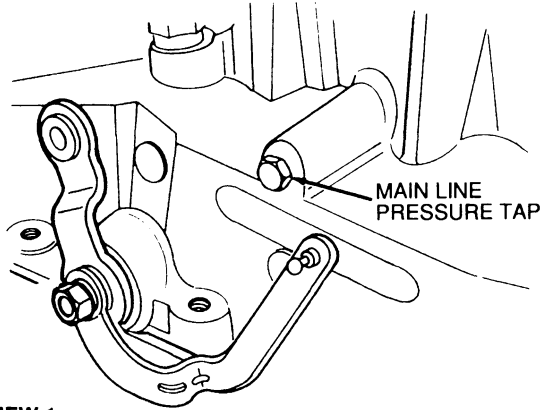
2. Connect a 2000 kPa (300 psi) gauge to the main line pressure tap on the case LH side just above the control levers. Have sufficient flexible hose to make the gauge accessible while operating the engine.

CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken not to accelerate or decelerate rapidly. Possible transmission failure could result.

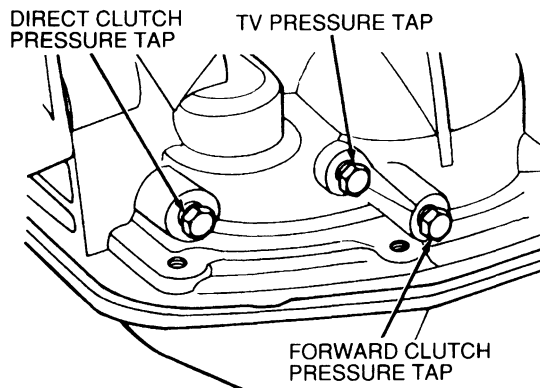
NOTE: WOT readings are to be made at full stall. However, be sure to run the engine at fast idle in NEUTRAL for cooling between tests.

DIAGNOSIS AND TESTING (Continued)

3. Connect a 0-690 kPa (0-100 psi) pressure gauge to the TV pressure tap on the RH side of the case. Have sufficient flexible hose to make the gauge accessible while operating the engine.



VIEW 1



VIEW 2

D3104-D

4. Run the engine until it is hot.

CAUTION: Idle pressure must be read with the throttle off the fast idle cam.

5. Apply the service and parking brakes firmly and shift through all the ranges. Record the line pressure and throttle pressure and compare it with specifications.

After making the control pressure tests, analyze the results related to the conditions in the following charts.

Keep in mind that clutch and servo leakage may or may not show up on the control pressure test. This is because the pump has a high output volume and the leak may not be severe enough to cause a pressure drop; and orifices between the pump and pressure chamber may maintain pressure at the source, even with a leak downstream. Pressure loss caused by a less than major leak is more likely to show up at idle than at WOT where the pump is delivering full volume.

Conversely, when manipulating the TV linkage to simulate WOT, but actually testing at idle, the leak is more likely to cause a pressure loss in the WOT position.

To further isolate leakage in a clutch or servo circuit, it is necessary to remove the oil pan and valve body and to perform case air pressure tests.

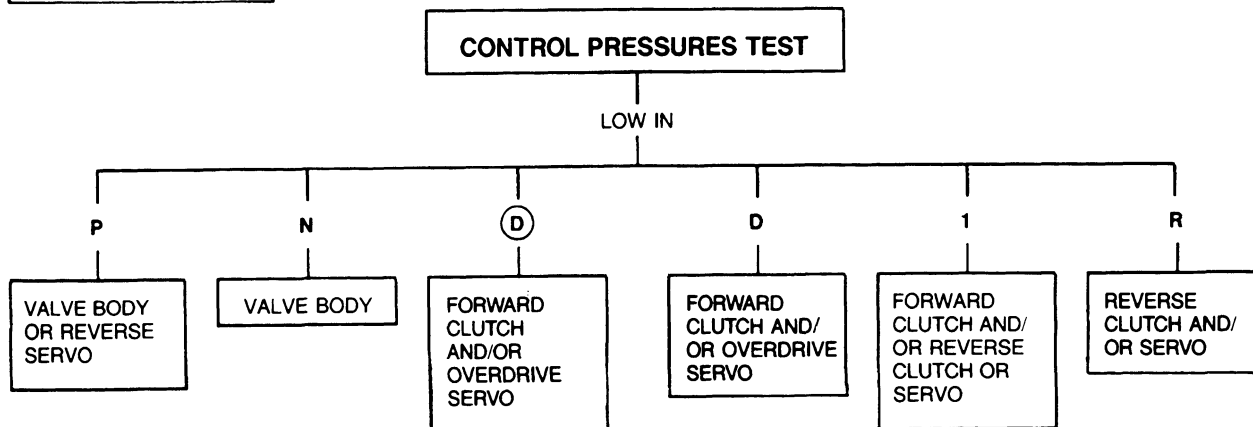
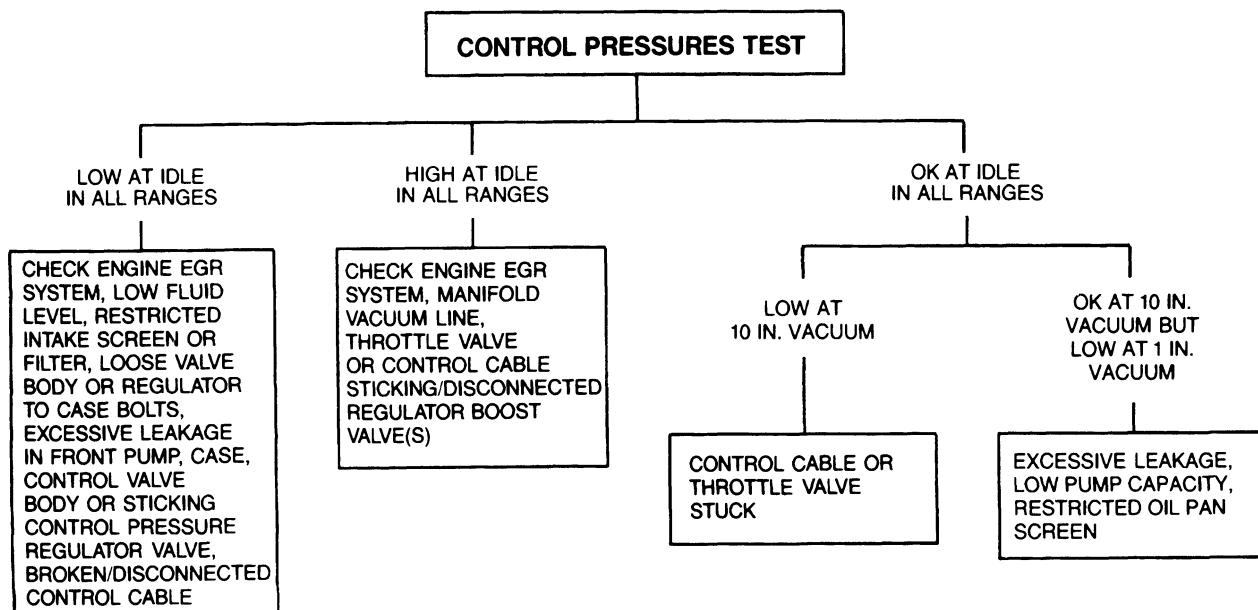
Control Pressures Condition	Possible Cause(s)
Low in P	Valve body bolts loose, main oil regulator valve sticking, low reverse servo leakage.
Low in R	Reverse clutch leakage, low reverse servo leakage. Valve body bolts loose.
Low in N	Valve body bolts loose, main oil regulator valve sticking.
Low in D	Forward clutch leakage, overdrive servo leakage, valve body bolts loose, main oil regulator valve sticking.
Low in D	Forward clutch leakage, overdrive servo leakage, valve body bolts loose, main regulator valve sticking.
Low in 1	Forward clutch leakage. Low/reverse servo leakage. Overdrive servo leakage.
Low at idle in all ranges	Low fluid level, restricted oil filter, loose valve body bolts, pump leakage, case leakage, valve body leakage, excessively low engine idle, fluid too hot, main oil regulator valve sticking.
High at idle in all ranges	TV linkage, valve body (throttle valve or main oil regulator valve sticking)
OK at idle but low at WOT	Internal leakage, pump leakage, restricted inlet screen, TV linkage, valve body (TV or TV limit valve sticking, main oil regulator valve sticking).

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DIAGNOSIS AND TESTING (Continued)

TV PRESSURE	LINE PRESSURE	RANGE	POSSIBLE CAUSE
High at WOT	High at WOT	All	TV limit valve not regulating pressure. Replace valve body.
Low at WOT	Low at WOT	All	Throttle valve stuck. Replace valve body. TV linkage out of adjustment / damaged / binding. Adjust and / or service as necessary.

TD4107A



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Direct Clutch Pressure Test

CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken not to accelerate or decelerate rapidly. Possible transmission failure could result.

The direct clutch pressure test outlined below will diagnose a low-pressure condition or leakage in the direct clutch circuit. A difference of 103 kPa (15 psi) or more between direct clutch pressure and line pressure (read at the forward clutch pressure tap) will prevent a normal 3-4 shift.

DIAGNOSIS AND TESTING (Continued)

1. Attach 0-2000 kPa (0-300 psi) pressure gauges to the forward clutch pressure tap and to the direct clutch pressure tap. Gauges must be accurate enough to distinguish a 103 kPa (15 psi) difference. (If this test is done in conjunction with a control pressure test, pressure gauges will be attached to all pressure taps.) Have sufficient flexible hose to read the gauges in the vehicle.
2. Drive the vehicle. When pressure is applied to the direct clutch, note the difference between the pressure read at forward clutch pressure tap and the direct clutch pressure.
3. If the difference in pressures is less than 103 kPa (15 psi), the direct clutch circuit is OK.
4. If the difference is greater than 103 kPa (15 psi), there could be a leak in the direct clutch pressure circuit. If the difference does not exceed 103 kPa (15 psi), the gauges on the line pressure and direct clutch pressure can be switched to confirm that gauge calibration difference is not the cause.

Stall Test

The stall test checks converter clutch operation and installation, the holding ability of the forward clutch, reverse clutch the low / reverse bands, the planetary one-way clutch, and engine performance.

Conduct this test with the engine coolant and transmission fluid at proper levels and at operating temperature and with the TV linkage set properly.

Apply the service and parking brakes firmly for each stall test.

1. Find the specified stall rpm for the vehicle by referring to the Special Specifications booklet. Use a grease pencil to mark the rpm on the dial of a tachometer.
2. Connect tachometer to engine.
3. In each of the following ranges: \odot , D, 1, R, press the accelerator to the floor and hold it just long enough to let the engine get to full rpm. While making this test, do not hold the throttle open for more than five seconds at a time.
4. Note the results in each range.
5. After each range, move the selector lever to NEUTRAL and run the engine at 1000 rpm for about 15 seconds to cool the converter before making the next test.
6. Refer to the following chart for corrective actions.

Selector Position	Stall Speeds High	Stall Speeds Low
Overdrive and D	Planetary One-Way Clutch	
Overdrive, D and 1	Forward Clutch	
Overdrive, D, 1 and R	General Problems Pressure Test. Check TV Cable Adjustment if Not Done Prior to Test	Converter Stator One-Way Clutch or Engine Performance
R	Reverse Clutch or Low / Reverse Band or Servo	

TD3083J

Transmission Fluid Cooler Flow Check

The linkage, fluid and control pressure must be within specifications before performing this flow check.

Remove the transmission dipstick from the filler tube. Place a funnel in the transmission filler tube. Raise the vehicle and remove the cooler return line from its fitting in the case. Attach a hose to the cooler return line and fasten the free end of the hose in the funnel installed in the filler tube.

Start the engine and set idle speed at 1000 rpm with the transmission in NEUTRAL.

Observe the fluid flow at the funnel. When the flow is solid (air bleeding has been completed), the flow should be liberal. If there is not a liberal flow at 1000 rpm in NEUTRAL, low pump capacity, main circuit system leakage, or cooler system restriction is indicated.

Check both of the metal cooler lines between the transmission and radiator for restrictions. Check for restrictions in the metal or rubber cooler lines to and from the auxiliary cooler, if so equipped. Visually check and physically feel all bends for kinks, especially rubber cooler lines, that would restrict flow and could result in transmission overheating or lack of lubrication.

To separate transmission trouble from cooler system trouble, observe the flow at the transmission case converter-out fitting.

DIAGNOSIS AND TESTING (Continued)**Shift Point Check—Road Test**

This check will determine if the governor pressure and shift control valves are functioning properly. During the shift point check operation, if the transmission does not shift within specification or certain gear ratios cannot be obtained, refer to Diagnosis to resolve the concern.

Check shift points with engine at normal operating temperature. Operate vehicle with gear selector in the OVERDRIVE detent. The transmission should accomplish 1-2, 2-3, and 3-4 upshifts within shift speed specifications.

Shift speed specifications can be found in the Special Specifications booklet.

Improper Shift Timing—4-3 Backout Shift

Improper shift timing: 4-3 backout shift (4-3 shift on full backout of accelerator pedal, accompanied by 3-4 shift when accelerator depressed) may be diagnosed / serviced by the verification of the following:

- Loose governor: Output shaft snap ring not seated or missing locator ball
- Worn or broken output shaft seal rings, large diameter
- Worn seal ring grooves
- Worn collector bore
- Output shaft holes blocked

Forced Downshifts

With the transmission selector in OVERDRIVE, depress the accelerator pedal to the floor. The transmission should downshift to third gear or to second gear, depending on vehicle road speed. Refer to the appropriate shift speed specifications.

The transmission will not make a 4-1 downshift.

When the vehicle road speed drops below 58 km / h (35 mph), the transmission automatically downshifts from overdrive into third gear.

The transmission will not shift into fourth gear (OVERDRIVE) at wide-open throttle.

Closed Throttle Downshifts

Closed throttle downshifts should be extremely difficult to detect. It may be necessary to attach 0-690 kPa (0-100 psi) pressure gauges to the forward and direct clutch pressure taps in order to detect 4-3 and 3-2 coastdown shifts.

With gauges attached, a 4-3 coast (closed throttle), downshift is signified by the application of the forward clutch. (The pressure reading from the gauge on the forward clutch pressure tap will indicate an increase in pressure from 0-4 14 kPa (0-60 psi). A 3-2 coast downshift is signified by the release of the direct clutch. (The pressure reading from the gauge on the direct clutch pressure tap will indicate a decrease in pressure from 4 14-0 kPa (60-0 psi). A 2-1 coast downshift should not be noticed or felt. The coast downshifts should occur within the limits set forth in the shift speed specifications.

Manual Downshifts

When the shift selector is moved from either OVERDRIVE or DRIVE range to the manual LOW 1 position, the transmission will downshift into second gear if the vehicle is moving over (approximately) 41 km / h (25 mph) and into first gear if the vehicle is moving less than (approximately) 41 km / h (25 mph).

The overdrive band is applied when the transmission is in manual second. The low-reverse band is applied when the transmission is in manual LOW.

Shift Test—In Shop

CAUTION: Never exceed 97 km / h (60 mph) speedometer speed.

A shift test can be performed in the shop to check for 1-2, 2-3 and 3-4 upshifts.

Raise the vehicle with an axle or frame hoist, so that the rear wheels are clear of the floor. Refer to Section 00-02.

CAUTION: Gradually apply brakes to stop rear wheels.

NOTE: After each test, move the selector lever to NEUTRAL and run the engine at 1000 rpm to cool the transmission.

To determine if automatic upshifts occur, place the transmission selector lever in OVERDRIVE and make a minimum throttle 1-2, 2-3, and 3-4 upshift. When the shift occurs, you will see the speedometer needle make a momentary surge and feel the driveline bump. If the shift points are within specification, the 1-2, 2-3, and 3-4 shift valves and governor are OK.

If the shift points are not within specification, perform a governor check to isolate the concerns.

Shift speed specifications can be found in the Special Specifications booklet.

Some tips on diagnosing concerns with specific components are:

Intermediate Clutch or Intermediate One-Way

Clutch: Transmission shift 1-3 or slips in second gear.

Reverse Clutch: Slip or no engagement in R. (Also can be caused by the low-reverse band or servo).

Forward Clutch or Planetary (Low) One-Way

Clutch: No engagement in forward ranges, or slip in forward.

Overdrive Band or Servo: No fourth gear, slip in fourth gear, or no engine braking in second gear in range 1.

Direct Clutch: Slip in third or fourth, or no upshift beyond second.

DIAGNOSIS AND TESTING (Continued)

Low-Reverse Band or Servo: No reverse or slip in reverse. Possibly no engine braking in manual low first gear, which would isolate the concern to the band rather than reverse clutch.

Governor: Erratic shifts could be caused by a sticking governor valve.

Accumulators: Leaking seals on the accumulator pistons can cause their respective clutches to slip. If the 2-3 accumulator seals leak, the symptoms could resemble a direct clutch or forward clutch concern.

TV Pressure Low: If the shifts seem soft or mushy, do not make any heavy throttle tests. Check and adjust the TV linkage before making a complete road test. Do not operate vehicle if TV cable is broken or disconnected at throttle body. Damage to friction elements will result since TV pressure is zero.

Governor Check


Perform a Shift Point Check as outlined, while on a road test or in the shop. If the shift points are not within specification, proceed with the following governor check:

Accelerate the vehicle to 40 km/h (25 mph), then completely back off the throttle. The transmission should shift to third gear.

Air Pressure Checks

NOTE: The passages can be tested adequately with air pressure regulated at 276 kPa (40 psi). However, it may be necessary to use higher air pressure of 620 kPa (90 psi) if there is difficulty in hearing the clutches apply.

A no drive condition can exist, even with the correct transmission fluid pressure, because of an inoperative clutch or band. The inoperative units can be located through a series of checks by substituting air pressure for the fluid pressure to determine the location of the malfunction.

For example, when the selector lever is in D or , a no drive condition may be caused by an inoperative forward clutch or one-way roller clutch. When there is no drive in 1, the difficulty could be caused by improper functioning of the forward clutch or low-reverse band and the one-way roller clutch. Failure to drive in reverse range could be caused by a malfunction of the reverse clutch, or low-reverse band or clutch. In each case, refer to the applicable Clutch and Band Application Chart to relate faulty transmission operation to a specific hydraulic component.

When there is a slip condition but it is not known whether it is in the valve body or in the hydraulic system beyond the valve body, the air pressure tests can be very valuable.

To make the air pressure checks, loosen the oil pan bolts and lower one edge of the oil pan to drain the transmission fluid. Remove the fluid pan and the control valve body assembly. The inoperative units can be located by introducing air pressure into the transmission case passages leading to the clutches, servos and governor.

If a servo or the accumulator does not operate, disassemble, clean and inspect to locate the source of the trouble. If air pressure applied to a clutch passage fails to operate the clutch or operates two clutches at once, check the fluid passages in the case and front pump to detect obstructions or damage.

To air test the automatic overdrive transmission, a main control to case gasket (Base No. 7D 100) and the following Special Service Tools will be required:

- AOD Transmission Test Plate With Screws T82L-7006-A.
- Test Plate Mounting Screws T82P-7006-C.
- Air Nozzle TOOL-7000-DE or equivalent.
- Air Nozzle Rubber Tip TOOL-7000-DD or equivalent.

With the main control body removed, position the adapter plate and gasket on the transmission. Install the adapter plate retaining screws and tighten the screws to 9-11 N·m (80-97 lb-in). Note that each passage is identified on the plate. Using the air nozzle equipped with the rubber tip, apply air pressure to each passage in the following order:

Reverse Clutch

Apply air pressure to the reverse clutch passage in the service tool. A dull thud can be heard when the clutch piston applies. In addition, movement of the reverse clutch drum may also be detected.

Forward Clutch

Apply air pressure to the forward clutch apply passage in the service tool plate. A dull thud can be heard or movement of the piston can be felt on the case as the clutch piston is applied.

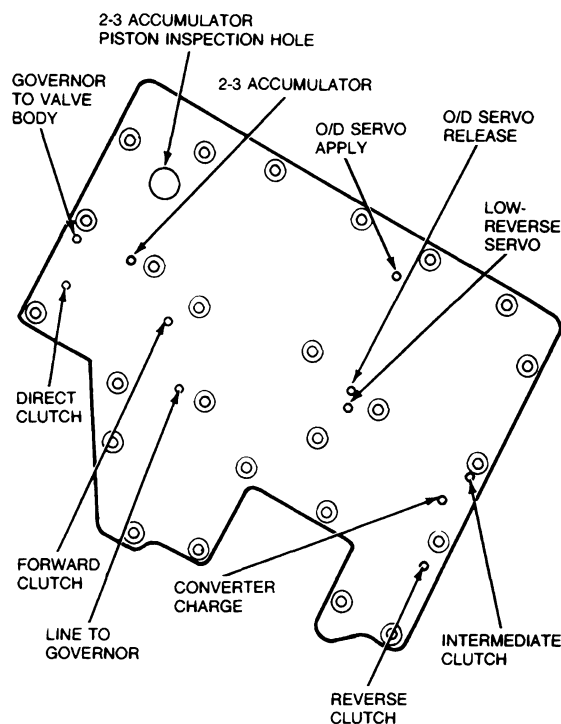
Intermediate Clutch

Apply air pressure to the intermediate clutch passage in the service tool plate. A dull thud can be heard or felt when the clutch applies.

DIAGNOSIS AND TESTING (Continued)

Overdrive Servo

Apply air pressure to the overdrive O/D servo apply passage in the service tool plate. Operation of the band is indicated by the tightening of the band around the reverse clutch drum. The O/D servo will return to the release position as a result of spring force from the release spring. Also, when the servo returns to the release position, a thud can be felt on the O/D servo cover. The band will then relax.



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Low-Reverse Servo

Apply air pressure to the low-reverse servo passage in the service tool plate. A dull thud can be heard when the low-reverse band tightens around the planetary assembly drum surface. Movement of the ring gear can also be detected.

Direct Clutch

Apply air pressure to the direct clutch apply passage. A dull thud should be heard or felt on the driveshaft if the clutch is operating.

2-3 Accumulator

Apply air pressure to the 2-3 accumulator passage. The accumulator piston should unseat. This can be detected by inserting a metal rod into the 2-3 piston hole. When the piston unseats, the rod will move. A thud can also be heard when the piston applies.

Governor

In order to air pressure check the line to governor passage and the governor to valve body passage, remove the driveshaft crossmember and extension housing.

Apply air pressure to the line to governor passage while holding a finger near the governor valve. If air is felt exiting the valve, the passage is clear.

To air pressure check the governor to valve body passage, remove the governor. Apply air pressure to the passage while holding a finger over holes in the output shaft. If air exits one of the holes, the passage is clear.

REMOVAL AND INSTALLATION

Transmission

NOTE: Completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. In addition, the cleaning of debris from the direct clutch check ball is often omitted. This omission can lead to a repeat servicing of the transmission. Cleaning and flushing procedures for transmission components, including the direct clutch check ball, can be found in the cleaning and inspection in this section.

NOTE: Do not soak oil filter in solvent cleaner. The filter material could disintegrate. Replace filter if transmission fluid is contaminated.

Removal

1. Disconnect the battery negative cable.
2. Raise the vehicle on a hoist and support with suitable safety stands.
3. Place a drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the bolts and allow the fluid to drain. Finally remove all of the pan bolts except two at the front, to allow the fluid to further drain. With fluid drained, install two bolts on the rear side of the pan to temporarily hold the pan in place.
4. Remove the converter drain plug access cover from the lower end of the converter housing.
5. Remove the converter-to-flywheel nuts. Place a wrench on the crankshaft pulley bolt to turn the converter to gain access to the nuts.

REMOVAL AND INSTALLATION (Continued)

6. Place a drain pan under the converter to catch the fluid. With the wrench on the crankshaft pulley bolt, turn the converter to gain access to the converter drain plug and remove the plug. After the fluid has been drained, reinstall the plug.

NOTE: To maintain initial driveshaft balance, mark the REAR driveshaft yoke and axle companion flange so they may be installed in their original positions.

7. Disconnect the driveshaft from the rear axle and slide shaft rearward from the transmission.
Install a seal installation tool in the extension housing to prevent fluid leakage.
8. Disconnect the cable from the terminal on the starter motor. Remove the two bolts and remove the starter motor. Disconnect the park / neutral position switch wires at the plug connector.
9. Remove the rear mount-to-crossmember bolts and the two crossmember-to-frame bolts.

10. Remove the two engine rear support-to-extension housing bolts.

11. Disconnect the TV cable from the transmission TV lever. Disconnect the shift cable from the transmission manual lever at the transmission.

12. Remove the bolt securing the TV bracket to the converter housing.

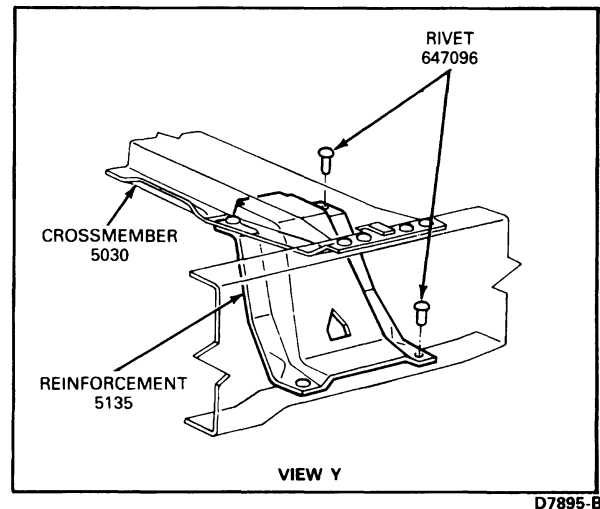
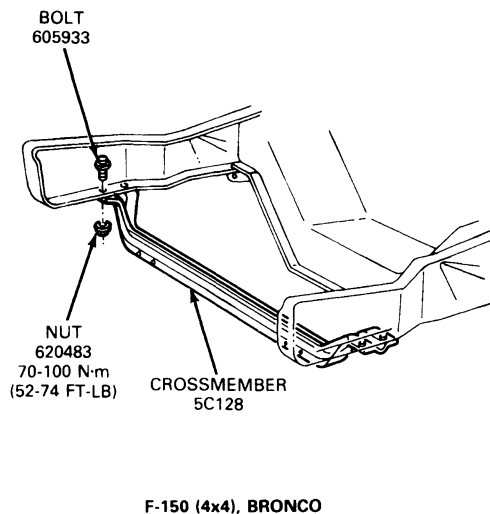
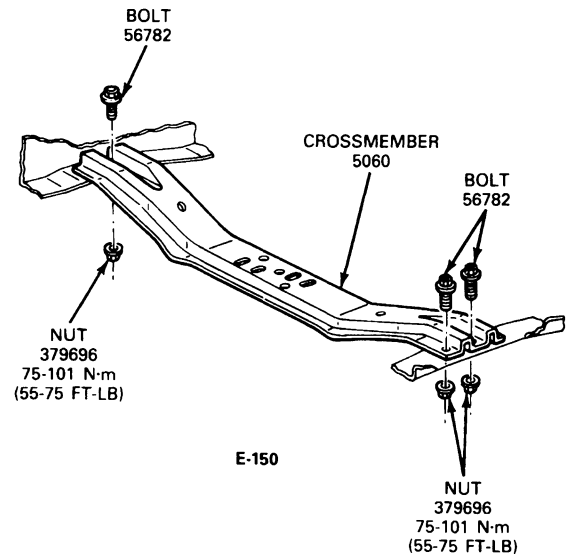
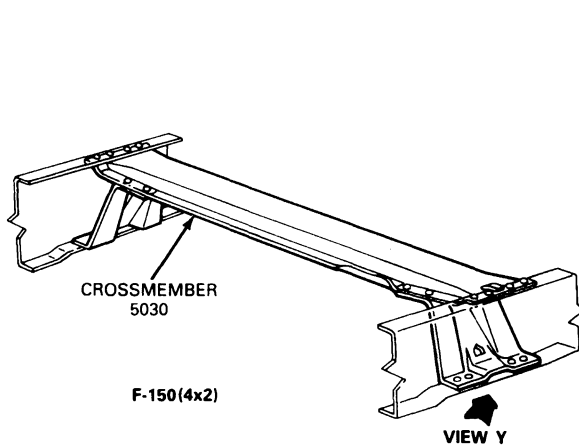
On 4x4 applications, remove the transfer case. Refer to the appropriate transfer case section in Group 07.

13. Raise the transmission with a transmission jack to provide clearance to remove the crossmember. Remove the rear mount from the crossmember and remove the crossmember from the side supports.

NOTE: The 4x4 application has a deep well oil pan. Use a transmission jack that will allow clearance for the oil pan depth and still provide support for the transmission at the oil pan rail.

REMOVAL AND INSTALLATION (Continued)

Crossmember Installation E-150, F-150 4x2 and 4x4 and Bronco



14. Lower the transmission to gain access to the oil cooler lines.
15. Disconnect each oil line from the fittings on the transmission.
16. Remove the bolt(s) that secures the transmission fluid filler tube to the cylinder block. Lift the filler tube and the dipstick from the transmission.
17. Secure the transmission to the jack with a chain.
18. Remove the converter housing-to-cylinder block bolts.
19. Carefully move the transmission and converter assembly away from the engine and, at the same time, lower the jack to clear the underside of the vehicle.

20. Remove the converter and mount the transmission in a holding fixture.

Installation

1. Tighten the converter drain plug to 11-38 N·m (8-28 ft·lb).
2. Position the converter on the transmission, making sure the converter drive flats are fully engaged in the pump gear by rotating the converter.
NOTE: Lube pilot with chassis grease.
3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with a chain.

REMOVAL AND INSTALLATION (Continued)

4. Rotate the converter until the studs and drain plug are in alignment with the holes in the flywheel.
5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot. The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft.
6. Install and tighten the converter housing-to-engine attaching bolts to specification.

NOTE: Before installing the torque converter to flywheel nuts, check to make sure that the converter is properly seated. The converter should move freely with respect to the flywheel. Grasp the stud. Movement back and forth should result in a metallic clank noise if the converter is properly seated. If the converter will not move, the transmission must be removed and the converter repositioned so that the impeller hub is properly engaged in the pump gear.
7. Remove the safety chain from around the transmission.
8. Install a new O-ring on the lower end of the transmission filler tube and lube the O-ring with transmission fluid. Insert the tube in the transmission case and secure the tube to the engine with the attaching bolt(s).
9. Connect the oil cooler lines to the right side of transmission case.
10. Secure the engine rear support to the extension housing and tighten the bolts to 82-108 N·m (60-80 ft·lb).
11. Position the crossmember on the side supports. Position the rear mount on the crossmember and install the attaching bolt and nut.
12. Install the transfer case. Refer to the appropriate transfer case section in Group 07. Lower the transmission and remove the jack.
13. Secure the crossmember to the side supports with the bolts and tighten them to specification.
14. Position the bellcrank to the converter housing and install the attaching bolt.
15. Connect the TV cable to the transmission TV lever. Connect the manual shift cable to the manual lever at the transmission.
16. Secure the converter-to-flywheel nuts and tighten them to specification.
17. Install the converter housing access cover.
18. Secure the starter motor in place with the bolts. Connect the cable to the terminal on the starter. Connect the neutral start switch wires at the plug connector.

NOTE: Lubricate the driveshaft yoke splines with Premium Long-Lift Grease XG-1-C or -K or equivalent.
19. Install the driveshaft so the index marks on the companion flange and rear yoke made during removal are aligned.
20. Adjust the shift cable as required. Refer to Section 07-05.
21. Adjust throttle linkage per the procedure outlined in the beginning of this section.
22. Lower the vehicle.
23. Fill the transmission to the correct level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C166-H). Connect the battery negative cable. Start the engine and shift the transmission to all ranges, then recheck the fluid level.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

Main Control Valve Body**Removal**

1. Raise the vehicle on a hoist so the transmission oil pan is accessible. Refer to Section 00-02.
2. Starting at the rear and working toward the front, loosen the oil pan bolts and drain the fluid from the transmission. It may be necessary to use a 3/8-inch or 1/4-inch drive ratchet and a 10mm universal socket to remove the oil pan bolts.
3. Remove the transmission oil pan bolts, pan and gasket. Discard gasket.
4. Remove three filter-to-valve body bolts and remove the filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the Dacron filter (do not clean the filter).

5. Remove the detent spring bolt and spring.
6. Remove the valve body to case bolts. Remove the valve body. Discard valve body to case gasket.

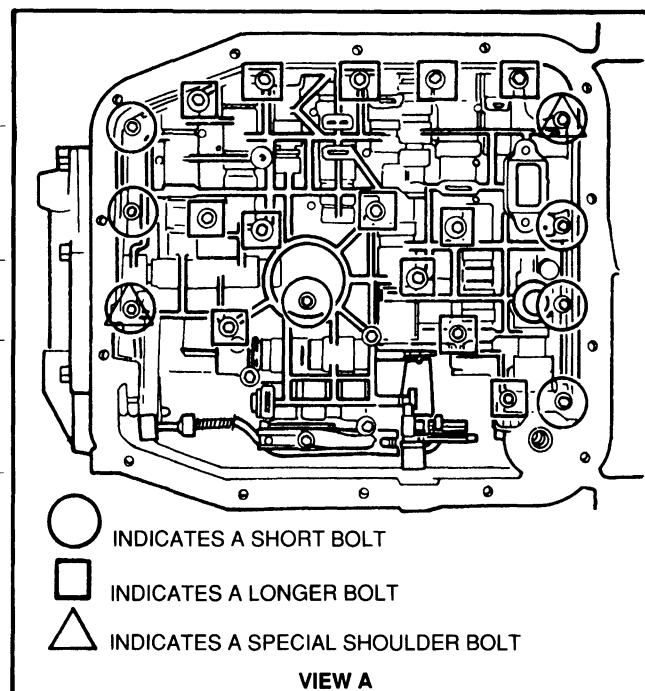
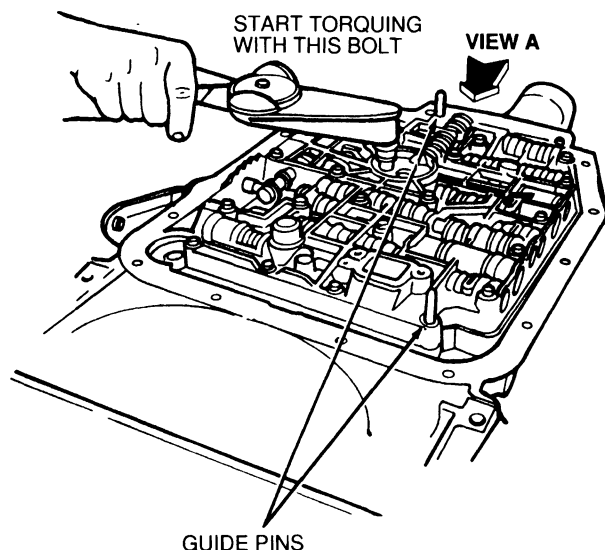
Installation

1. Clean and inspect the valve body as described in this section prior to installation.
2. Position the valve body and a new gasket to the case, making sure that the inner manual lever and inner TV levers are engaged. Install the two shoulder bolts first as shown in View B of the following illustration.

REMOVAL AND INSTALLATION (Continued)

3. Install and tighten valve body-to-case bolts to 9-11 N·m (80-97 in·lb).

TIGHTEN THE ATTACHING BOLTS TO 9-11 N·m (80-97 IN·LB). START IN THE CENTER AND WORK OUTWARD.



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4. Install and tighten the detent spring and attaching bolts to 9-14 N·m (80-120 in·lb).
5. Load the throttle lever (TV) spring against the separator plate.
6. Using three filter bolts install the Dacron filter and gasket to the valve body and tighten the bolts to 9-14 N·m (80-120 in·lb).
7. Clean the transmission oil pan and gasket surfaces thoroughly.
8. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8-14 N·m (72-120 in·lb).
9. Remove safety stands and lower the vehicle and fill the transmission to the correct level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C166-H).
10. Adjust TV cable linkage as outlined in this section.

Overdrive Servo Assembly

Removal

1. Raise the vehicle on a hoist so the transmission fluid pan is accessible. Position safety stands under vehicle.
2. Starting at the rear and working toward the front, loosen the oil pan bolts and drain the fluid from the transmission.

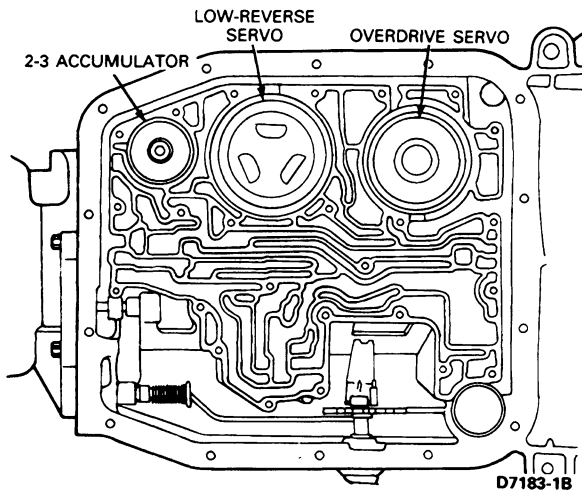
CAUTION: Do not reuse the fluid.

3. Remove the transmission fluid pan bolts, pan and gasket. Discard gasket.
4. Remove three filter to valve body bolts and remove the Dacron filter grommet and gasket. Discard gasket. If the fluid is contaminated, discard the Dacron filter. (Do not clean the filter.)

5. Remove the detent spring and bolt.
6. Remove the valve body to case bolts. Remove the valve body. Discard valve body to case gasket.
7. Depress overdrive servo piston cover with a hammer handle and remove the retaining snap ring.
8. Using Servo Piston Remover Tool T80L-77030-B apply air pressure to the servo piston release passage in order to remove the overdrive servo piston cover and spring. Cover the servo piston pocket to prevent the piston from falling out of the case and becoming damaged. Remove the piston from the cover.

REMOVAL AND INSTALLATION (Continued)

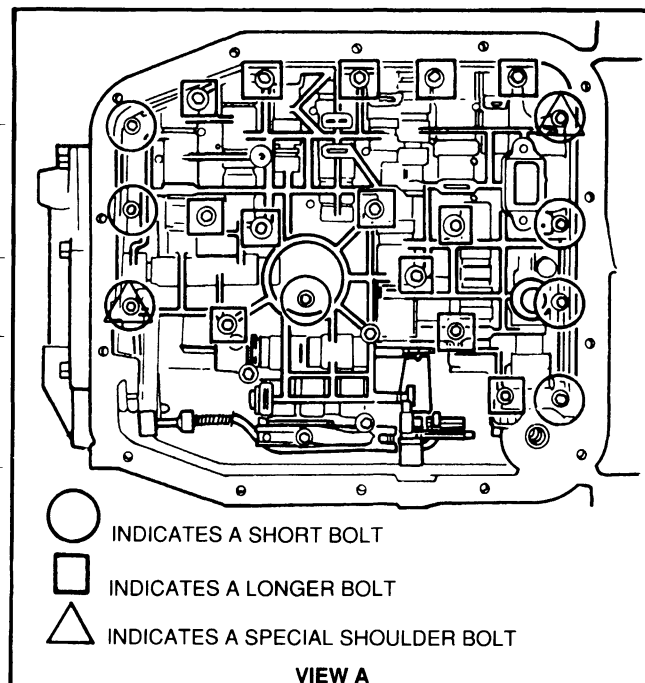
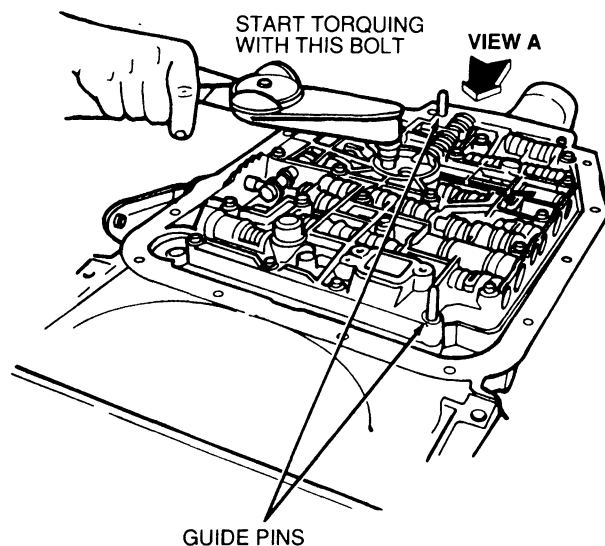
9. Remove the rubber seals from the piston and the cover.



Installation

1. Clean and inspect the servo piston and cover for nicks and /or burrs. Clean and inspect the servo piston pocket in the case for nicks and burrs also.
2. Install new servo piston and cover seals on the piston and cover, respectively.
3. Lubricate the piston seals with either clean transmission fluid or a petroleum jelly.
4. Install the servo piston into the cover, lubricate the cover seals and the overdrive servo pocket in the case.
5. Assemble the return spring to the servo piston.
6. Install the overdrive cover, piston and spring assembly into the overdrive servo pocket in the case. Make sure the servo rod contacts the bank apply pocket while installing. Failure to do so will result in a no 3-4 shift condition.
7. Using the handle of a hammer, depress the overdrive servo sufficiently to gain clear access to the retaining snap ring groove in the case. Install the snap ring.
8. Inspect the outer edge of the overdrive servo pocket for possible nicks and burrs which might have been raised during the removal or installation of the retaining snap ring.
9. Remove nicks and burrs with a "fine" honing stone and clean the effected areas thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case, and subsequent cross leakage.
10. Clean and inspect the valve body, as described in this section prior to installation.
11. Position a new valve body gasket to the separator plate.
12. Position a new separator plate gasket to the valve body and case, making sure that the inner manual lever and inner TV lever are engaged. Install the two shoulder bolts first as shown in View B of the following illustration.
13. Install and tighten the attaching bolts to 9-11 N-m (80-100 in-lb).

TIGHTEN THE ATTACHING BOLTS TO 9-11 N-m (80-97 IN-LB). START IN THE CENTER AND WORK OUTWARD.



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REMOVAL AND INSTALLATION (Continued)

14. Install and tighten the detent spring and bolt to specification.
15. Remove the guide Pins T80L-77 100-A and install and tighten the remaining two valve body-to-case bolts to specification.
16. Position the throttle lever (TV) spring against the separator plate.
17. Using three filter bolts, install the filter and gasket to the valve body and tighten bolts to 9-14 N·m (80-120 in·lb).
18. Clean the transmission oil pan and gasket surfaces thoroughly.
19. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8-14 N·m (72-120 in·lb).
20. Remove safety stands and lower the vehicle and fill the transmission to the correct level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C166-H).
21. Adjust TV cable linkage as outlined in this section.

Low-Reverse Servo Assembly**Removal**

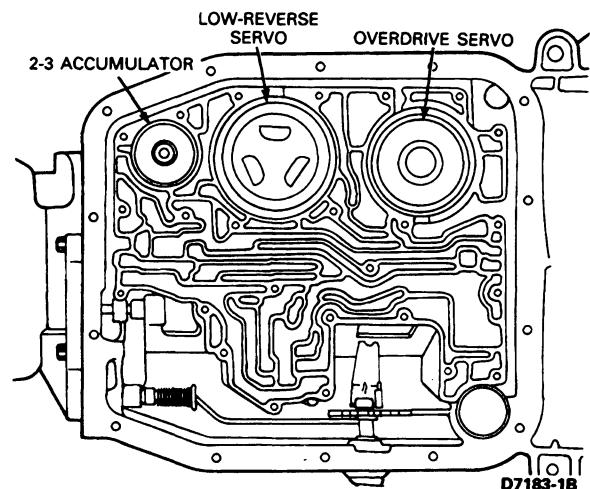
1. Raise the vehicle on a hoist so the transmission oil pan is accessible. Position safety stands under vehicle.
2. Starting at the rear and working toward the front, loosen the oil pan bolts and drain the fluid from the transmission.

CAUTION: Do not reuse the fluid.

3. Remove the transmission oil pan bolts pan and gasket. Discard gasket.
4. Remove three filter to valve body bolts and remove the filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the filter (do not clean the filter).
5. Remove the detent spring and bolts.
6. Remove the valve body to case bolts. Remove the valve body. Discard valve body to case gasket.
7. Depress the reverse servo piston cover with a hammer handle. Remove the retaining snap ring and piston cover.

NOTE: Reverse servo piston may spring free from case when cover is removed. Care must be taken to prevent such an occurrence.

8. To remove the reverse servo piston and spring, apply air pressure to the servo piston release passage using Tool T80L-77030-B. Cover the servo piston pocket to prevent the piston from falling out of the case when air is applied and becoming damaged.

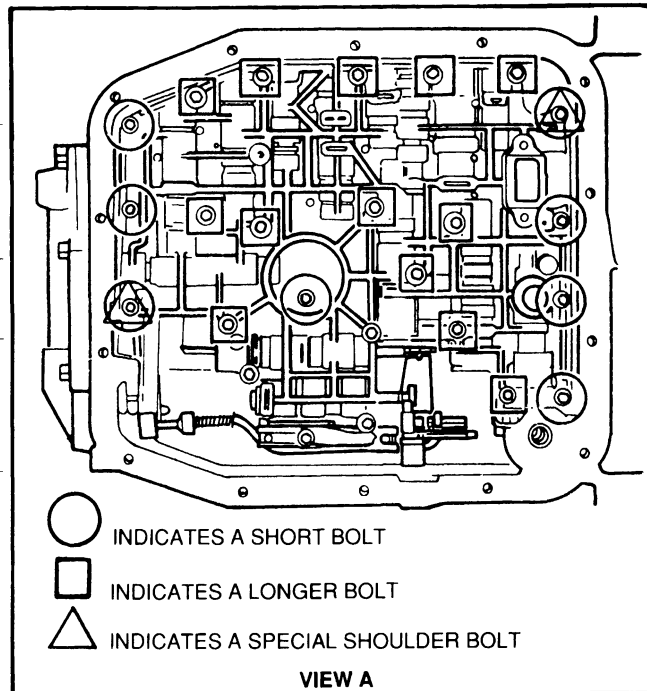
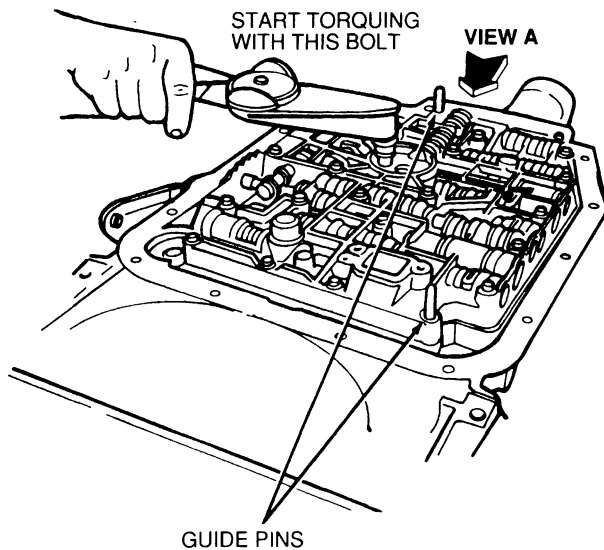
**Installation**

1. Clean and inspect the servo pocket in the case.
2. Clean the reverse servo piston, cover and return spring. Inspect the piston and cover sealing edges for cuts, burrs or irregular wear pattern. Replace if necessary.
3. Assemble the return spring to the servo piston.
4. Install the reverse servo piston and spring and the servo cover into the case reverse servo pocket.
NOTE: Make sure that the servo piston is reinstalled with the same rod length as the one which was removed.
5. Using the handle of a hammer, depress the reverse servo piston and cover sufficiently to gain clear access to the retaining snap ring groove in the case. Install the snap ring.
6. Inspect the outer edge of reverse servo pocket for nicks or burrs which might have been raised during the removal or installation of the retaining snap ring.
7. Remove nicks or burrs with a "fine" honing stone and clean the effected surfaces thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case and subsequent cross leakage.

REMOVAL AND INSTALLATION (Continued)

8. Clean and inspect the valve body, as described in this section.
9. Position a new valve body gasket to the separator plate.
10. Install valve body guide pins using Tool T80L-77 100-A to the case. Position a new separator plate gasket to the valve body and case, making sure that the inner manual lever and inner TV lever are engaged. Install the two shoulder bolts first as shown in View B of the following illustration.
11. Install and tighten valve body-to-case bolts to 9-11 N·m (80-100 in-lb).

TIGHTEN THE ATTACHING BOLTS TO 9-11 N·m (80-97 IN-LB). START IN THE CENTER AND WORK OUTWARD.



D10526-A

12. Install and tighten the detent spring and bolt to 9-14 N·m (80-120 in-lb).
13. Position the throttle lever spring against the separator plate.
14. Using three filter bolts install the Dacron filter and gasket to the valve body and tighten the bolts to 9-14 N·m (80-120 in-lb).
15. Clean the transmission oil pan and gasket surfaces thoroughly.
16. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the bolts to 8-14 N·m (72-120 in-lb).
17. Remove safety stands and lower the vehicle and fill the transmission to the correct level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C166-H).
18. Adjust TV cable linkage as outlined in this section.

2-3 Accumulator Piston**Removal**

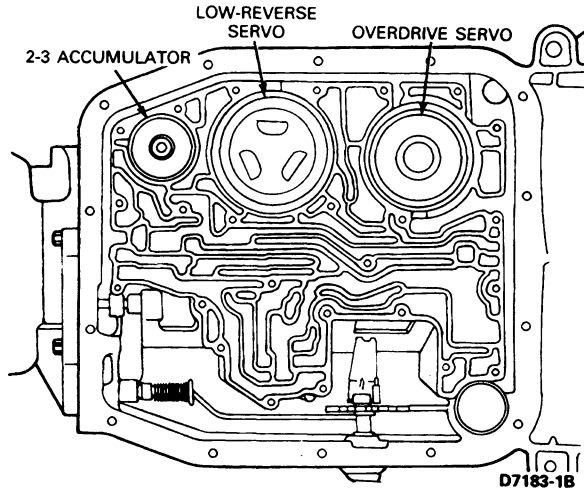
1. Raise the vehicle on a hoist so the transmission oil pan is accessible. Position safety stands under vehicle.
2. Starting at the rear and working toward the front loosen the oil pan bolts and drain the fluid from the transmission.

CAUTION: Do not reuse the fluid.

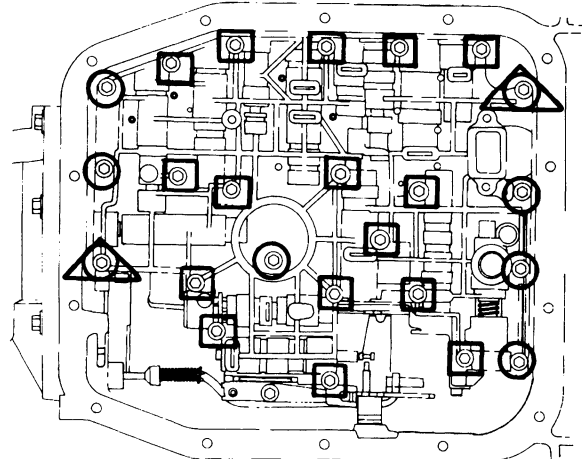
3. Remove the transmission oil pan bolts, pan and gasket. Discard gasket.
4. Remove the three filter-to-valve body bolts and remove the filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the filter (do not clean the filter).
5. Remove the detent spring and bolt.

REMOVAL AND INSTALLATION (Continued)

6. Remove the valve body-to-case bolts. Remove the valve body. Discard the valve body-to-case gasket.
7. Depress the 2-3 accumulator piston cover. Remove the retaining snap ring, cover and spring.
8. Remove the 2-3 accumulator piston.
9. Remove the seals from the 2-3 accumulator piston. If the seals have nicks, cuts or irregular wear patterns, then discard the seals.

**Installation**

1. Clean and inspect the 2-3 accumulator piston. Replace piston if damaged.
2. Clean and inspect the 2-3 accumulator pocket in the case for nicks, burrs or porosity.
3. Install seals on the 2-3 accumulator piston.
4. Install the 2-3 accumulator piston into the case.
5. Install the return spring and cover.
6. Install the retaining snap ring.
7. Inspect the outer edge of 2-3 accumulator piston pocket for nicks or burrs which might have been raised during the removal or installation of the retaining snap ring.
8. Remove nicks or burrs with a "fine" honing stone and clean the affected surfaces thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case and subsequent cross leakage.
9. Clean and inspect the valve body, as described in this section.
10. Position a new valve body to case gasket to the separator plate.
11. Position the valve body to the case making sure that the inner manual lever and inner TV lever are engaged. Install the two shoulder bolts first as shown in the following illustration.
12. Install and tighten valve body-to-case bolts to 9-11 N·m (80-100 in-lb).
13. Install and tighten the detent spring and attaching bolt to 9-14 N·m (80-120 in-lb).
14. Position the throttle lever spring against the separator plate.
15. Using three filter bolts install the filter and gasket to the valve body and tighten the bolts to 9-14 N·m (80-120 in-lb).
16. Clean the transmission oil pan and gasket surfaces thoroughly.
17. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the bolts to 8-14 N·m (72-120 in-lb).
18. Remove safety stands and lower the vehicle and fill the transmission to the correct level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C 166-H).
19. Adjust TV cable as outlined in this section.

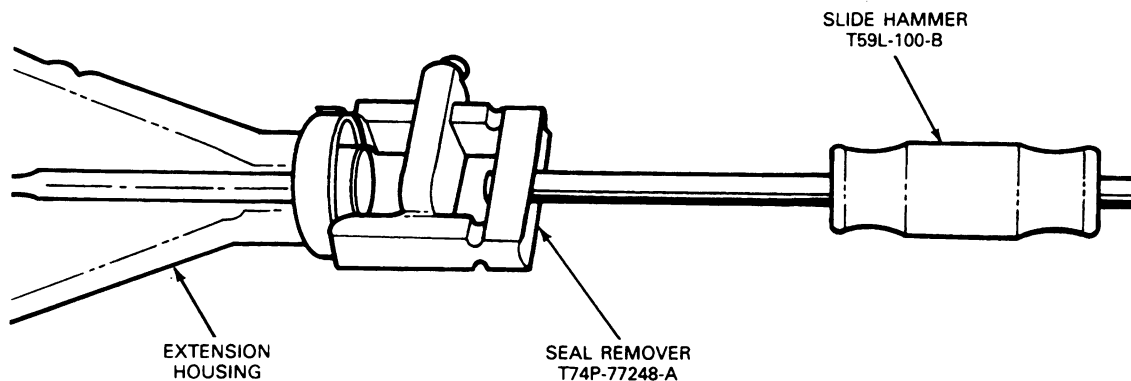


- INDICATES A SHORT BOLT
 □ INDICATES A LONGER BOLT
 △ SHOULDER BOLT

D10716-A

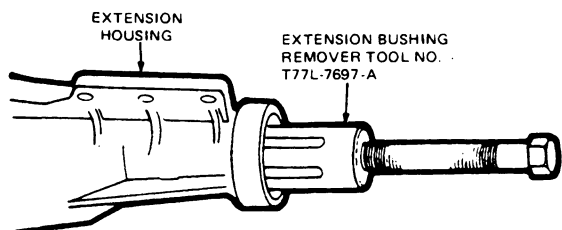
REMOVAL AND INSTALLATION (Continued)**Extension Housing Bushing and Rear Seal****Removal**

1. Raise the vehicle on a hoist and position safety stands under vehicle. Disconnect the driveshaft at the rear axle flange and remove it from the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original positions.
2. When only the rear seal needs replacing, carefully remove with Seal Remover Tool T74P-77248-A and Slide Hammer T59L-100-B as shown.



D3931-2B

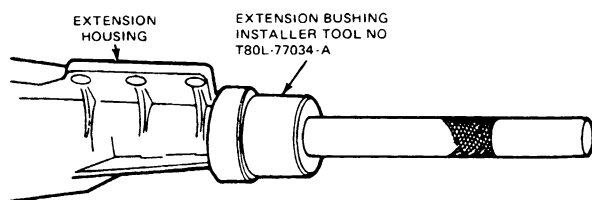
3. Remove the bushing as shown. Use the bushing remover Tool T77L-7697-A carefully so that the output shaft spline is not damaged.



D3988-1A

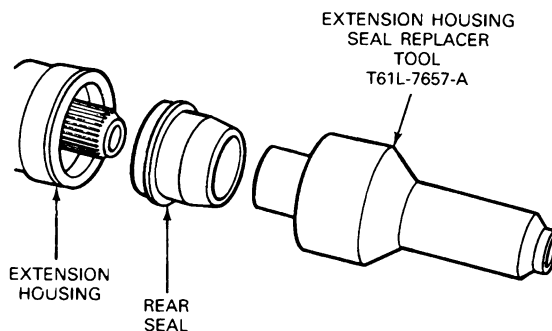
Installation

1. When installing a new bushing use special Tool T80L-77034-A.



D3989-1A

2. Before installing a new seal, inspect the sealing surface of the universal joint yoke for scores. If scores are found, replace the yoke.
3. Inspect the counterbore of the housing for burrs. Remove burrs with crocus cloth.
4. Install the seal into the housing with Tool T61L-7657-A. The seal should be firmly seated in the bore. Coat the inside diameter of the rubber portion of the seal with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B).



D7179-1B

REMOVAL AND INSTALLATION (Continued)**Extension Housing****Removal**

1. Raise the vehicle on a hoist and position safety stands under vehicle.
2. Disconnect the parking brake cable from the equalizer, if so equipped.
3. Disconnect the driveshaft from the rear axle flange and remove from the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original positions.
4. Remove the engine rear support-to-extension housing attaching bolts.
5. Place a jack under the transmission and raise just enough to remove the weight from the engine rear support.
6. Remove the bolt that secures the engine rear support to the crossmember and remove the support.
7. Place a drain pan under the rear of the transmission case.

NOTE: The extension housing bolts have been coated with a sealant. More torque may be required to remove these bolts.
8. Lower the transmission and remove the extension housing attaching bolts. Slide the extension housing off the output shaft and allow the fluid to drain.
9. Remove and discard extension housing gasket.

Installation

1. Clean the mounting surface on the transmission and on the extension housing. Remove any sealant from the bolts and the case bolt holes. Position a new gasket on the transmission. Coat the bolts with Ford Threadlock and Sealer EOAZ-19554-AA (ESE-M4G204-A, Type II) or Ford Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) Teflon® tape.
2. Hold the extension housing in place and secure with the bolts. Tighten to 22-27 N·m (16-20 ft·lb).
3. Raise the transmission high enough to position the engine rear support on the crossmember.
4. Secure the support to the crossmember with the attaching bolt and nut. Tighten the bolt to 68-94 N·m (50-70 ft·lb).
5. Lower the transmission and remove the jack. Install the engine rear support-to-extension housing attaching bolts. Tighten the bolts to 82-108 N·m (60-80 ft·lb).
6. Connect the parking brake cable to the equalizer (if so equipped) and adjust the parking brake as required.
7. Install the driveshaft, aligning the index marks (made during removal), in the transmission and connect shaft to rear axle flange.
8. Remove safety stands and lower the vehicle. Fill the transmission to the correct level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C166-H). Start the engine and shift the transmission through all ranges, then recheck the fluid level.

Governor**Removal**

1. Raise the vehicle on a hoist and position safety stands under vehicle.
2. Disconnect the parking brake cable from the equalizer.
3. Disconnect the driveshaft from the rear axle flange and remove from the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original position.
4. Remove the engine rear support-to-extension housing attaching bolts.
5. Place a jack under the transmission and raise just enough to remove the weight from the engine rear support.
6. Remove the bolt that secures the engine rear support to the crossmember and remove the support.

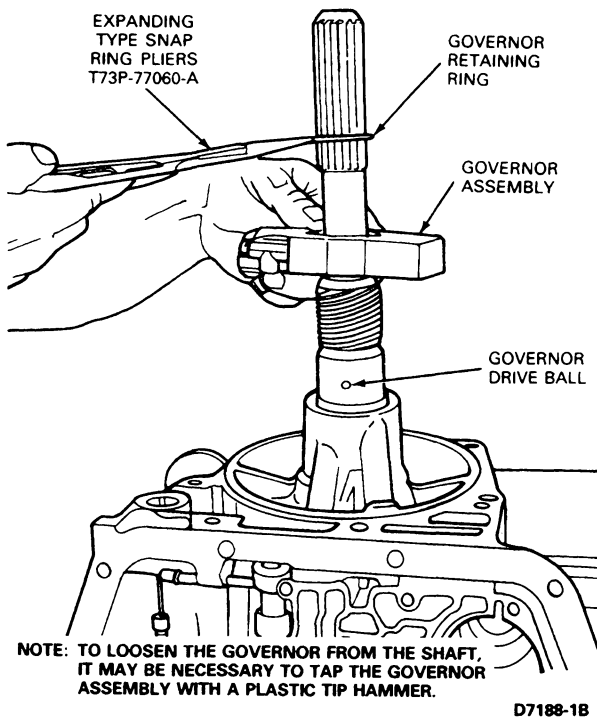
7. Place a drain pan under the rear of the transmission case.

NOTE: The extension housing bolts have been coated with a sealant. More torque may be required to remove these bolts.
8. Lower the transmission and remove the extension housing attaching bolts. Slide the extension housing off the output shaft and allow the fluid to drain.
9. Remove and discard the extension housing gasket.

NOTE: If the governor body only is to be removed, skip Steps 11 and 12.
10. Remove the governor-to-output shaft retaining snap ring.
11. Using a soft-faced hammer, tap the governor assembly off the output shaft. Remove the governor driveball.

REMOVAL AND INSTALLATION (Continued)

12. Remove the governor-to-counterweight screws. Lift the governor from the counterweight.

**Installation**

1. Lubricate the governor valve parts with clean transmission fluid. Make certain that the valve moves freely in the valve body bore.
2. Position the governor valve body on the counterweight with the cover facing toward the front of the vehicle. Install the two screws, and tighten to specification.
3. Position the governor drive ball into the pocket of the output shaft.
4. Align the key way in the counterweight to the governor drive ball. Drive the governor assembly onto the output shaft with soft-faced hammer if necessary.
5. Reinstall the governor to output shaft retaining snap ring.
6. Clean the mounting surface on the transmission and on the extension housing. Remove any sealant from the bolts and the case bolt holes. Position a new gasket on the transmission, coat the bolts with Ford Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A Type II) or Ford Pipe Sealant with Teflon D8AZ-19554-A (ESG-M4G194-A and ESR-M187-A) Teflon® tape.
7. Hold the extension housing in place and secure with the bolts. Tighten bolts to 22-27 N·m (16-20 ft-lb).
8. Raise the transmission high enough to position the engine rear support on the crossmember.
9. Secure the support to the crossmember with the attaching bolt and nut. Tighten the bolt to 68-94 N·m (50-70 ft-lb).
10. Lower the transmission and remove the jack. Install the engine rear support-to-extension housing attaching bolt. Tighten the bolts to 82-108 N·m (60-80 ft-lb).
11. Connect the parking brake cable to the equalizer (if so equipped) and adjust the parking brake as required.
12. Install the driveshaft, after aligning the index marks (made during removal), in the transmission and connect shaft to rear axle flange.
13. Fill the transmission to the correct level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C166-H).

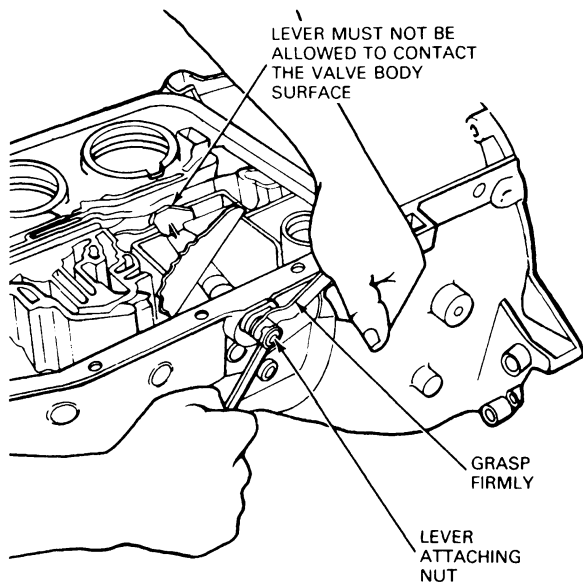
Internal and External Shift Linkage**Removal**

1. Raise the vehicle on a hoist so that the transmission oil pan is accessible. Position safety stands under vehicle.

2. Apply penetrating oil to the outer throttle lever attaching nut to prevent breaking the inner throttle lever.

REMOVAL AND INSTALLATION (Continued)

3. Grasp the outer throttle lever and hold firmly. Then remove the outer throttle lever nut and lockwasher. Swing lever and TV cable assembly clear for access path.



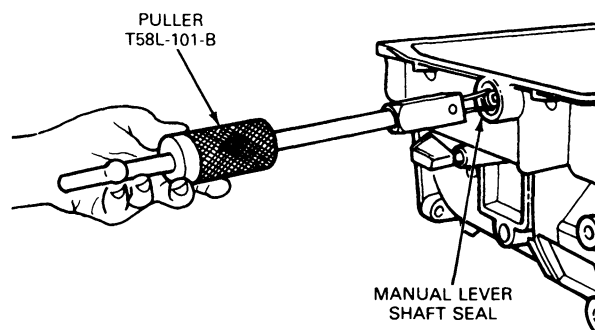
D7193-1A

4. Carefully disconnect shift cable from the transmission shift arm by pulling cable end off ball stud.
5. Place a drain pan under the transmission oil pan. Starting at the rear of the pan and working toward the front, loosen the bolts and allow the fluid to drain. Remove all of the bolts except two at the rear to allow the fluid to further drain. It is necessary to use a 1/4-inch drive with a 10mm universal socket for access to remove the oil pan bolts. After all the fluid has drained, remove the two remaining bolts and the fluid pan. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if it is in good condition.
6. Remove the three filter-to-valve body bolts and remove the filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the filter (DO NOT clean the filter).
7. Remove the manual lever detent spring and bolt.
8. Remove manual lever retaining pin using a narrow sharp screwdriver — this must be done carefully.
9. Note assembled position of the TV lever torsion spring, then remove the spring.

10. Slide a 5/8-inch open end wrench over the inner manual lever close to the bottom of the lever. Do not allow the wrench to contact the rooster comb area. Using a 21mm wrench (some 13/16-inch wrenches secure the nut better), remove the manual lever attaching nut. Securely hold the inner manual lever with the open end wrench while applying break torque to the manual lever attaching nut.

NOTE: Note the orientation of the outer manual lever (pointing up or down) before removal.

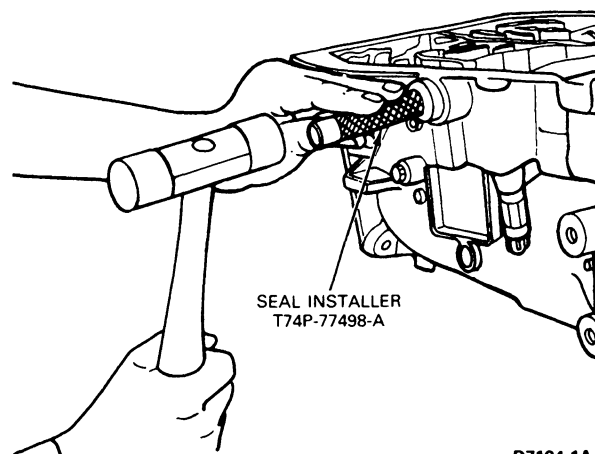
11. Remove the outer manual lever from the case.
12. Remove the inner throttle lever and shaft assembly.
13. Remove the inner manual lever and park pawl actuating rod assembly.
14. Disconnect the park pawl actuating rod from the inner manual lever.
15. Remove the manual lever oil seal with a screwdriver or seal remover Tool T58L-101-B. Discard the oil seal.



D3951-1B

Installation

1. Install a new manual lever seal into the case using Seal Replacer Tool T74P-77498-A.



D7194-1A

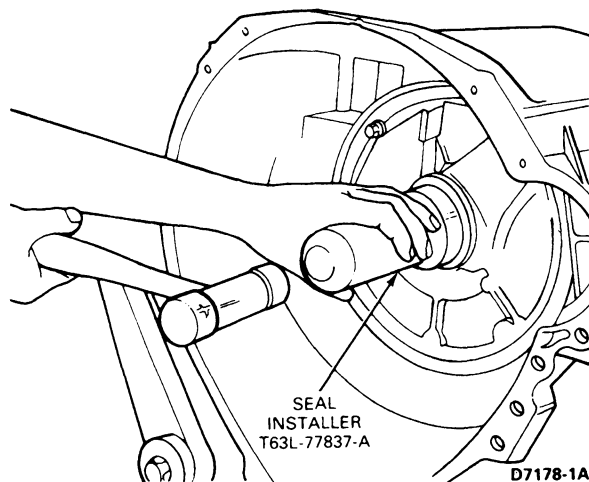
REMOVAL AND INSTALLATION (Continued)

2. Check the manual lever, the shaft and the threads for damage.
3. With the manual lever nut on the inner throttle lever and shaft assembly, slide the inner throttle lever through the inner manual lever.
4. Slide the outer manual lever in the case. Make sure the lever is oriented in the up position.
5. Allow the inner throttle lever and shaft assembly to slide through the ID bore of the outer manual lever.
6. Snug the manual lever nut against the inner manual lever making sure the flats are properly aligned. Tighten the nut to remove free play, and torque the nut to 26-37 N·m (19-27 ft·lb).
7. Position TV lever torsion spring on the inner throttle valve shaft and align in notch.
8. Push manual lever all the way into the case. Make sure inner manual lever pin is engaged in manual valve detent slot and inner throttle lever is acting on the TV valve. Park / neutral position switch plunger must also be riding on cam surface of inner manual lever.
9. Install new manual lever retaining pin in case (light press fit). Pin must be flush to slightly below pan gasket surface.
10. Install the new throttle lever seal in the outer manual lever counterbore with a 13mm thin wall socket, using the end that the ratchet drive would be inserted into, to seat the seal. Install .030 inch to .060 inch below the surface.
11. Install detent spring. Make sure detent spring roller is centered on rooster comb. Tighten to 9-14 N·m (80-120 in·lb).
12. Install the throttle valve outer lever (do not push inner throttle valve lever past throttle valve).
13. Install throttle lever lockwasher and nut. Tighten nut to 16-22 N·m (12-16 ft·lb).
14. Check park function and operation of TV lever and manual lever before further assembly.
15. Connect shift cable to the shift arm of the manual lever by snapping the cable end fitting over the ball stud. Make sure the manual lever is in the same position as adjustment is required.
16. Using three filter bolts, install the filter and gasket to the valve body and tighten bolts to 9-14 N·m (80-120 in·lb).
17. Clean the transmission oil pan and gasket surfaces thoroughly.
18. Reassembly oil pan with a new pan gasket. Tighten bolts to 9-14 N·m (80-120 in·lb).
19. Remove safety stands. Lower the vehicle and fill the transmission to the correct level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or - DDX, E4AZ-19582-B (ESP-M2C166-H).
20. Check and adjust the TV cable linkage at the throttle body.

NOTE: Identification numbers on the seal must face outward.

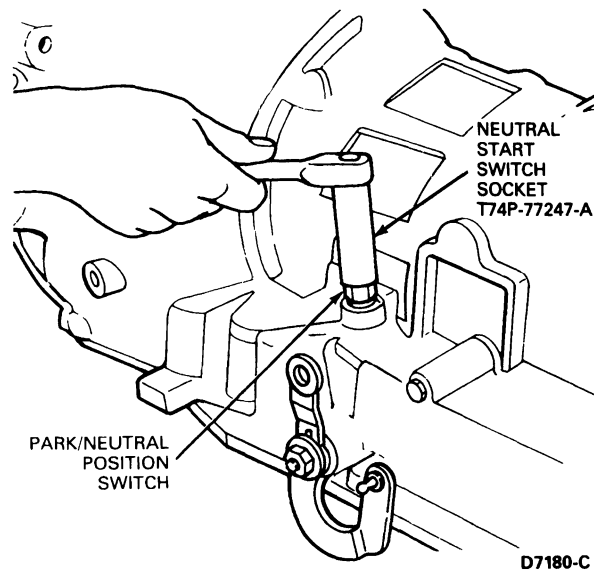
Front Pump Seal**Removal and Installation**

1. Remove the transmission from the vehicle as described in this section.
2. Remove the pump seal using seal remover TOOL-1175-AC and slide hammer T59L-100-B.
3. Install the seal using seal installer Tool T63L-77837-A.
4. Install the transmission as described in this section.



REMOVAL AND INSTALLATION (Continued)**Park / Neutral Position (PNP) Switch****Transmission Out of Vehicle****Removal and Installation**

1. Using the neutral start switch socket Tool T74P-77247-A remove the PNP switch from the case.
2. Remove the O-ring seal and discard.
3. Install a new seal on the PNP switch.
4. Lube seal with transmission fluid.
5. Install the PNP switch in the case using the neutral start switch socket Tool T74P-77247-A. Tighten to 11-15 N·m (8-11 ft-lb).

**Transmission in Vehicle****Removal**

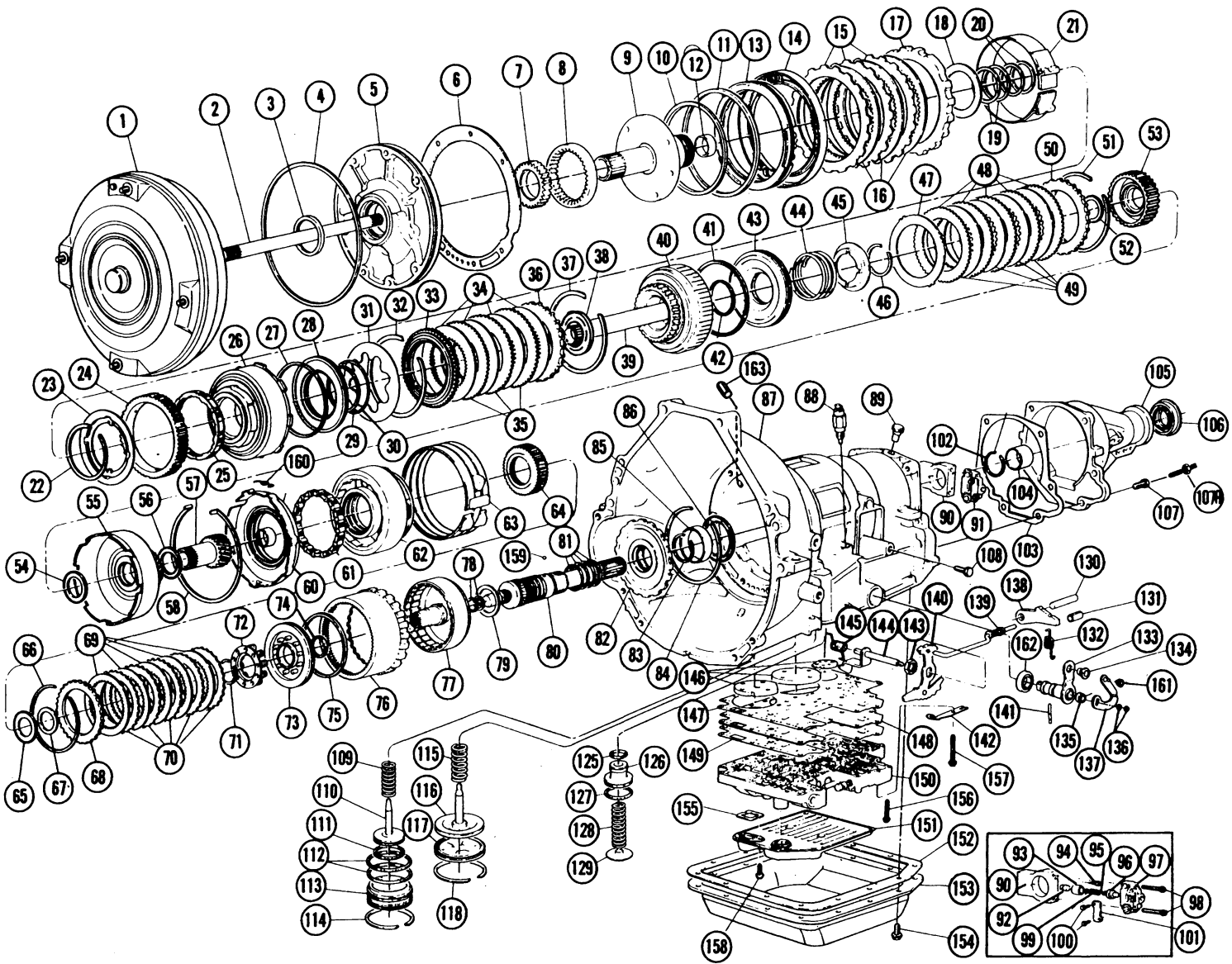
1. Raise the vehicle on a hoist and position safety stands under vehicle.
2. Disconnect the PNP switch electrical harness from the PNP switch. Lift the harness straight up off the switch. **(No lateral movement.)**
3. Using the neutral switch socket Tool T74P-77247-A remove the neutral start switch and O-ring seal.

Installation

1. Install a new O-ring seal on a new neutral start switch.
2. Lube seal with transmission fluid.
3. Install the new switch and seal into the case, using the neutral start switch socket Tool T74P-77247-A. Tighten to 11-15 N·m (8-11 ft-lb).
4. Connect the PNP switch harness to the new PNP start switch.
5. Remove safety stands and lower the vehicle.

DISASSEMBLY

Transmission



D6583-E

DISASSEMBLY (Continued)

Item	Part Number	Description
1	7902	Torque Converter
2	7F206	Direct Drive Shaft
3	7A248	Front Pump Seal
4	7D441	Front Pump O-Ring
5	7A103	Front Pump Body
6	7A136	Front Pump Gasket
7	7C010	Front Pump Drive Gear
8	7C011	Front Pump Driven Gear
9	7A106	Stator Support—Front Pump
10	7F225	Interm. Clutch Piston Inner Lip Seal
11	7F224	Interm. Clutch Piston Outer Lip Seal
12	7B258	Front Pump Bushing
13	7E005	Interm. Clutch Piston
14	7F222	Interm. Clutch Piston Return Springs and Retainer
15	7B442	Interm. Clutch External Spline Steel Plates (Sel.)
16	7B164	Interm. Clutch Internal Spline Friction Plates
17	7B066	Interm. Clutch Pressure Plate
18	7D014	No. 1 Thrust Washer (Front Pump) Selective
19	7D020	Stator Support Seal Rings (Rev. Clutch) (1 and 2)
20	7D019	Stator Support Seal Rings (Fwd. Clutch) (3 and 4)
21	7F196	Overdrive Band
22	389790-S	Interm. OWC Retaining Snap
23	7D191	Interm. OWC Retaining Plate
24	7F221	Interm. OWC Outer Race
25	7A089	Interm. One-Way Clutch Assy
26	7D044	Reverse Clutch Drum
27	7D403	Reverse Clutch Piston Seal (Outer)
28	7D402	Reverse Clutch Piston
29	7D404	Reverse Clutch Piston Seal (Inner)
30	7D256	Thrust Ring
31	7B070	Reverse Clutch Piston Return Spring
32	7A577	Retaining Ring
33	7B066	Reverse Clutch Front Pressure Plate
34	7E311	Forward and Reverse Clutch Internal Spline Friction Plate
35	7B442	Reverse Clutch External Spline Steel Plate
36	7F278	Forward and Reverse Clutch Rear Pressure Plate
37	7D483	Reverse Clutch Retaining Ring (Sel.)
38	7G008	No. 2 Needle Bearing
39	7F212	Turbine Shaft
40	7F207	Forward Clutch Cylinder and Turbine Shaft

(Continued)

Item	Part Number	Description
41	7F227	Forward Clutch Piston Seal (Outer)
42	7F228	Forward Clutch Piston Seal (Inner)
43	7L140	Forward Clutch Piston
44	7F230	Forward Clutch Piston Return Spring
45	7F229	Return Spring Retainer
46	388099	Retaining Snap Ring
47	7E085	Waved Plate
48	7B442	Forward Clutch External Spline Steel Plate
49	7E311	Forward and Reverse Clutch Internal Spline Friction Plate
50	7F278	Forward and Reverse Clutch Pressure Plate
51	7D483	Retaining Snap Ring (Selective)
52	7G040	No. 3 Needle Bearing (Fwd. Clutch)
53	7D051	Forward Clutch Hub
54	7F244	No. 4 Needle Bearing
55	7A019	Reverse Sun Gear and Drive Shell Assy
56	7F244	No. 5 Needle Bearing
57	7A399	Forward Sun Gear
58	388501	Center Support Retaining Ring
60	7C363	Center Support Planetary
61	7504	Planetary OWC Cage Spring and Roller Assy
62	7A396	Planetary Assy
63	7D095	Reverse Band
64	7F236	Direct Clutch Hub
65	7F243	No. 7 Needle Bearing (Direct Clutch Inner)
66	388065	Retaining Snap Ring (Selective)
67	7F237	Thrust Spacer
68	7B477	Direct Clutch Pressure Plate
69	7E313	Direct Clutch Internal Spline Plates
70	7F238	Direct Clutch External Spline Plates
71	388104	Retaining Snap Ring
72	7F235	Return Spring and Retainer
73	7F254	Direct Clutch Piston
74	7F234	Direct Clutch Piston Seal (Inner)
75	7C000	Direct Clutch Piston Seal (Outer)
76	7A153	Ring Gear and Park Gear
77	7F283	Direct Cylinder
78	7F284	Output Shaft Small (2) Steel Seal Rings (Direct Clutch) (5 and 6)
79	7F240	No. 8 Needle Bearing (Direct Clutch Outer)
80	7060	Output Shaft

(Continued)

DISASSEMBLY (Continued)

Item	Part Number	Description
81	7F273	Output Shaft Large (4) Steel Rings (7, 8, 9 and 10)
82	7D164	Output Shaft Hub
83	97713	Retaining Snap Ring (O.P.S. Hub to O.P.S.)
84	97713	Retaining Snap Ring (O.P.S. Hub to Ring Gear)
85	7E110	Rear Case Bushing
86	7F242	No. 9 Needle Bearing (Rear Case)
87	7005	Case Assy
88	7A247	Neutral Start Switch
89	7034	Vent Cap
90	7A189	Governor Counterweight
91	7C063	Body Assy—Governor
92	7A303	Plug Governor
93	7A304	Sleeve Governor
94	7E242	Screen Assy—Gov. Oil
95	7A302	Spring Gov. Valve
96	7C054	Valve Governor
97	7A300	Body Governor
98	N800273	Bolt (Governor Body to Counterweight)
99	7A305	Clip—(Governor Cover to Governor Body)
100	N800274	Bolt (Governor Cover to Governor Body)
101	7A301	Cover—Governor Valve Body
102	388104	Retaining Snap Ring (Governor Assy to O.P.S.)
103	7086	Extension Housing Gasket
104	7A034	Extension Housing Bushing
105	7A039	Extension Housing
106	7052	Extension Housing Seal
107	N803747-S100	Bolt (Ext. Hsg. to Case) M6-12.5 x 30 (6 Req'd)
107A	N803521-S100	Stud (Ext. Hsg. to Case) M8 x 1.25 x .54 Hex Shld. Depending on Application (1 Req'd., Hole 6)
108	376649	Pipe Plug—1/8-27 Dry Seal
109	7F201	Overdrive Servo Piston Return Spring
110	7F200	Overdrive Servo Piston
111	SEE NOTE	Overdrive Piston Seal
112	388515	Overdrive Servo Cover Seal Rings
113	7F204	Overdrive Servo Cover
114	388216	Retaining Snap Ring (O/D Servo to Case)
115	7D031	Reverse Servo Piston Return Spring
116	7D030	Reverse Servo Piston (Selective)
117	7D281	Reverse Servo Cover

(Continued)

Item	Part Number	Description
118	388215-S100	Retaining Snap Ring (Rev. Servo to Case)
125	7F250	2-3 Accumulator Valve Seal (Small)
126	7F251	2-3 Accumulator Valve
127	7F249	2-3 Accumulator Valve Seal (Large)
128	7F285	2-3 Accumulator Valve Return Spring
129	7B264	2-3 Accumulator Retainer
130	7D071	Park Pawl Shaft
131	7D419	Guide Cup (Not Serviced)
132	7D070	Park Pawl Return Spring
133	7F338	Manual Lever
134	7341	Grommet
135	7F337	Throttle Lever Oil Seal
136	N62004-S51	Attaching Nut and Lock Washer—M8 x 1.25
137	7F291	Throttle Lever (Outer)
138	7A441	Park Pawl
139	7A232	Park Pawl Actuating Rod
140	7A115	Manual Lever (Inner)
141	7B210	Roll Pin—1/8 x 0.95 Grooved
142	7E332	Detent Spring
143	N800287-S51	Attaching Nut (Manual LVR)—M14 x 1.5 Hex
144	7F290	Throttle Lever (Inner)
145	7F292	Throttle Torsion Spring
146	7F282	Valve Body Reinforcement Plate
147	7C155	Separator Plate Gasket (Upper)
148	7A008	Separator Plate
149	7D100	Separator Plate Gasket (Lower)
150	7A100	Valve Body (Main Control)
151	7F003	Filter and Grommet Assy—Oil Pan
152	7A191	Oil Pan Gasket
153	7A264	Oil Pan
154	390233-S2	Bolt (Oil Pan to Case)—M8 1.25 x 15 (14 Req'd)
155	7E062	Oil Filter Gasket
156	N605775-S	Bolt (Valve Body to Case) M6 1.0 x 30 (8 Req'd)
157	N606022-S	Bolt (Valve Body to Case) M6 1.0 x 40 (17 Req'd)
158	N605772-S	Bolt (Screen to Valve Body) M6 1.0 x 16 (3 Req'd)
159	353351-S	Ball (Governor Drive)
160	7F277	Spring (Anti Clunk)
161	7F434	Grommet
162	7B498	Oil Seal Assy
163	N804799-S100	Connector Assy 5/16 Tube x 1/4 External Pipe Plug

TD6583E

DISASSEMBLY (Continued)

NOTE: Part number for item No. 111 varies by application. Refer to Master Parts Catalog.

NOTE: Before beginning the transmission overhaul, review the following guidelines. These general rules are provided to emphasize the need for attention to detail and care when servicing an automatic transmission.

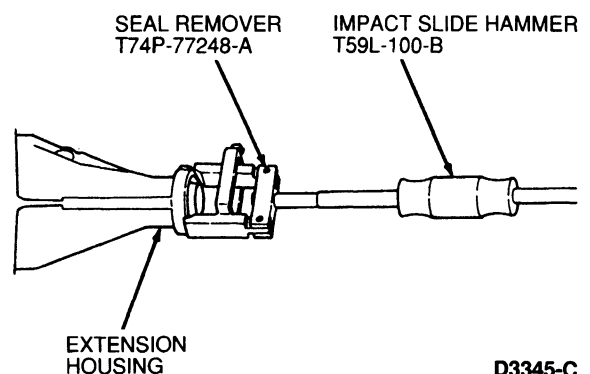
- If the transmission is being removed for major overhaul, it is important to completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service.
- The cleaning of debris from the direct clutch check ball is often omitted. This omission can lead to a repeat servicing of the transmission.
- Cleaning and flushing procedures for transmission components, including the direct clutch check ball, can be found under Cleaning and Inspection.
- Thorough cleaning of the transmission exterior will reduce the possibility that damaging contaminants might enter the subassemblies during disassembly and assembly.
- All fasteners must be tightened to the torque indicated in the text. In addition to appearing in the text, the necessary torques can be found under Specifications.
- When building up subassemblies, each component part should be lubricated with clean transmission fluid. It is also good practice to lubricate the subassemblies as they are installed in the case.
- Needle bearings, thrust washers and seals should be lightly coated with petroleum jelly during subassembly build up or transmission assembly.
- Many components and surfaces in the transmission are precision machined. Careful handling during disassembly, cleaning, inspection and assembly can prevent unnecessary damage to machined surfaces.
- When building up subassemblies or assembling the transmission, always use new gaskets and seals.
- The transmission service area should be kept clean, well organized and supplied with clean lint-free shop cloths.
- Whenever a seal is removed from a piston, shaft or servo, note the type of seal and when applicable, the direction of the sealing lip.

Extension Housing Seal**Tools Required:**

- Impact Slide Hammer T59L-100-B
- Seal Remover T74P-77248-A

Removal

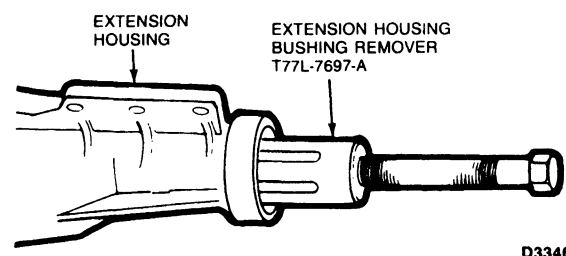
Remove the extension housing seal using Impact Slide Hammer T59L-100-B and Seal Remover T74P-77248-A.

**Extension Housing Bushing****Tools Required:**

- Extension Housing Bushing T77L-7697-A

Removal

1. Remove the extension housing seal as outlined.
2. Remove the extension housing bushing using Extension Housing Bushing Remover T77L-7697-A or equivalent.



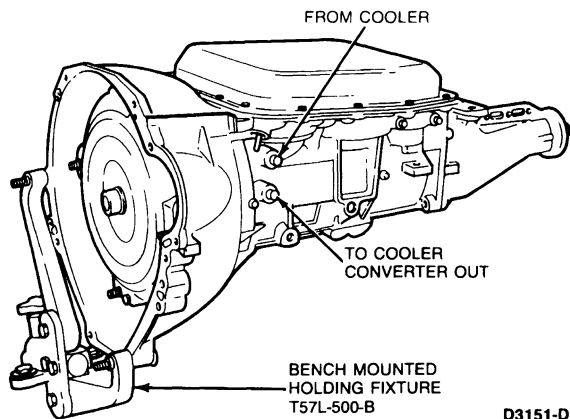
DISASSEMBLY (Continued)**Transmission****Tools Required:**

- Bench Mounted Holding Fixture T57L-500-B
- Impact Slide Hammer T59L-100-B
- Gauge Bar T80L-77003-A
- Servo Piston Selection Tool T80L-77030-A
- Servo Piston Remover T80L-77030-B
- Front Pump Remover Adapters T80L-77103-A
- Pump Puller Adapters T89L-70010-A
- Depth Micrometer D80P-4201-A
- Dial Indicator with Bracketry TOOL-4201-C

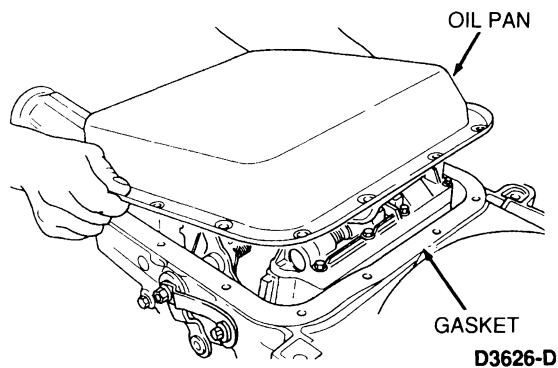
Disassembly

NOTE: The torque converter is relatively heavy. Be prepared to handle the weight.

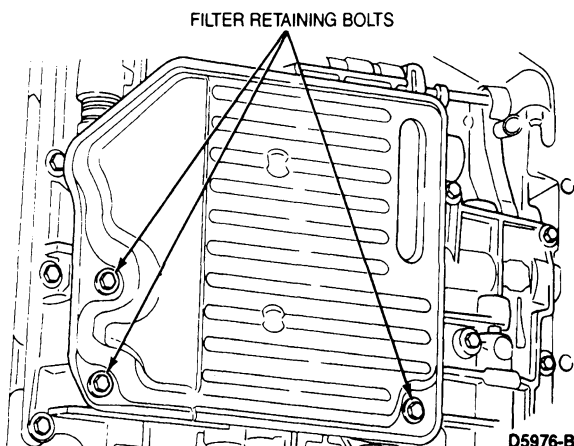
1. Remove torque converter prior to mounting in bench fixture.
2. Mount the transmission in Bench Mounted Holding Fixture T57L-500-B.



3. Remove the 14 oil pan retaining bolts, the oil pan and the pan gasket. Discard the gasket.

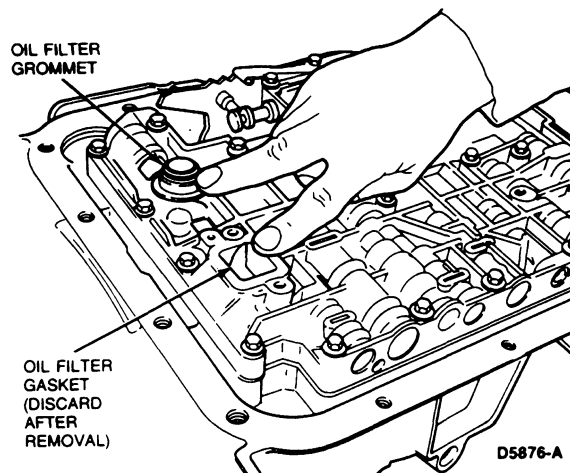


4. Remove the three oil filter retaining bolts.

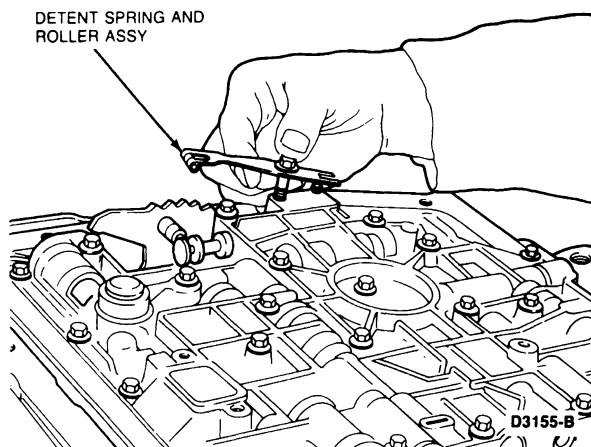


Remove the filter, grommet and gasket and discard.

NOTE: Always use a new filter. Never attempt to clean or reuse a dirty filter.



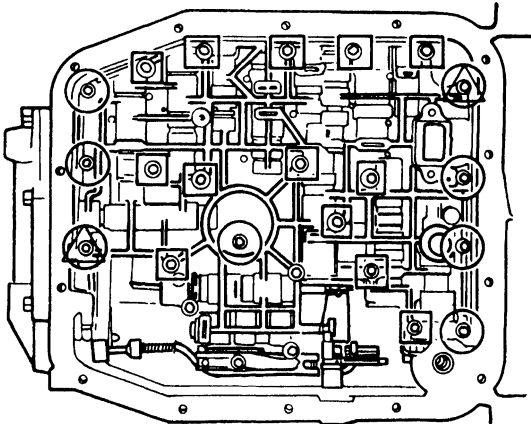
5. Remove the manual lever detent spring and roller assembly.



DISASSEMBLY (Continued)

NOTE: The four front, one center and three rear retaining bolts are shorter than the others.

6. Remove the remaining 24 valve body-to-case retaining bolts, the valve body assembly and the valve body gasket.

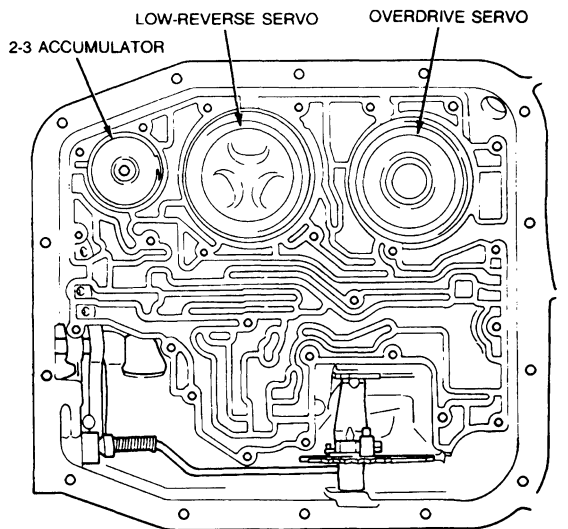


- INDICATES A SHORT BOLT
 □ INDICATES A LONGER BOLT
 △ INDICATES A SPECIAL SHOULDER BOLT

D10650-A

7. This illustration shows the position of the overdrive servo, the low reverse servo, and the 2-3 accumulator.

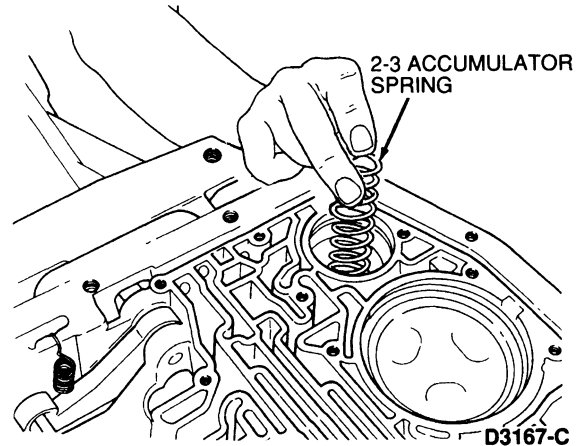
Remove these components from the transmission using the following procedures.



D3157-C

2-3 Accumulator**Removal**

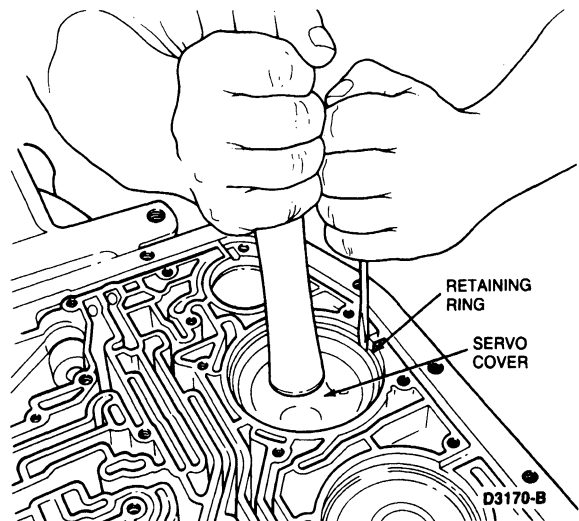
8. Lift piston retainer from bore.
9. Remove the accumulator piston spring.



10. Remove the accumulator piston.

Low/Reverse Servo**Removal**

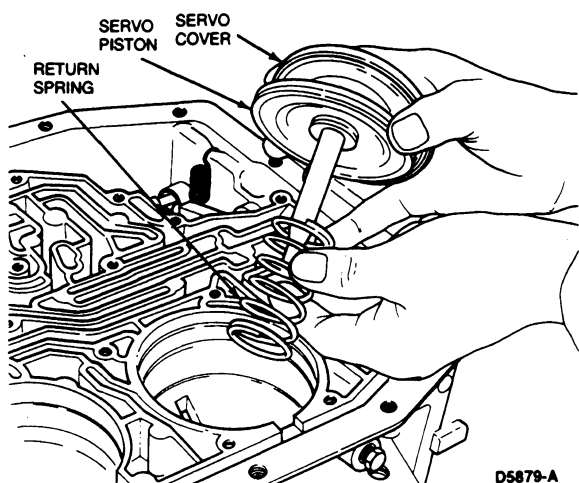
11. Using a hammer handle or wooden dowel, push down on the servo cover and remove the retaining ring.



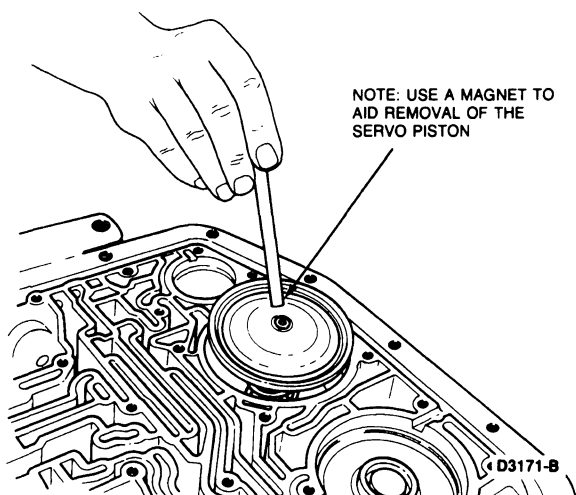
D3170-B

DISASSEMBLY (Continued)

12. Remove the servo piston, and the piston return spring.

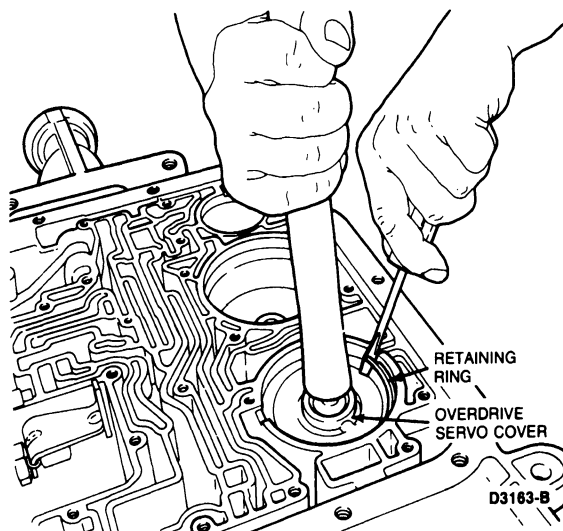


NOTE: If necessary, a magnet can be used to lift the piston from the bore.

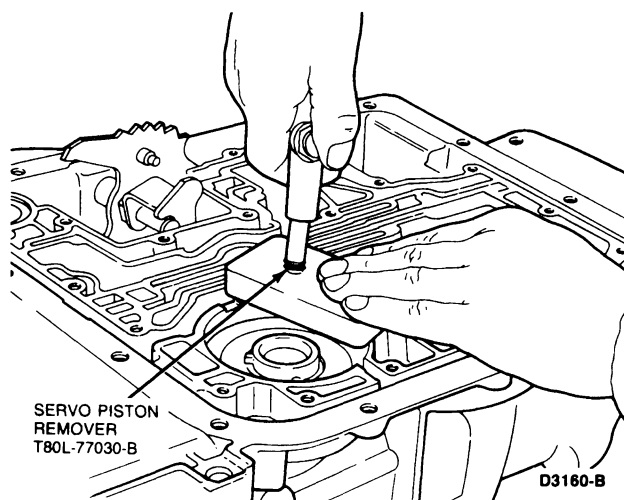


Overdrive Servo Removal

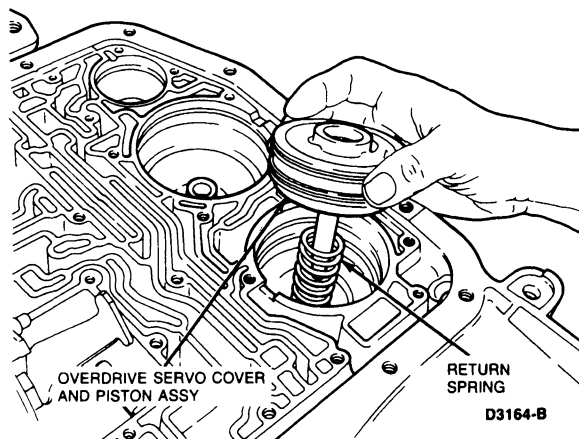
13. Using a hammer handle or wooden dowel, push down on the servo cover and remove the retaining ring.



14. Remove spring.



15. Remove the cover and piston as a unit.

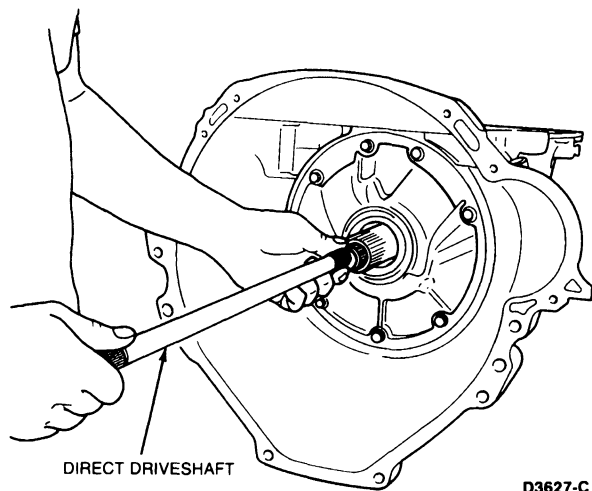


DISASSEMBLY (Continued)

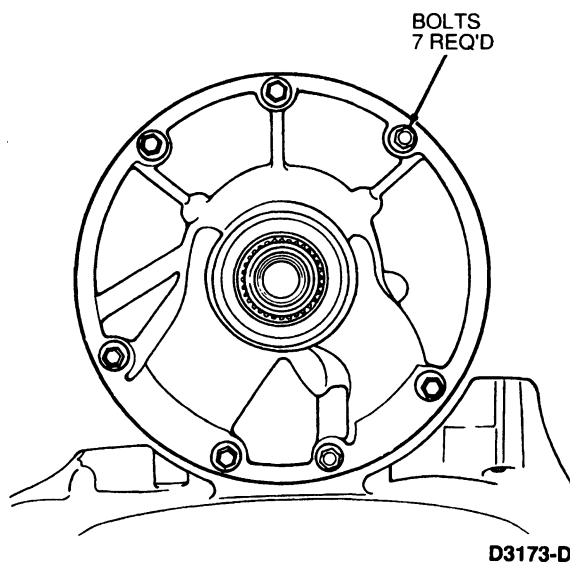
CAUTION: Make certain a portion of the Servo Piston Remover T80L-77030-B extends over the bore to prevent the cover from flying out of the bore.

If the cover sticks in the bore, use Servo Piston Remover T80L-77030-B and air pressure to aid removal.

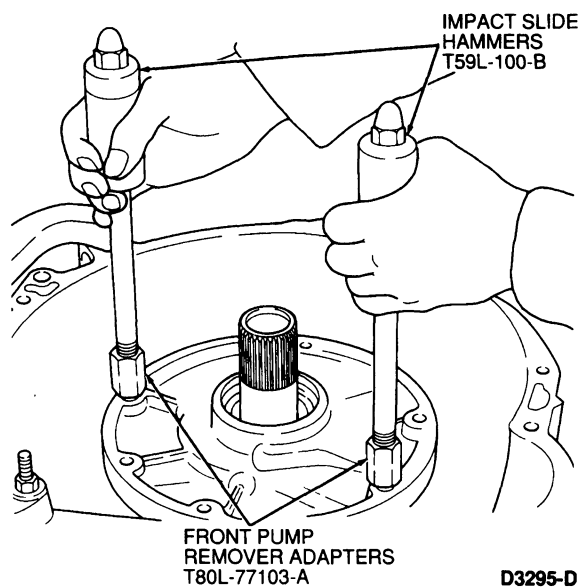
16. Remove the direct driveshaft.



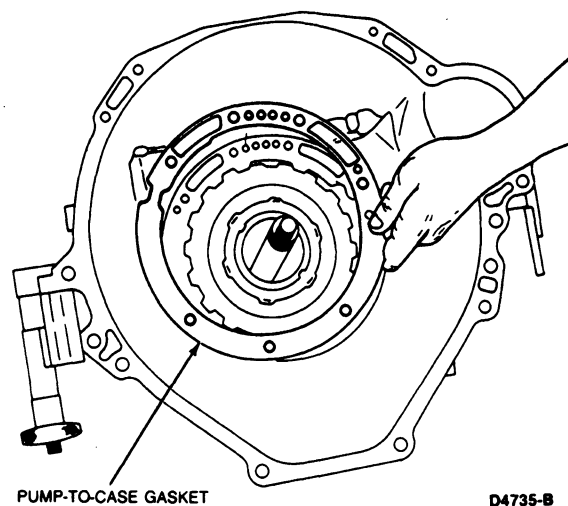
17. Using a 10mm socket, remove the seven pump body retaining bolts. All bolts have been coated with a sealant. More break torque might be required to remove the bolts. Before reinstallation, clean bolts and bolt holes in case and pump. Coat bolts with Threadlock and Sealer E0AZ-19554-AA (ESE-M4G204-A) or Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent.



18. Remove the pump assembly using Impact Slide Hammer T59L-100-B and Pump Puller Adapters T89L-70010-A.

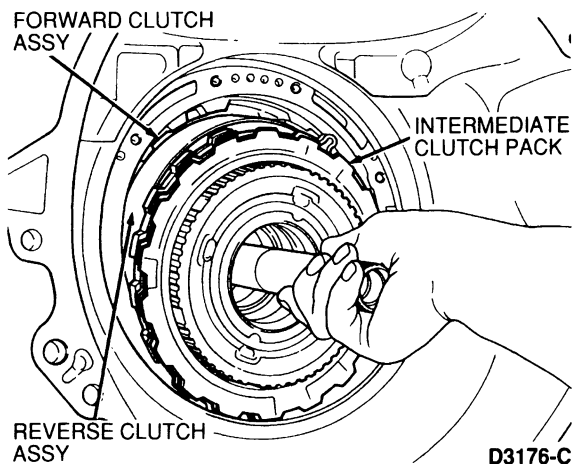


19. Remove the pump-to-case gasket and discard.

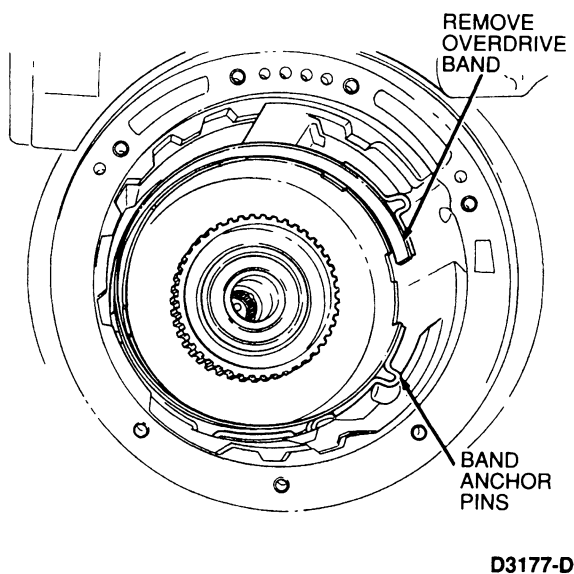


CAUTION: Remove the following assemblies carefully to prevent damage to the overdrive band friction material by the reverse clutch drive lugs.

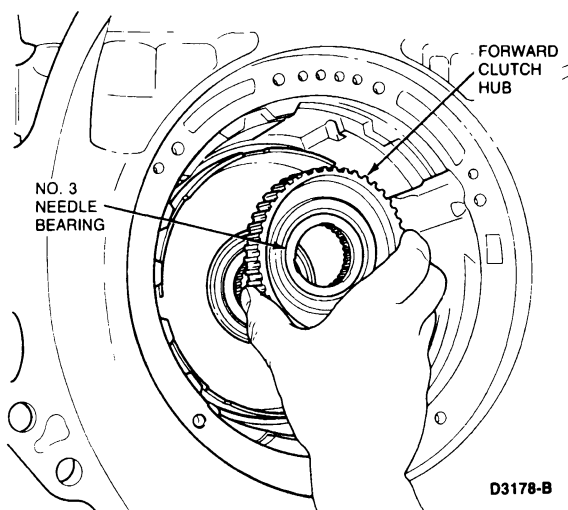
20. Grasp the turbine shaft firmly and pull the following components out of the case as an assembly:
- Intermediate clutch pack
 - Intermediate one-way clutch
 - Reverse clutch

DISASSEMBLY (Continued)**d. Forward clutch**

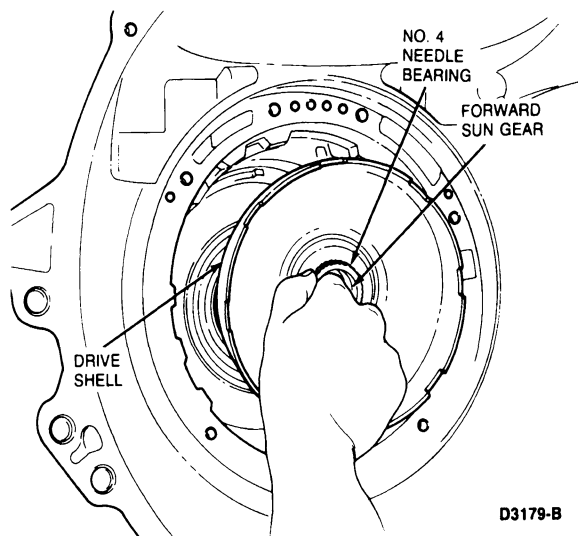
21. Disengage the overdrive band from the anchor pins and remove from the case.



22. Remove the forward clutch hub and the No. 3 needle bearing as an assembly.

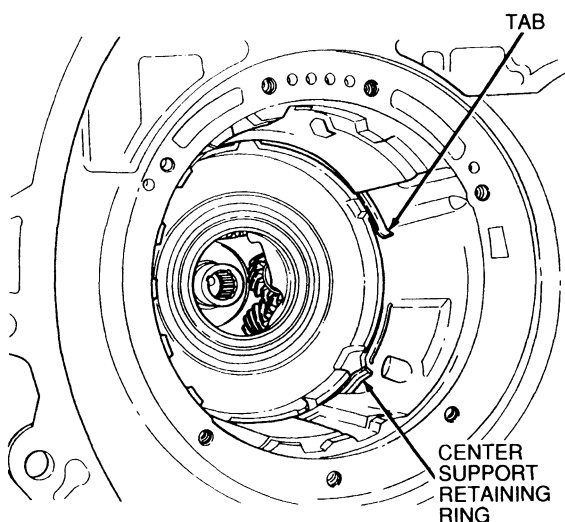


23. Remove the forward sun gear, No. 5 needle bearing, reverse sun gear and drive shell and the No. 4 needle bearing as an assembly.



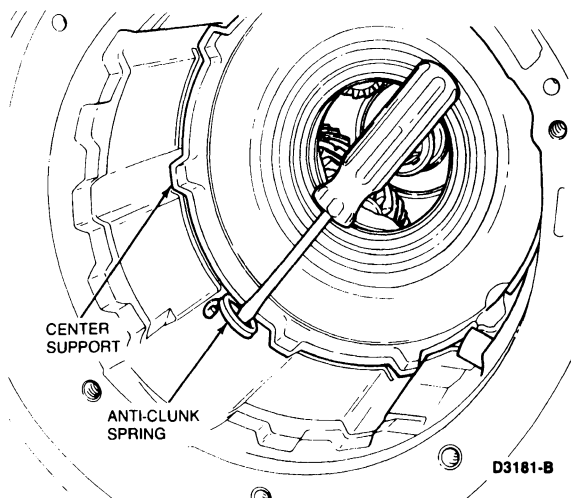
DISASSEMBLY (Continued)

24. Remove the center support retaining ring. Note position of tabs for assembly.

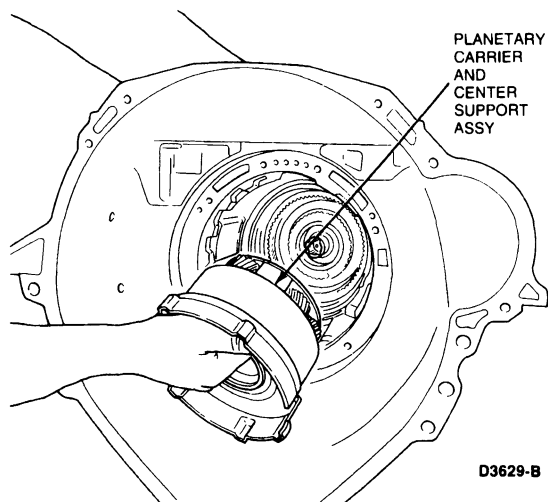


D3180-C

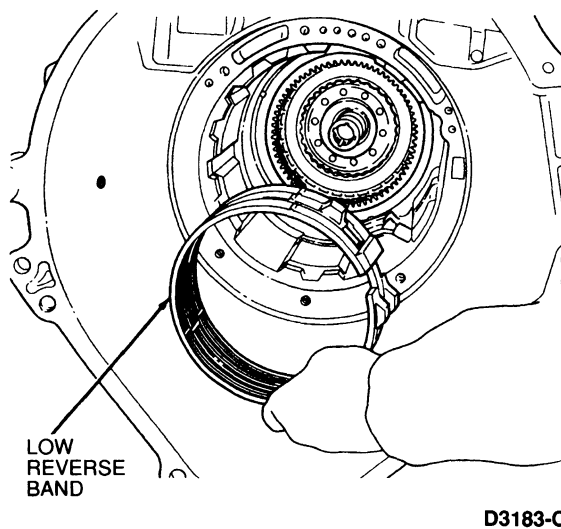
25. Using a screwdriver, pry the anti-clunk spring out from between the center support and the case.
NOTE: Note the location for assembly.



26. Remove the center support and planetary carrier as an assembly.

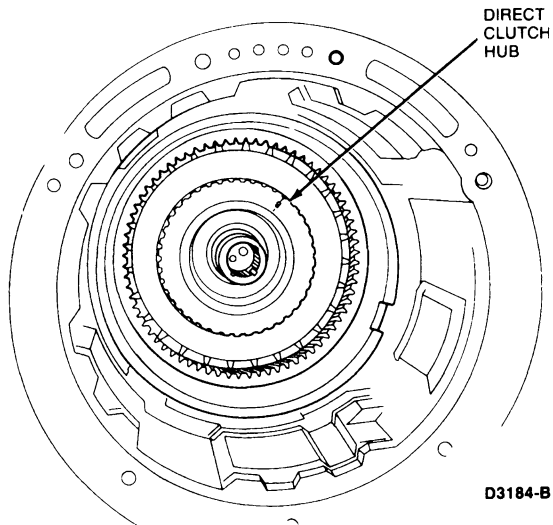


27. Remove the reverse band.



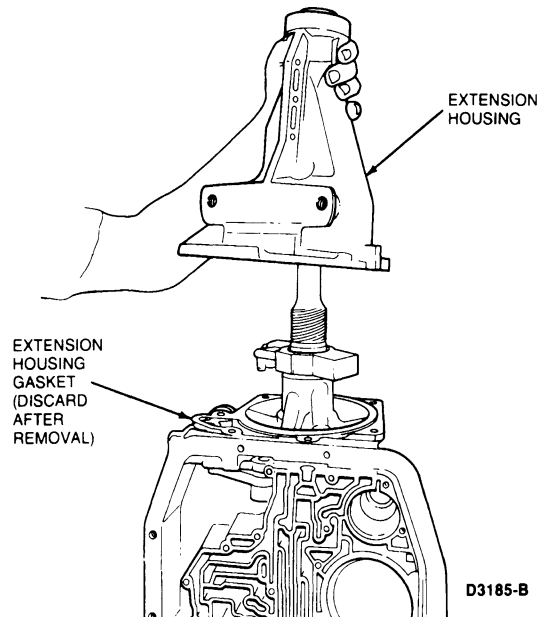
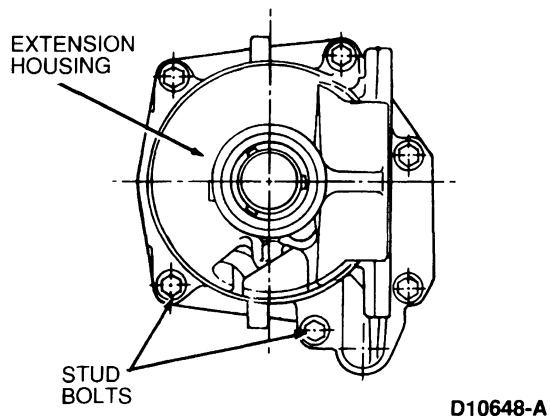
DISASSEMBLY (Continued)

28. If the direct clutch hub and No. 7 needle bearing did not come out with the planetary carrier, reach in and lift them out of the direct clutch.



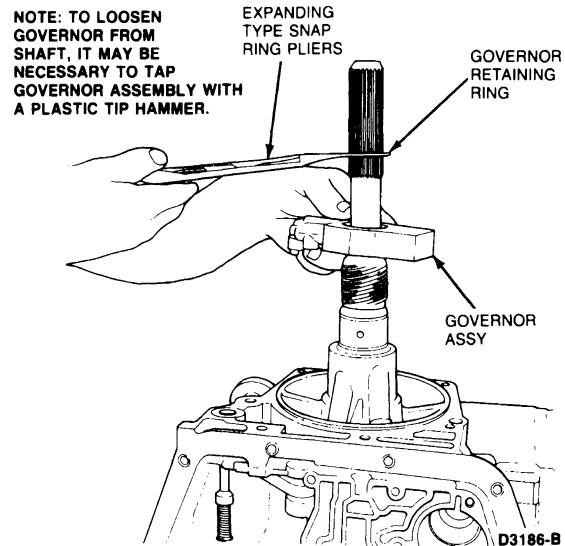
NOTE: The extension housing bolts have been coated with a sealant. More break torque may be required to remove these bolts.

29. Remove the six extension housing retaining bolts and the extension housing. Note location of one stud bolt for installation.



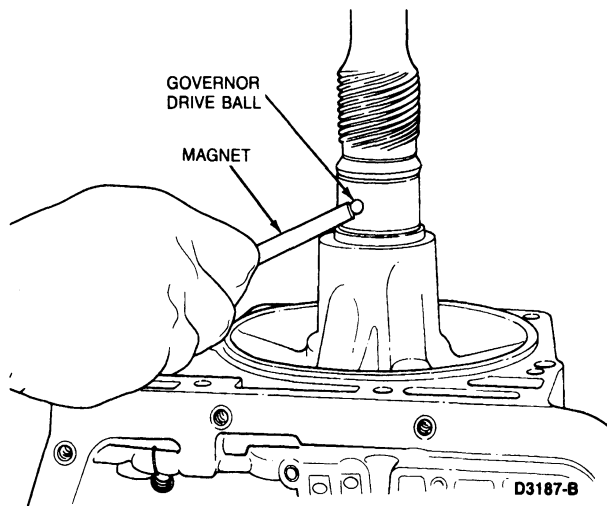
CAUTION: If the transmission is positioned with the output shaft pointing up, do not allow the shaft assembly to fall through the case when the governor is removed.

30. Remove the retaining ring and governor assembly.

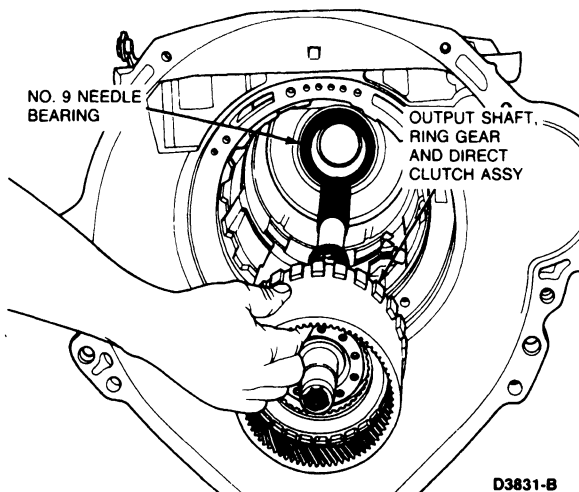


DISASSEMBLY (Continued)

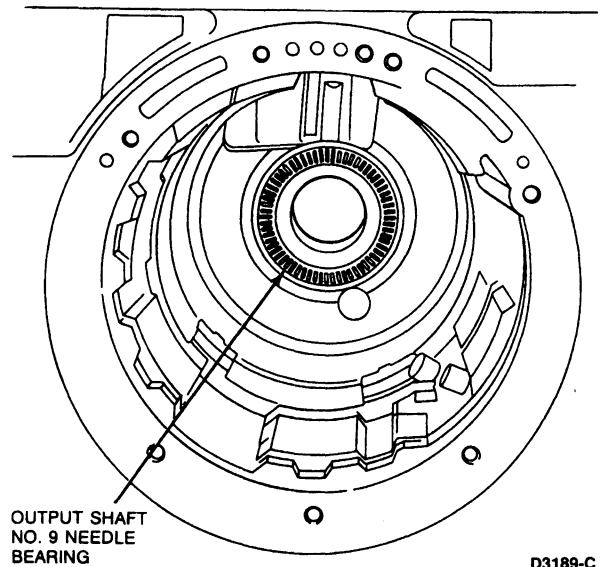
31. Remove the governor drive ball from the output shaft. A magnet may be used to aid removal.



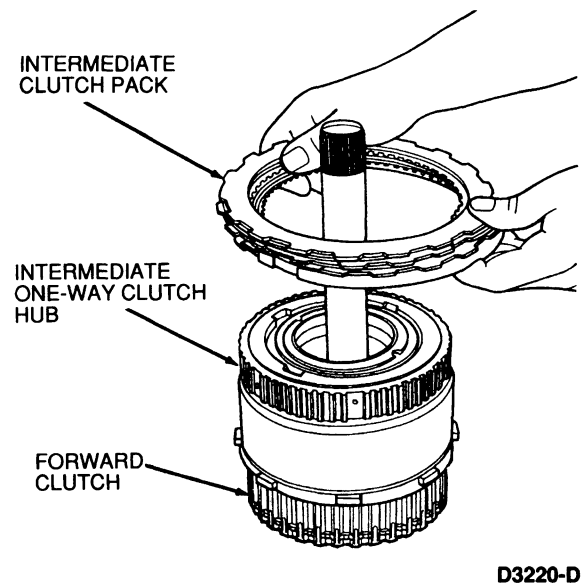
32. Remove the output shaft, the ring gear and the direct clutch as an assembly, through the front of the case.



33. Remove the output shaft No. 9 needle bearing from the rear of the case.

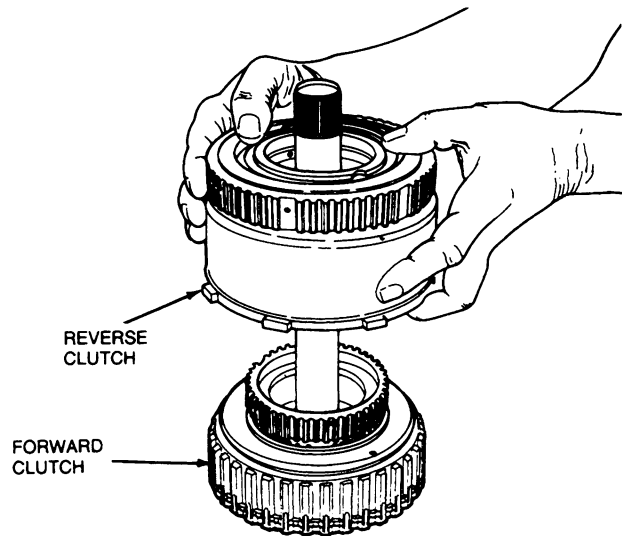


34. Remove the intermediate clutch pack from the intermediate one-way clutch.



DISASSEMBLY (Continued)

35. Remove the reverse clutch assembly from the forward clutch assembly.



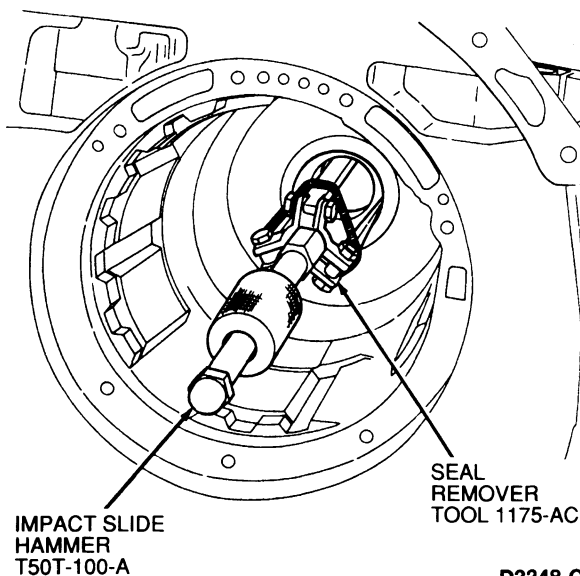
D4571-C

Subassemblies**Case Bushing****Tools Required:**

- Thread Impact Slide Hammer T50T-100-A
- Seal Remover TOOL-1175-AC

Removal

To remove the transmission case bushing, use Thread Impact Slide Hammer T50T-100-A and Seal Remover TOOL-1175-AC or equivalent.



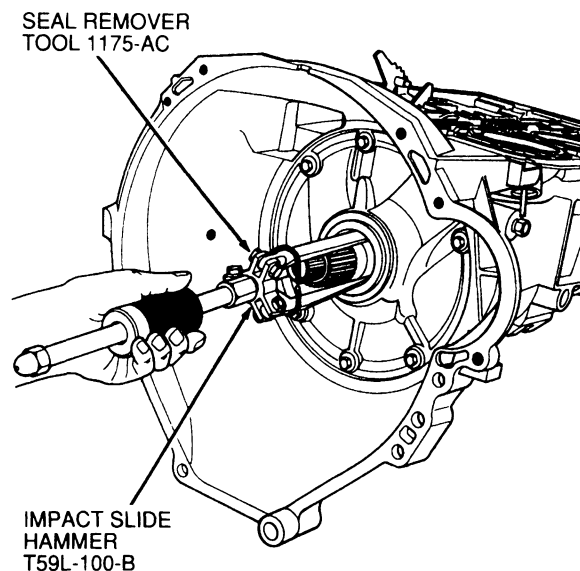
D3348-C

Pump Seal**Tools Required:**

- Impact Slide Hammer T59L-100-B
- Seal Remover TOOL-1175-AC

Removal

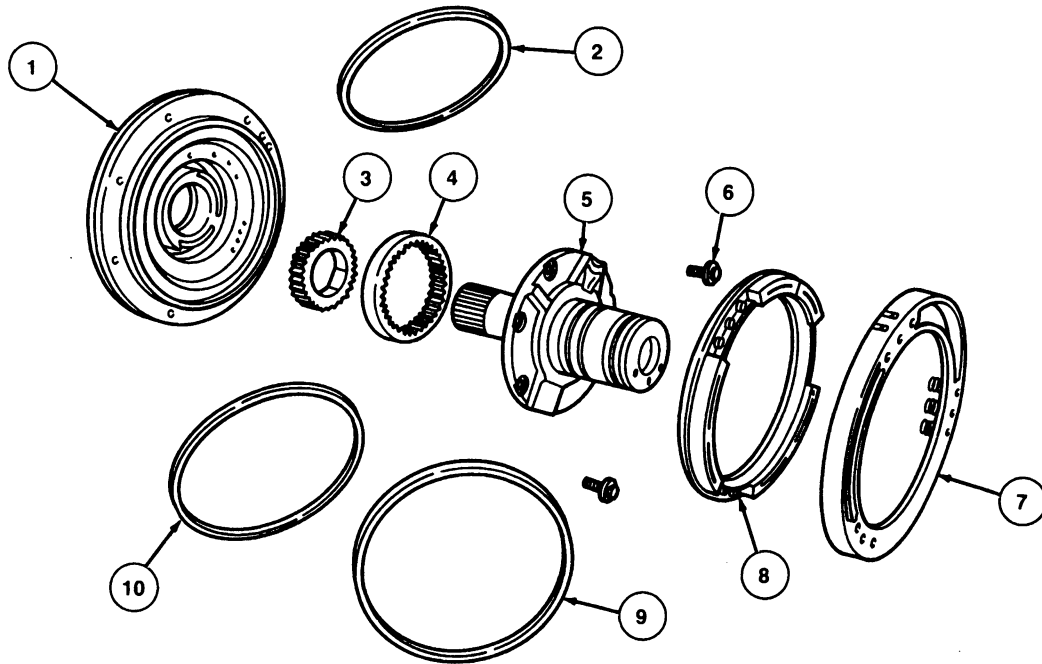
Remove the pump seal using Seal Remover TOOL-1175-AC and Impact Slide Hammer T59L-100-B.



D3247-D

DISASSEMBLY (Continued)**Pump and Intermediate Clutch Piston****Tools Required:**

- Lip Seal Protector T80L-77005-A



D3190-C

Item	Part Number	Description
1	7A103	Front Pump Body
2	7D441	Front Pump O-Ring Seal
3	7C010	Front Pump Drive Gear
4	7C011	Front Pump Driven Gear
5	7A108	Stator Support—Front Pump
6	—	Stator Support to Pump Body Bolts

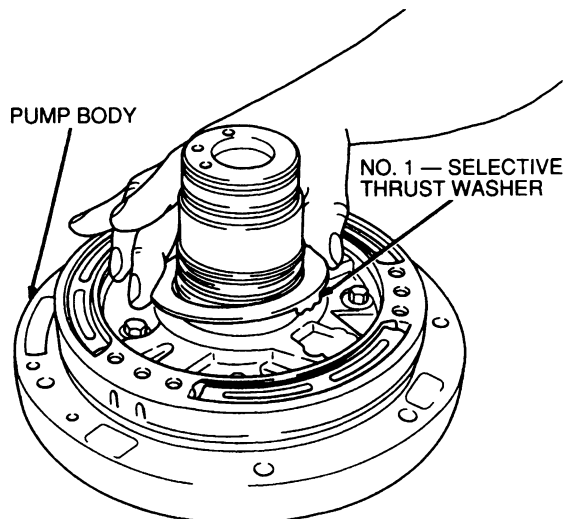
(Continued)

Item	Part Number	Description
7	7F222	Intermediate Clutch Piston Return Spring and Retainer Assy
8	7E006	Intermediate Clutch Piston Outer Lip Seal
9	7F224	Intermediate Clutch Piston Inner Lip Seal
10	7F225	Intermediate Clutch Piston Lip Seal Protector

TD3190C

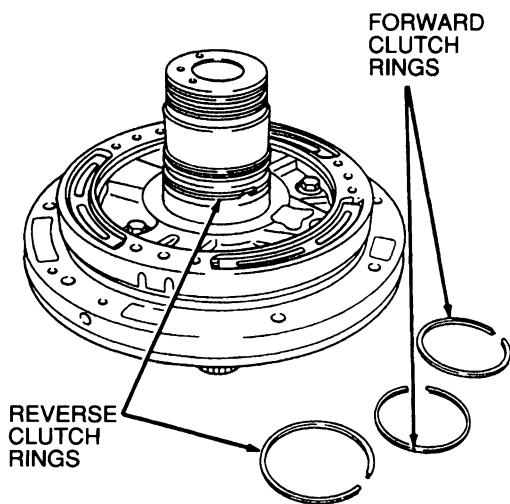
DISASSEMBLY (Continued)**Disassembly**

1. Remove the No. 1 thrust washer.



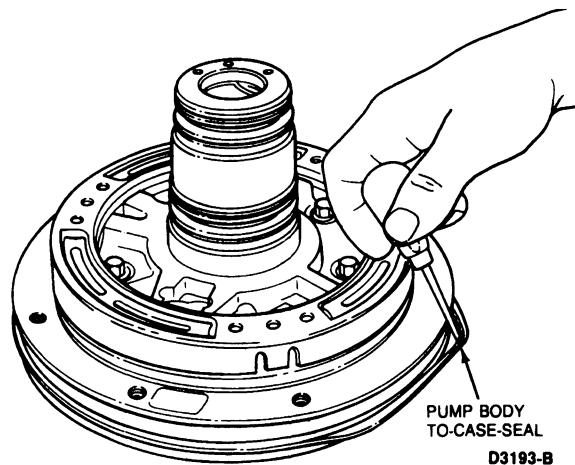
D3833-C

2. Remove the four pump seal rings.
The reverse clutch rings are larger than the forward clutch rings.

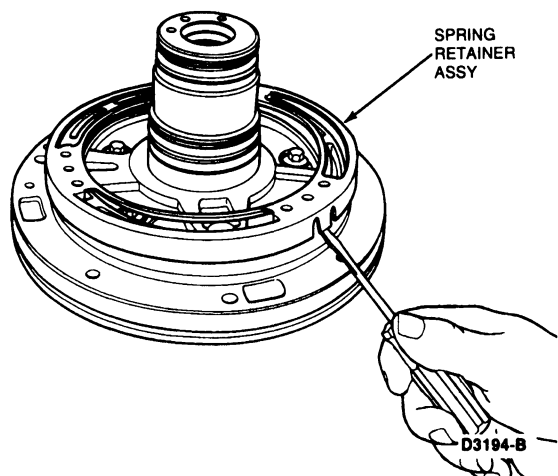


D3633-E

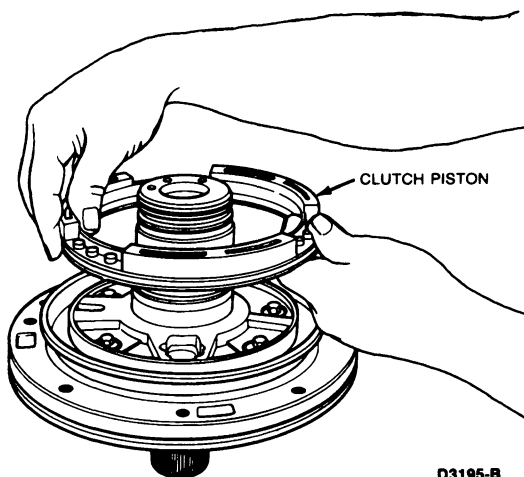
3. Remove the pump body-to-case seal and discard.



4. Remove the spring retainer assembly by carefully dislodging the tabs.

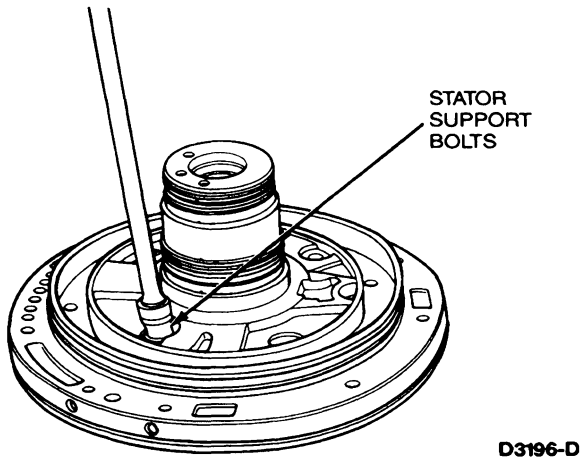


5. Remove the clutch piston.

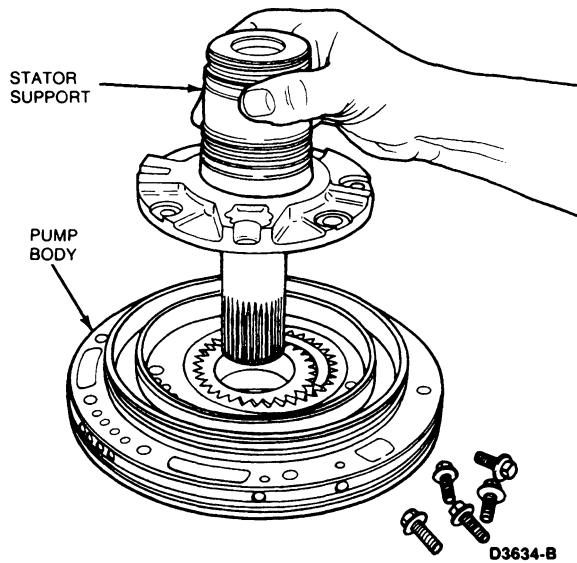


DISASSEMBLY (Continued)

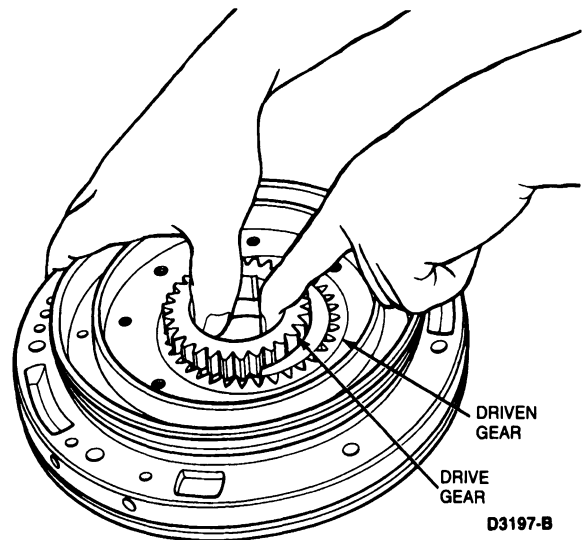
6. Remove the five 10mm stator support bolts.



7. Remove the stator support.



8. Remove the drive and driven pump gears from the pump body.

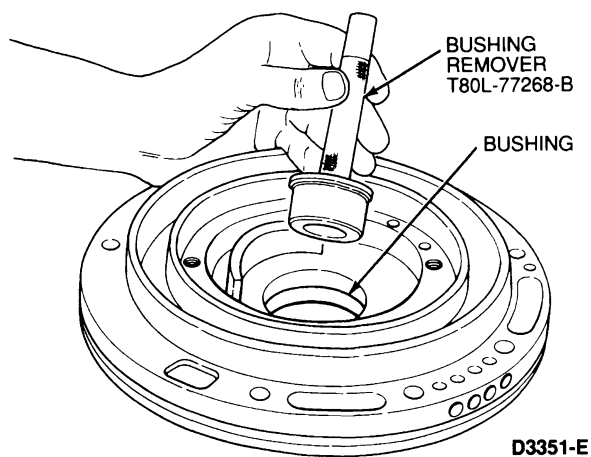
**Pump Bushing****Tools Required:**

- Oil Pump Bushing Remover T80L-77268-B

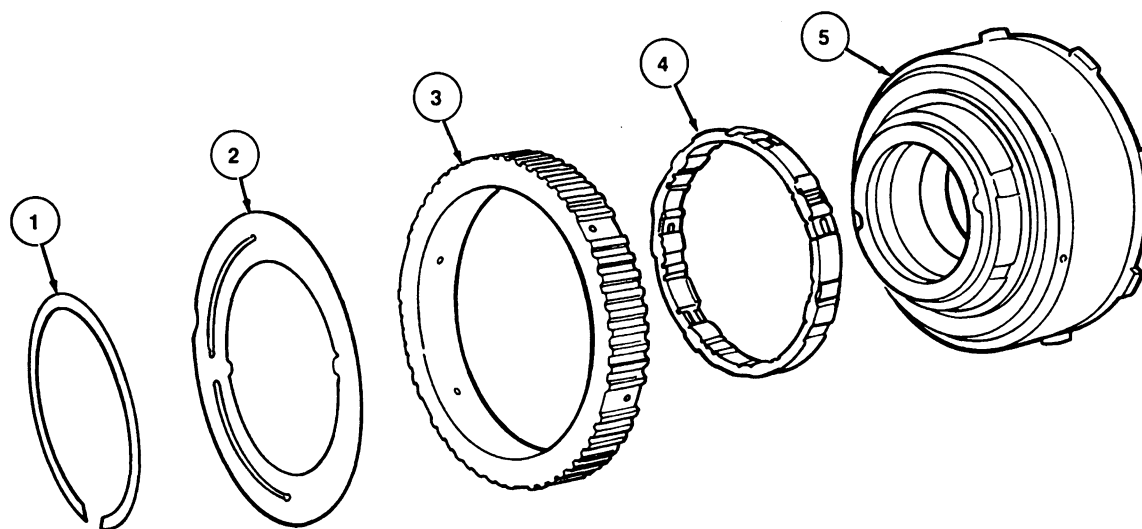
Removal

Remove the bushing using Oil Pump Bushing Remover T80L-77268-B.

DISASSEMBLY (Continued)



Intermediate One-Way Clutch



D3229-C

Item	Part Number	Description
1	389790-S	Intermediate One-Way Roller Clutch Retaining Snap Ring
2	7F262	Intermediate One-Way Roller Clutch Retaining Plate

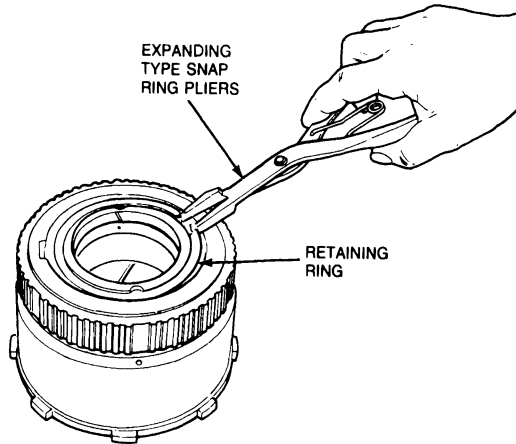
(Continued)

Item	Part Number	Description
3	7F221	Intermediate One-Way Roller Clutch Outer Race
4	7F271	Intermediate One-Way Roller Clutch
5	7F215	Reverse Clutch Drum

TD3229C

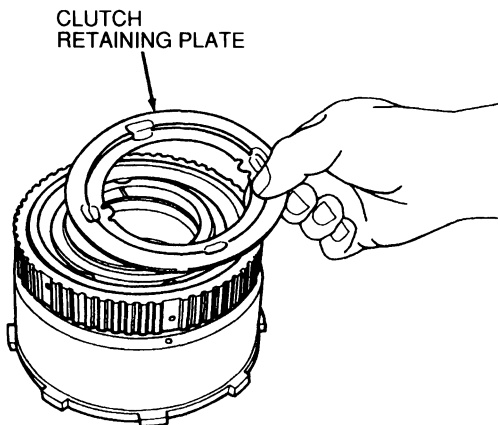
DISASSEMBLY (Continued)**Disassembly**

1. Using snap ring pliers, remove the clutch retaining ring.



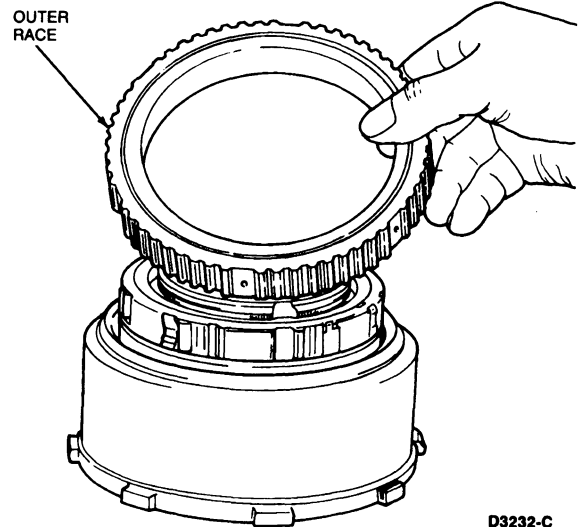
D3230-B

2. Remove the clutch retaining plate.



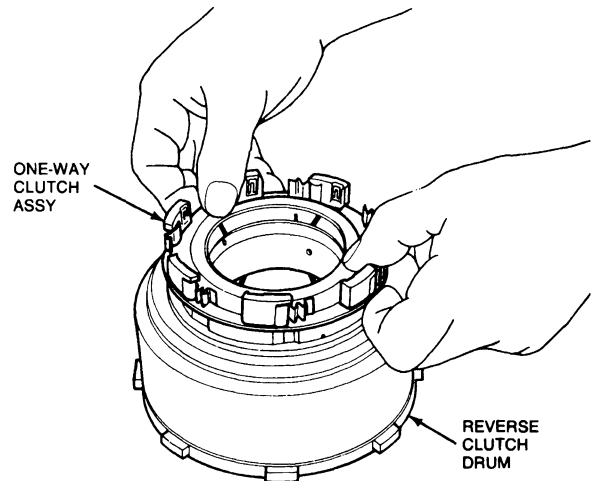
D3231-C

3. Remove the clutch outer race by lifting on the race while turning counterclockwise.



D3232-C

4. Carefully lift the one-way clutch from the inner race.

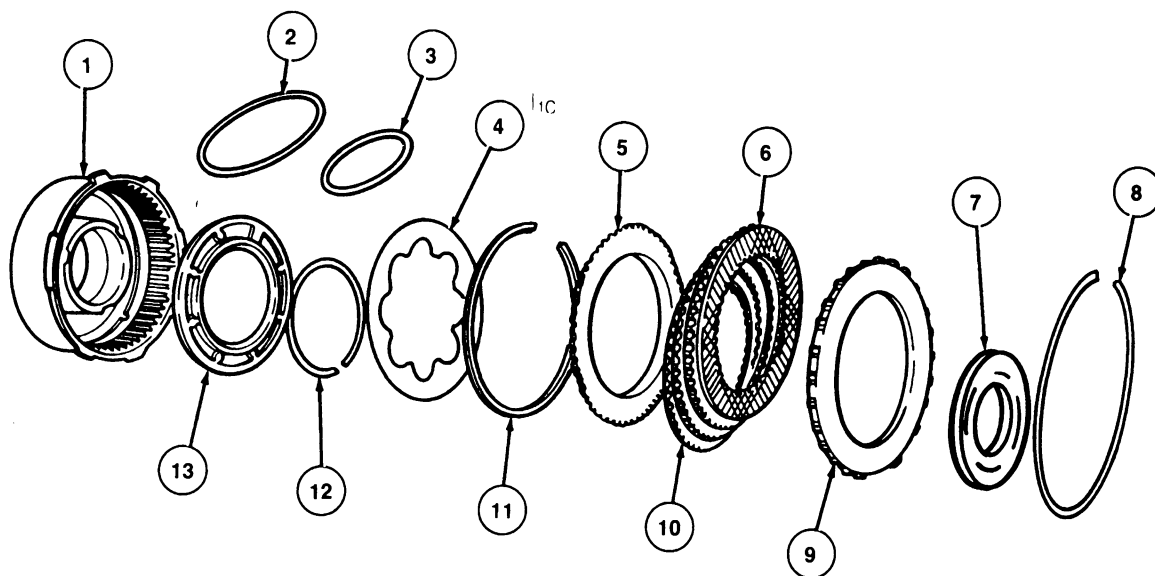


D3233-B

Reverse Clutch**Tools Required:**

- Clutch Spring Compressor T65L-77515-A
- Reverse Clutch Outer Seal Protector T80L-77403-A
- Reverse Clutch Inner Seal Protector T80L-77403-B
- Reverse Clutch Spring Compressor Plate T80L-77405-A
- Air Nozzle TOOL-7000-DE

DISASSEMBLY (Continued)



D6585-C

Item	Part Number	Description
1	7F215	Reverse Clutch Drum
2	7D403	Outer Reverse Clutch Piston Seal
3	7D404	Inner Reverse Clutch Piston Seal
4	7D405	Reverse Clutch Piston Return Spring
5	7B066	Reverse Clutch Pressure Plate
6	7E311	Reverse Clutch Internal Spline Friction Plates

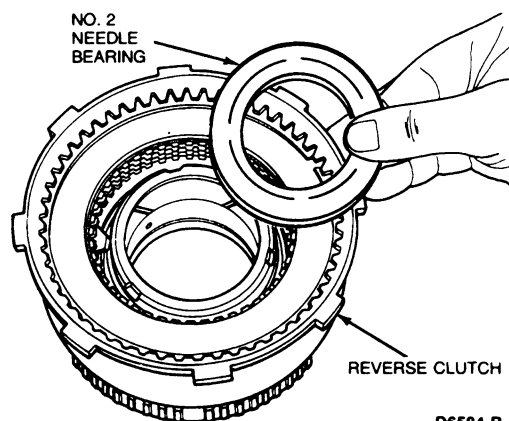
(Continued)

Item	Part Number	Description
7	7G008	Number Two Needle Bearing
8	7D483	Reverse Clutch Selective Retaining Ring
9	7F278	Forward and Reverse Clutch Rear Pressure Ring
10	7B442	Reverse Clutch External Spline Steel Plates
11	7D406	Return Spring Retaining Ring
12	7D256	Thrust Ring
13	7E079	Reverse Clutch Piston

TD6585C

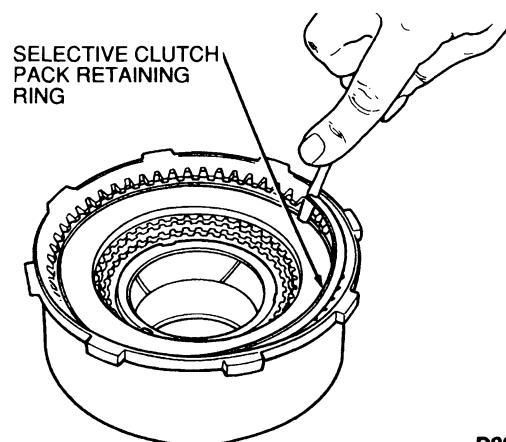
Disassembly

1. Remove the No. 2 needle bearing.



D6584-B

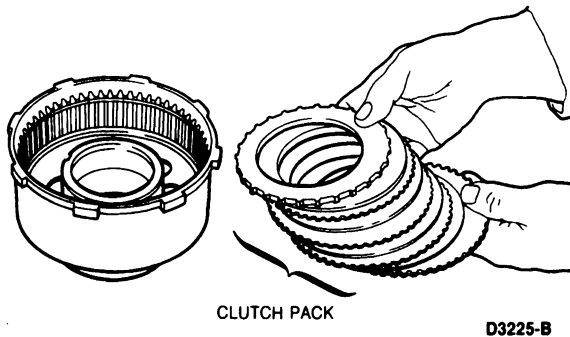
2. Remove the clutch pack retaining ring.



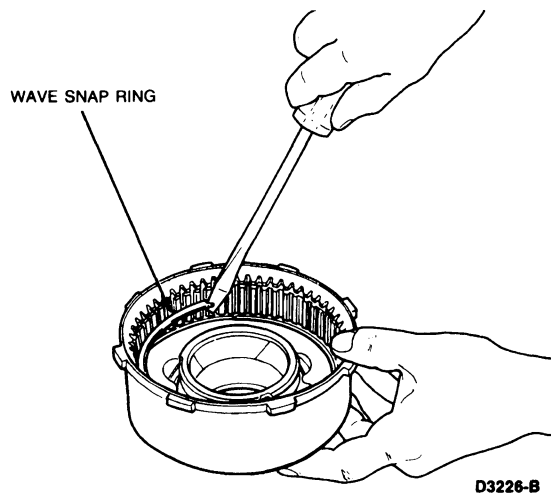
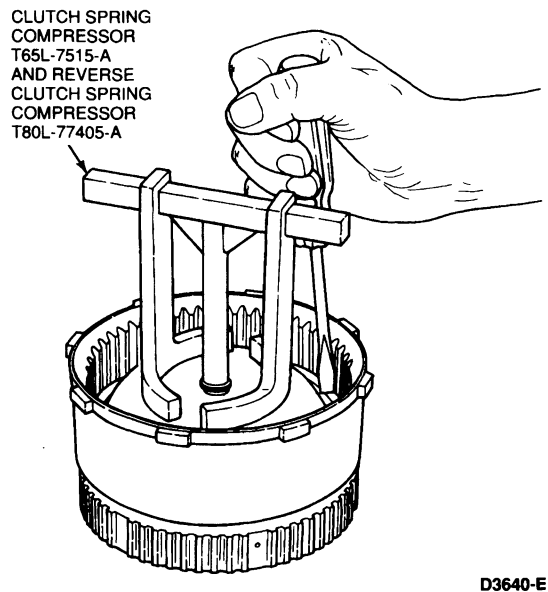
D3224-C

DISASSEMBLY (Continued)

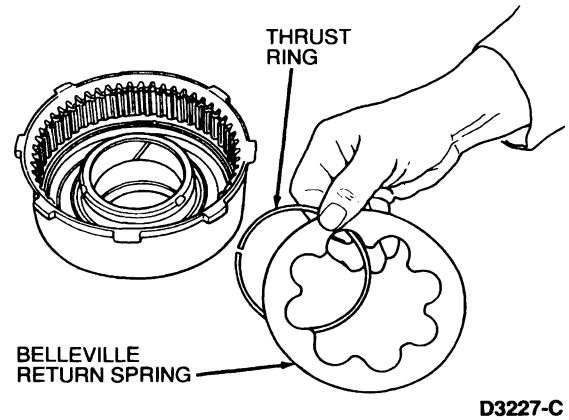
3. Remove the clutch pack.



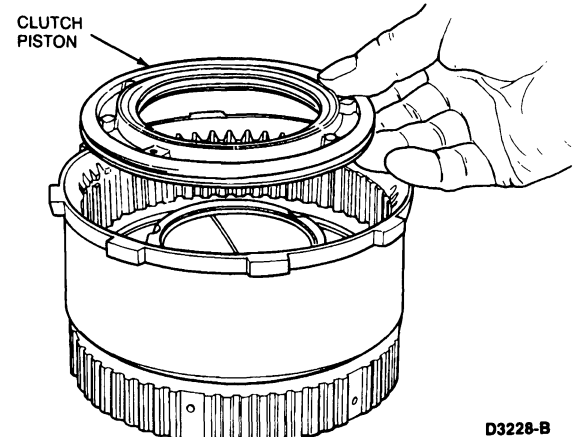
4. Remove the wave snap ring using Clutch Spring Compressor T65L-77515-A and Reverse Clutch Spring Compressor Plate T80L-77405-A.



5. Remove the piston return spring and the thrust ring.

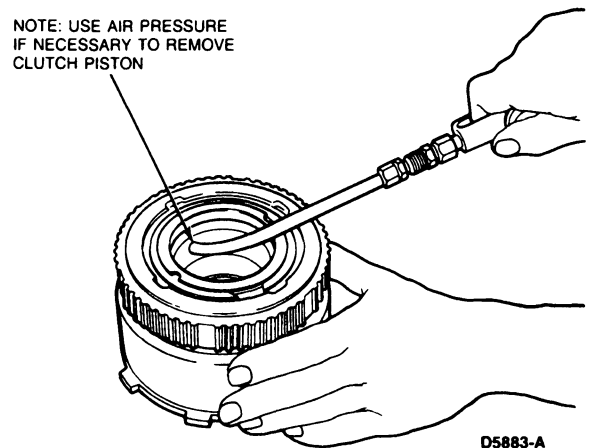


6. Remove the clutch piston.



NOTE: To aid removal, it may be necessary to apply air pressure to the drum. Block the opposite hole with a finger.

NOTE: USE AIR PRESSURE IF NECESSARY TO REMOVE CLUTCH PISTON

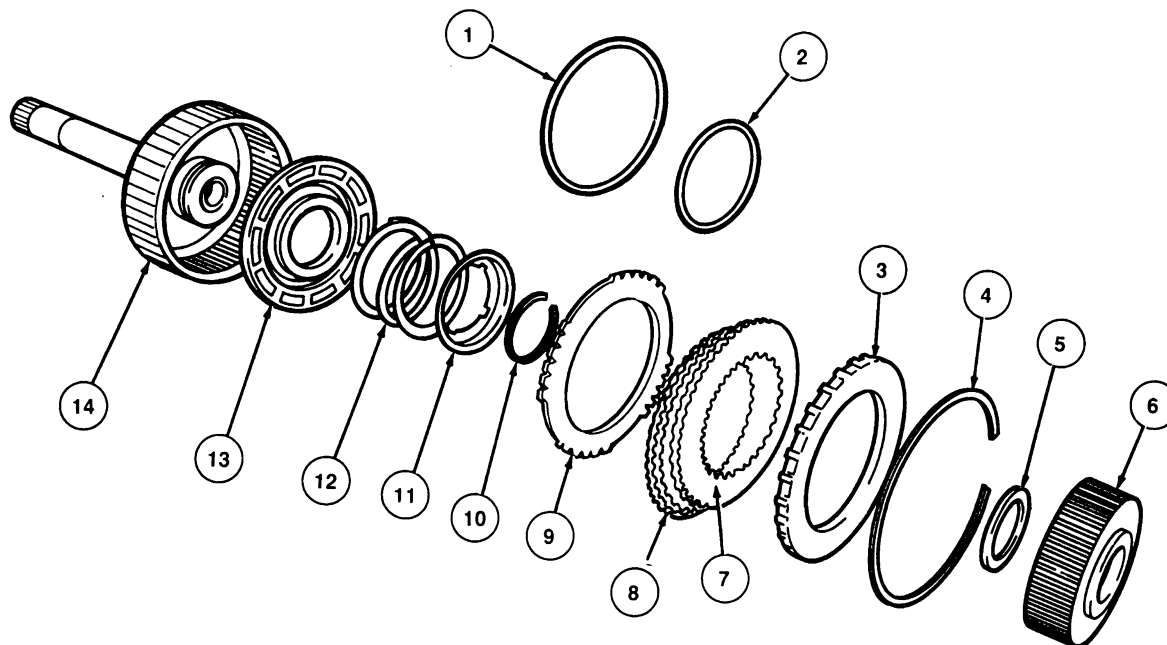


**Forward Clutch
Tools Required:**

DISASSEMBLY (Continued)

- Clutch Spring Compressor T65L-77515-A
- Forward Clutch Outer Lip Seal Protector T68P-7D158-A
- Forward Clutch Inner Lip Seal Protector T80L-77140-A

- Forward Clutch Spring Compressor Extension T80L-77515-A
- Air Nozzle TOOL-7000-DE



D2334-D

Item	Part Number	Description
1	7F227	Outer Forward Clutch Piston Seal
2	7F228	Inner Forward Clutch Piston Seal
3	7F278	Forward and Reverse Clutch Pressure Plate
4	7D483	Forward Clutch Pack Retaining Ring
5	7G040	Number 3 Needle Bearing
6	7D051	Forward Clutch Hub

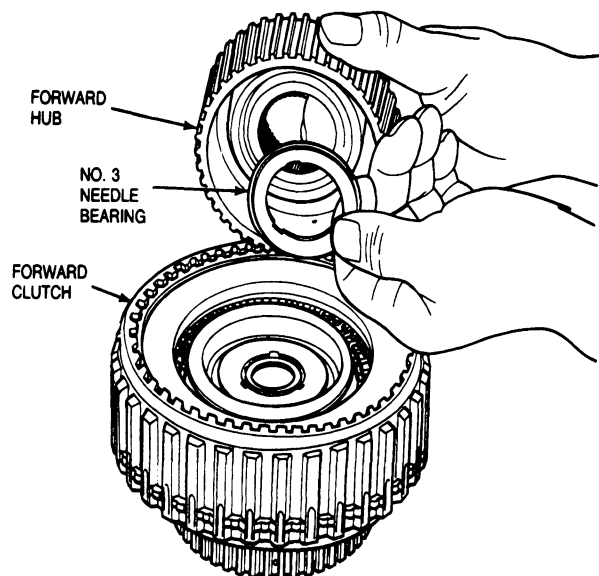
(Continued)

Item	Part Number	Description
7	7E311	Internal Spline Clutch Plates
8	7B442	External Spline Clutch Plates
9	7E085	Wave Plate
10	388099	Retaining Snap Ring
11	7F229	Return Spring Retainer
12	7F230	Forward Clutch Piston Return Spring
13	7L140	Forward Clutch Piston
14	7F207	Forward Clutch Cylinder and Turbine Shaft Assy

TD2334D

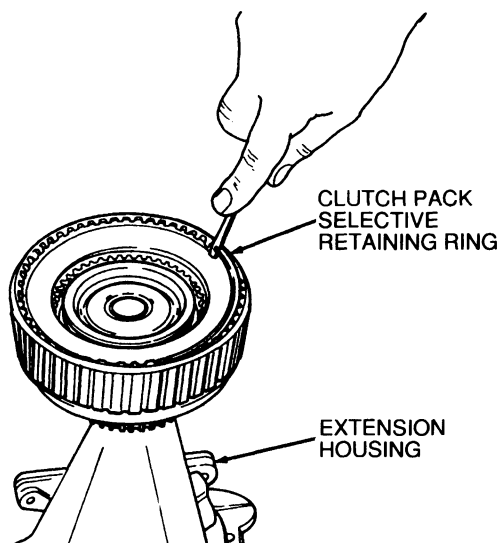
DISASSEMBLY (Continued)**Disassembly**

1. Remove the clutch hub and No. 3 needle bearing, if not already removed.



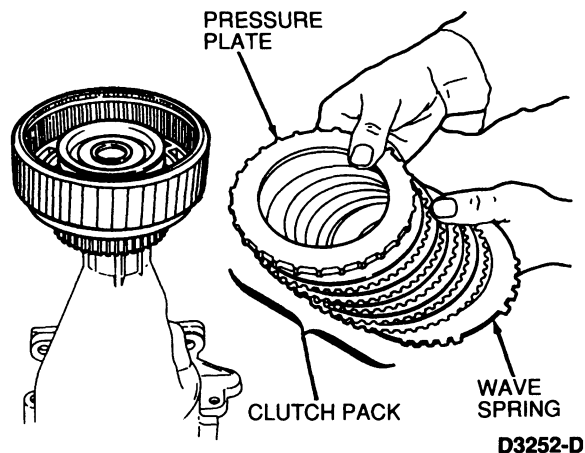
D3832-C

2. Remove the clutch pack selective retaining ring.
NOTE: To aid handling, the clutch may set in the extension housing or a 51mm (2-inch) diameter hole may be cut in the work bench.



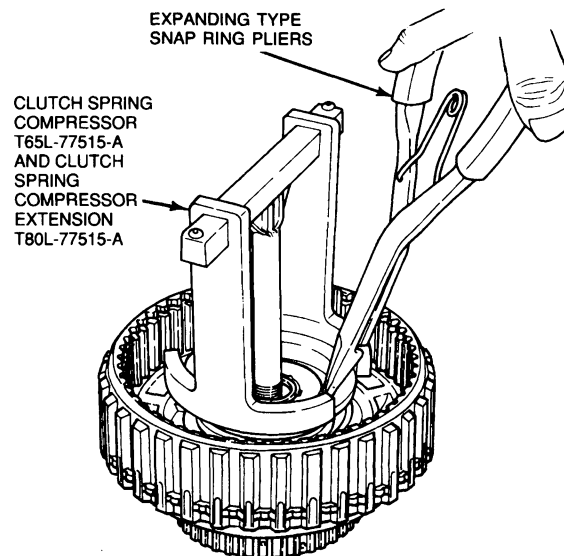
D3236-D

3. Remove the clutch pack.



D3252-D

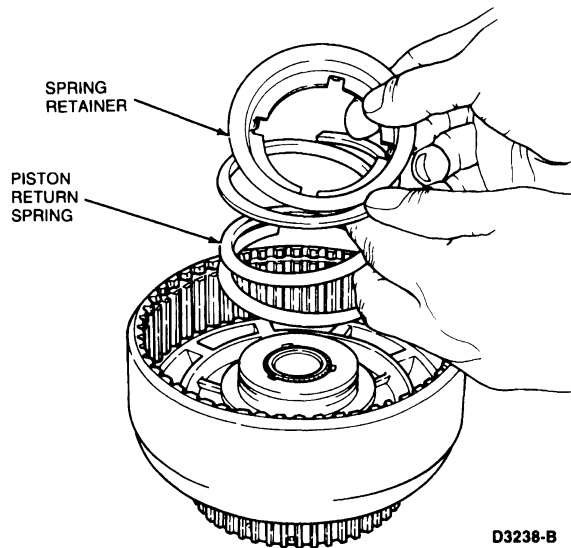
4. Compress the piston return spring using Clutch Spring Compressor T65L-77515-A, and Forward Clutch Spring Compressor Extension T80L-77515-A.



D4954-D

DISASSEMBLY (Continued)

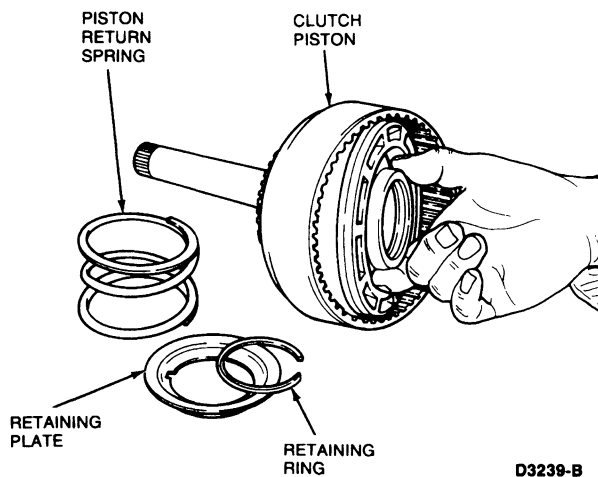
Remove the retaining ring and spring retainer.



D3238-B

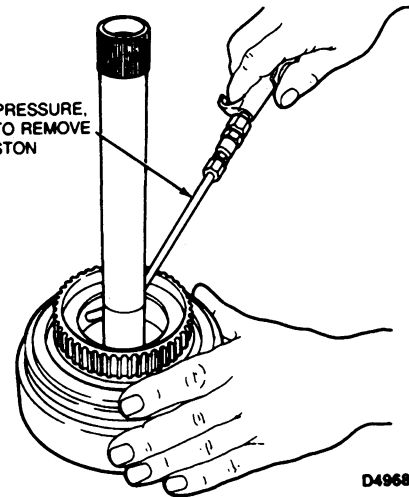
5. Remove the clutch piston.

Note the position and direction of the lip seals and remove.



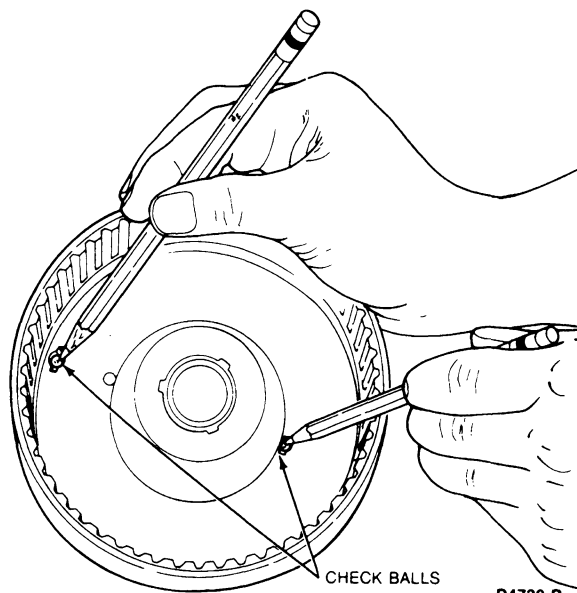
D3239-B

NOTE: USE AIR PRESSURE, IF NECESSARY TO REMOVE THE CLUTCH PISTON



D4968-A

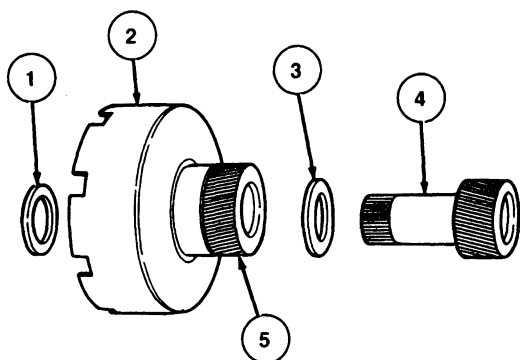
NOTE: Ensure check balls in clutch cylinder are free and clean. Check for proper seating.



D4739-B

DISASSEMBLY (Continued)

Sun Gear and Drive Shell



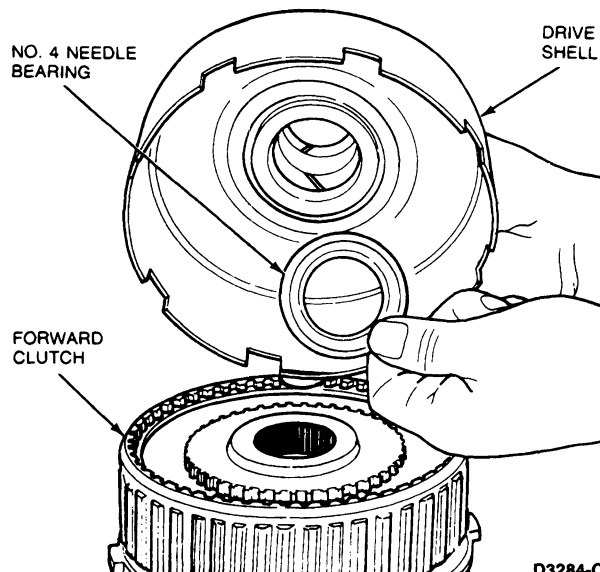
D3334-C

Item	Part Number	Description
1	7F244	Number 4 Needle Bearing
2	7A019	Drive Shell Assy
3	7F244	Number 5 Needle Bearing
4	7A399	Forward Sun Gear
5	—	Reverse Sun Gear Part of 7A019 Drive Shell Assy

TD3334C

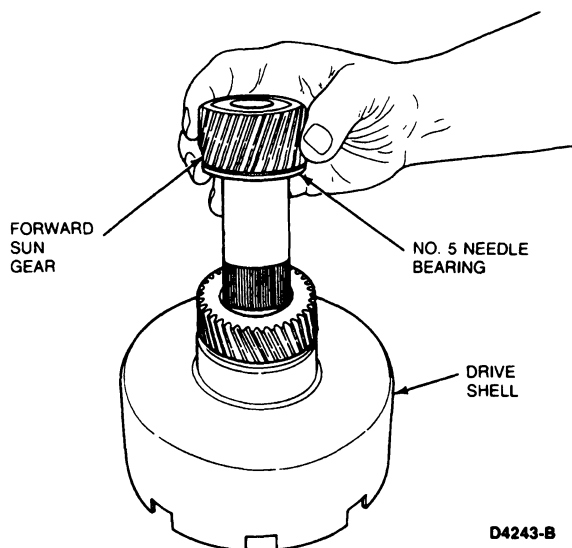
Disassembly

1. Remove the No. 4 needle bearing from the drive shell.



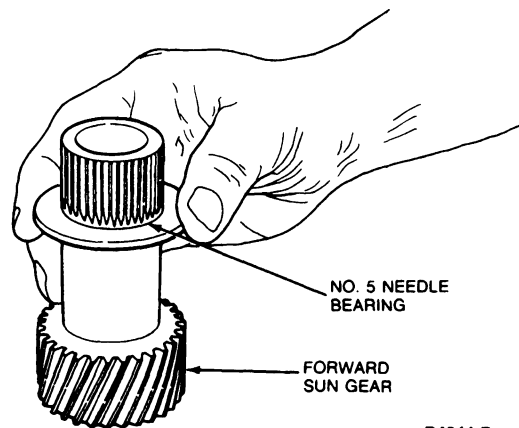
D3284-C

2. Remove the forward sun gear and No. 5 needle bearing from the drive shell.



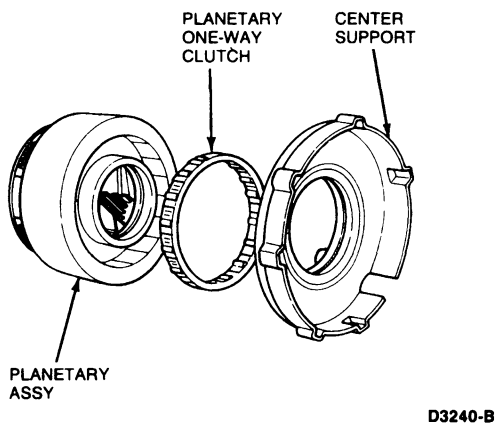
D4243-B

3. Remove the No. 5 needle bearing from the forward sun gear.

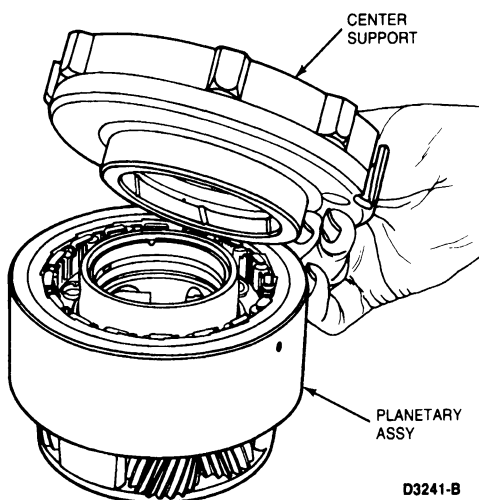


D4244-B

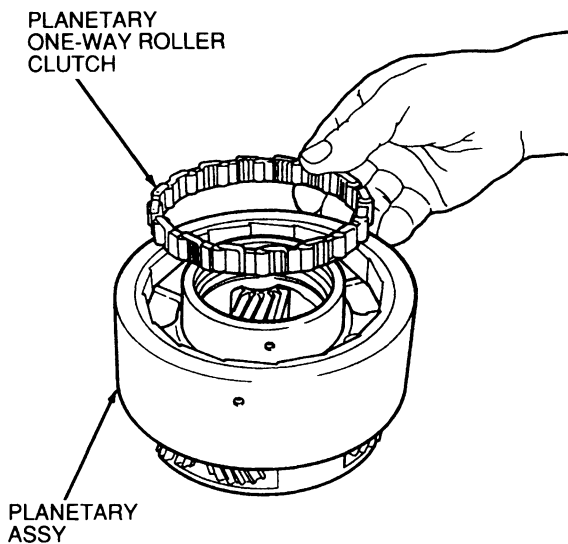
NOTE: The sun gear and drive shell is assembled as part of the transmission assembly procedure.

DISASSEMBLY (Continued)**Center Support and Planetary One-Way Roller Clutch****Disassembled View****Disassembly**

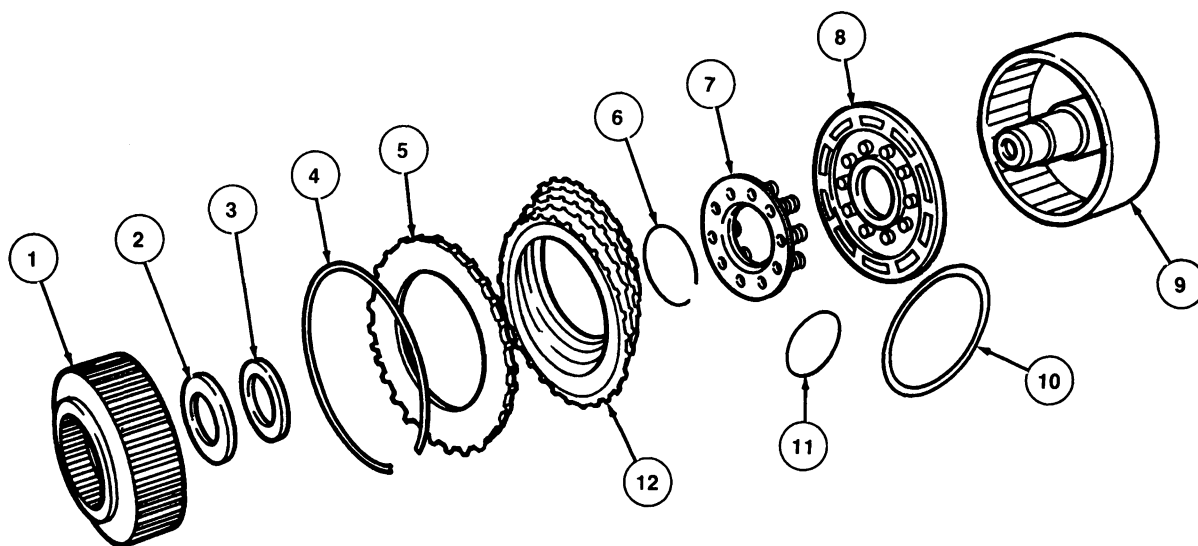
1. Remove the center support from the planetary carrier. Rotate the center support counterclockwise and lift.



2. Carefully remove the planetary one-way roller clutch from the planetary assembly.

**Direct Clutch****Tools Required:**

- Clutch Spring Compressor T65L-77515-A

DISASSEMBLY (Continued)

D3024-E

Item	Part Number	Description
1	7F236	Direct Clutch Hub
2	7F243	Number 7 Needle Bearing
3	7F237	Bearing Support Thrust Spacer
4	388065-6-7-8	Selective Clutch Pack Retaining Snap Ring
5	7B477	Direct Clutch Pressure Plate
6	388104	Direct Clutch Piston Snap Ring

(Continued)

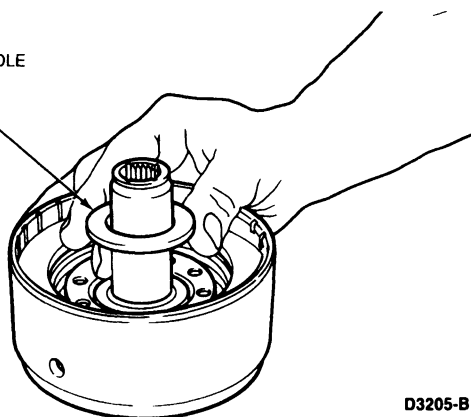
Item	Part Number	Description
7	7F235	Direct Clutch Return Spring and Retainer Assy
8	7F254	Direct Clutch Piston
9	7F283	Direct Clutch Cylinder
10	7C000	Outer Direct Clutch Piston Seal
11	7F234	Inner Direct Clutch Piston Seal
12	7E313 (Internal) 7F238 (External)	Direct Clutch Spline Plates

TD3024E

Disassembly

1. Remove the No. 7 direct clutch hub inner needle bearing.

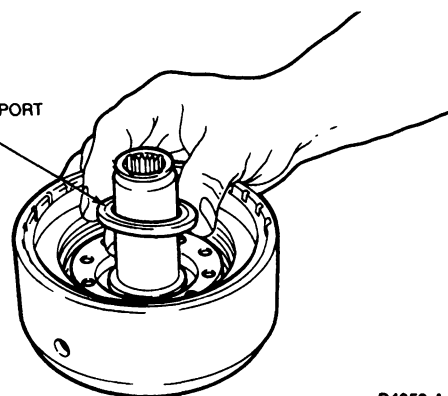
NO. 7 NEEDLE BEARING



D3205-B

2. Remove bearing support.

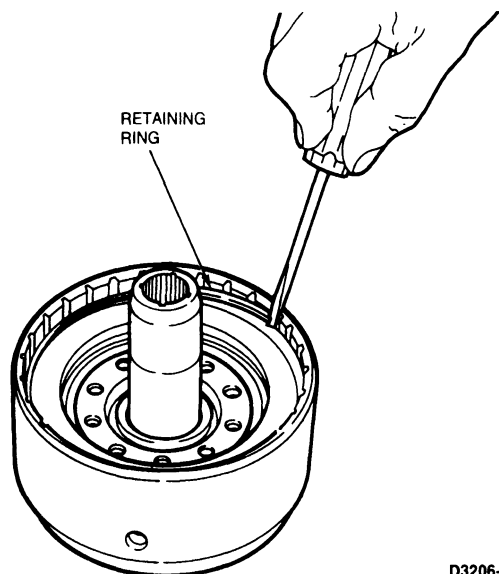
BEARING SUPPORT



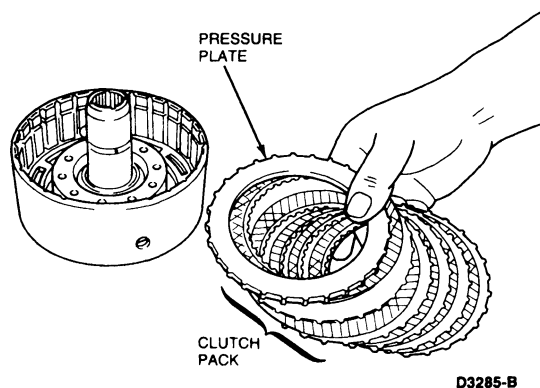
D4953-A

DISASSEMBLY (Continued)

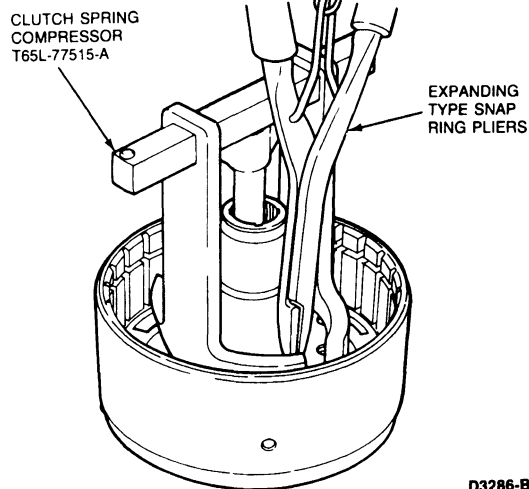
3. Remove the clutch pack selective retaining snap ring.



4. Remove the clutch pack from the cylinder.

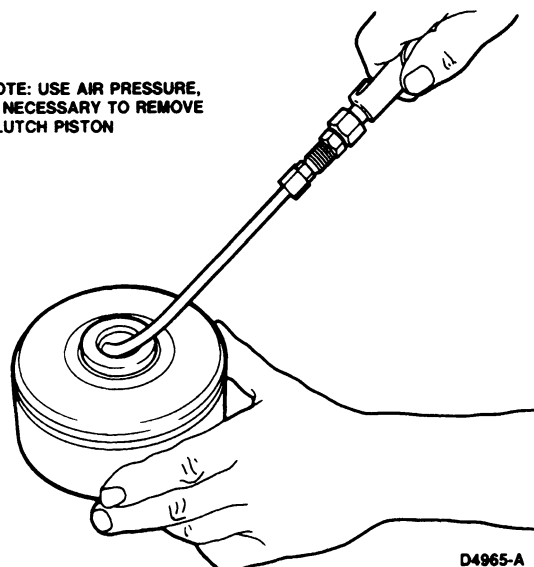


5. Using Clutch Spring Compressor T65L-77515-A, compress the piston return springs. Remove the piston retaining ring using expanding-type snap ring pliers.



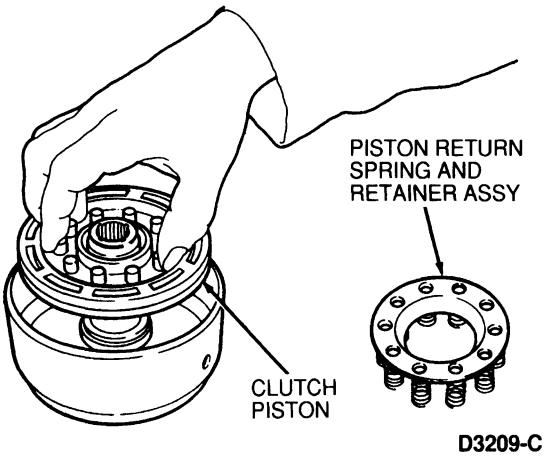
6. Remove the spring retainer assembly and piston from the cylinder.

NOTE: USE AIR PRESSURE, IF NECESSARY TO REMOVE CLUTCH PISTON

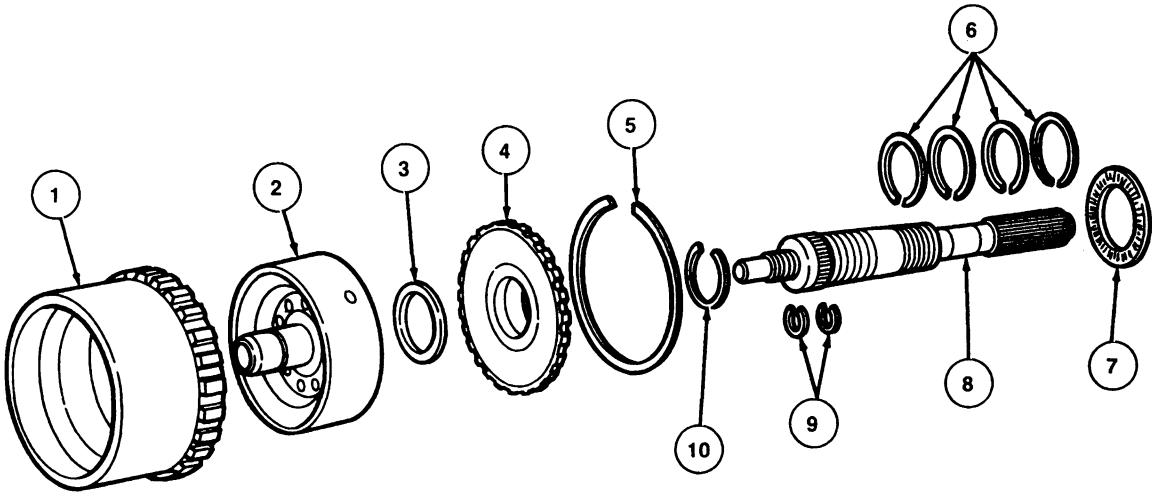


Note the position and direction of the lip seals and then remove.

DISASSEMBLY (Continued)



Output Shaft
Disassembled View



D3645-E

Item	Part Number	Description
1	7A153	Ring Gear
2	7F283	Direct Clutch Cylinder
3	7F240	Number 8 Needle Bearing
4	7D164	Output Shaft Hub
5	97713	Hub to Ring Gear Snap Ring

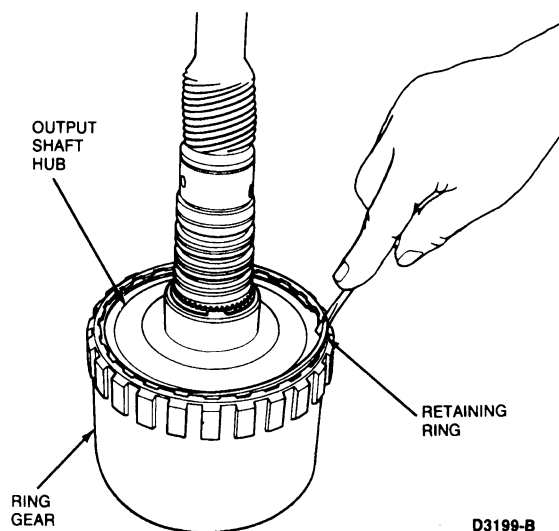
(Continued)

Item	Part Number	Description
6	7F273	Seal Rings (4 Req'd)
7	7F242	Number 9 Needle Bearing
8	7060	Output Shaft
9	7F284	Steel Seal Rings (2 Req'd)
10	388104	Output Shaft to Hub Retaining Snap Ring

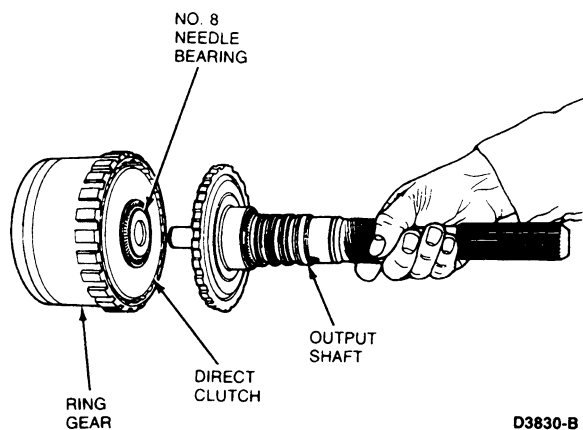
TD3645E

DISASSEMBLY (Continued)**Disassembly**

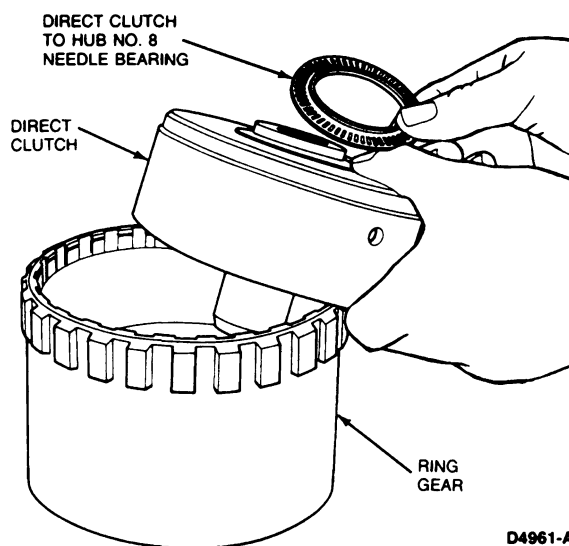
1. Remove the ring retaining the output shaft hub to the ring gear.



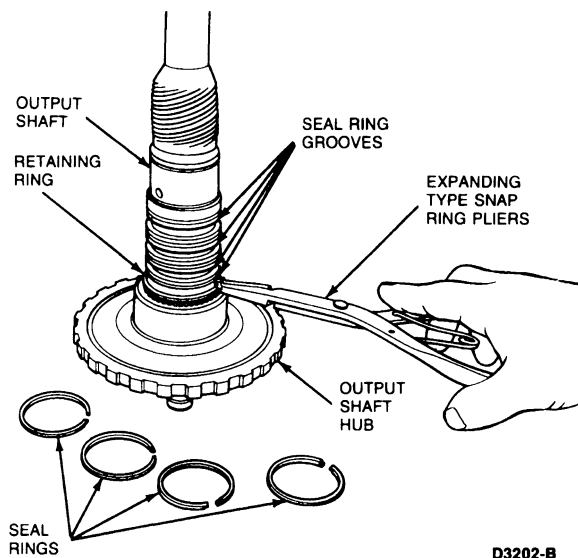
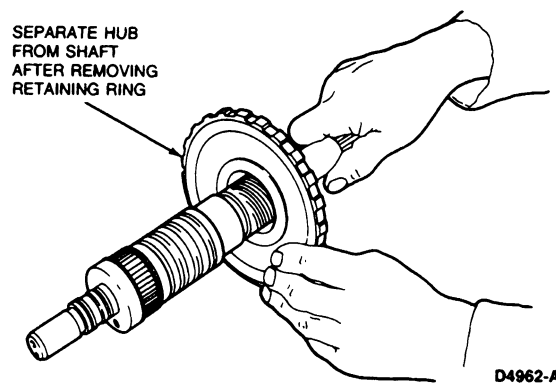
2. Separate the output shaft and hub assembly from the ring gear.



3. Remove the direct clutch from the ring gear and the No. 8 needle bearing from the back of the direct clutch.

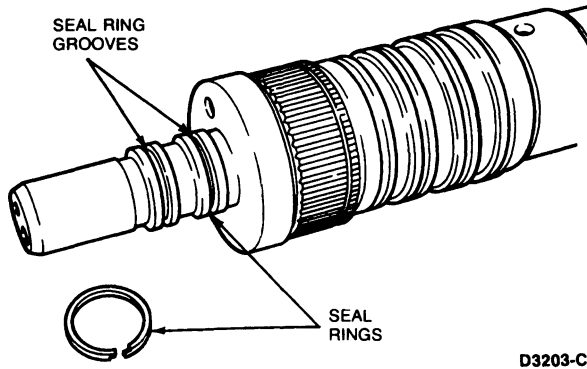


4. Remove the four output shaft seal rings and the hub-to-output shaft retaining ring. Separate the hub from the output shaft.



DISASSEMBLY (Continued)

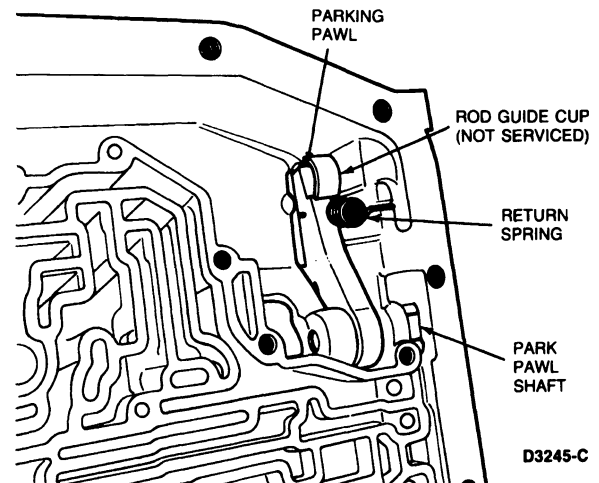
5. Remove the two direct clutch seal rings from the output shaft.

**Governor****Disassembly**

1. Remove the screws retaining the counterweight to the governor body.
2. Remove the cover screws and cover.
3. Remove the plug, sleeve and governor valve from the governor body.
4. Remove screen from governor body.

Parking Pawl**Removal**

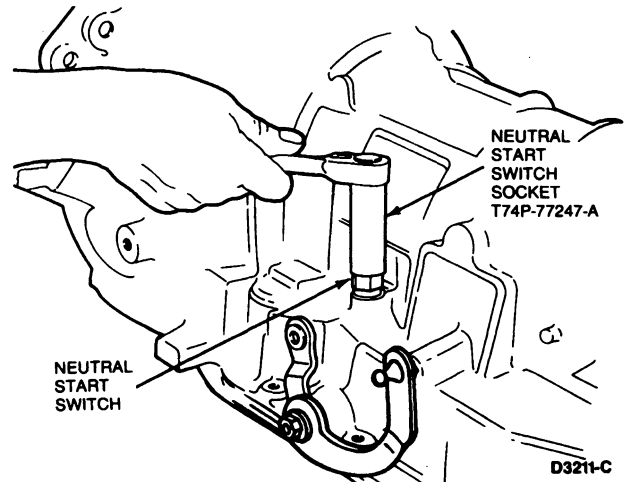
1. Slide the park pawl shaft out the rear of the case and remove the parking pawl.
2. Remove the return spring.

**Neutral Start Switch****Tools Required:**

- Neutral Start Switch Socket T74P-77247-A

Removal

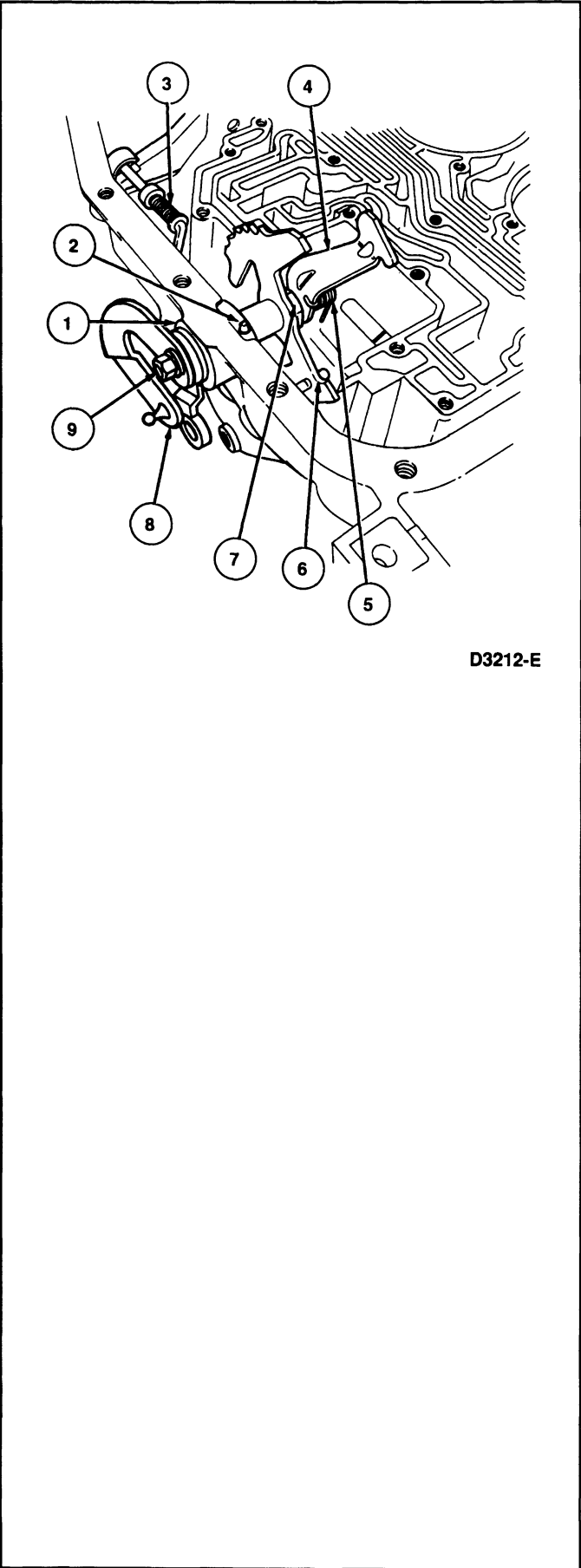
1. Using the Neutral Start Switch Socket T74P-77247-A, remove switch from case.
2. Remove the O-ring seal and discard.

**Manual and Throttle Linkage****Tools Required:**

- Puller T58L-101-B
- Impact Slide Hammer T59L-100-B

NOTE: Before disassembling the linkage, observe the location of the various levers.

DISASSEMBLY (Continued)

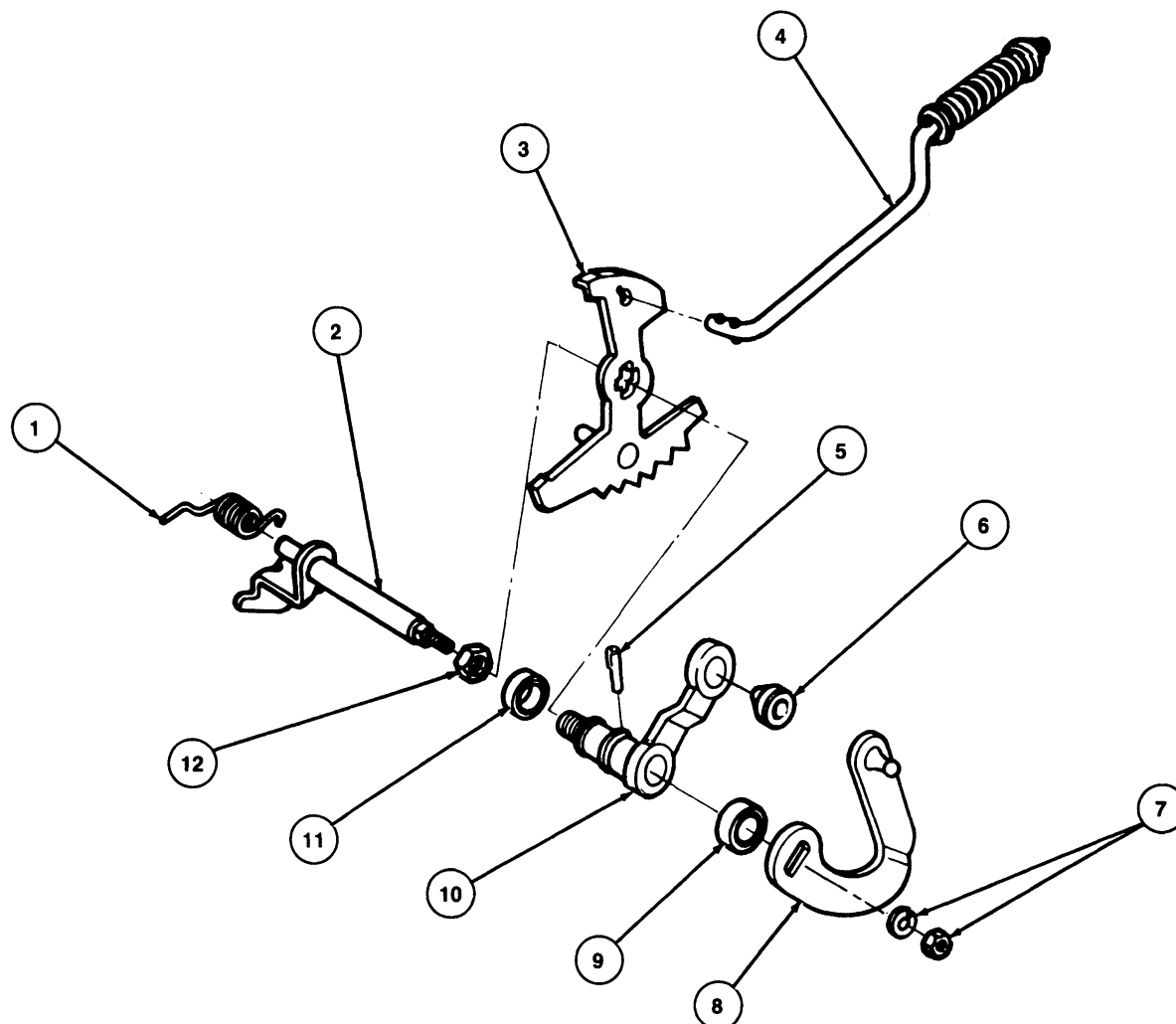


D3212-E

Item	Part Number	Description
1	7F338	Outer Manual Lever
2	7B210	Manual Lever Retaining Pin
3	7A232	Parking Pawl Actuating Rod
4	7F290	Inner Throttle Lever
5	7F292	Throttle Lever Torsion Spring
6	7A115	Inner Manual Lever
7	N800287-S51	Manual Lever Retaining Nut
8	2F291	Outer Throttle Lever
9	N62004-S51	Throttle Lever Retaining Nut

TD3212E

DISASSEMBLY (Continued)



D3632-F

Item	Part Number	Description
1	7F292	Throttle Lever Torsion Spring
2	7F290	Inner Throttle Lever and Shaft Assy
3	7A115	Inner Manual Lever
4	7A232	Parking Pawl Actuating Rod
5	7B210	Manual Lever Retaining Pin
6	7341	Grommet

(Continued)

Item	Part Number	Description
7	N62004-S51	Throttle Lever Retaining Nut and Washer
8	2F291	Outer Throttle Lever
9	7F337	Throttle Lever Oil Seal
10	7F338	Outer Manual Lever
11	7B498	Manual Lever Shaft Oil Seal
12	N800287-S51	Manual Lever Retaining Nut

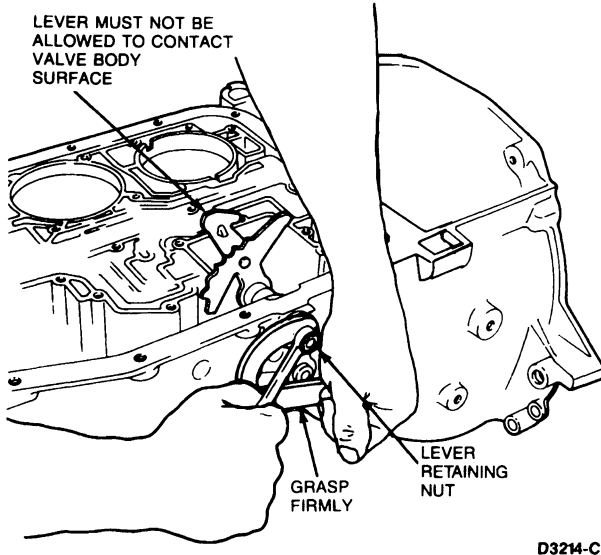
TD3632F

DISASSEMBLY (Continued)

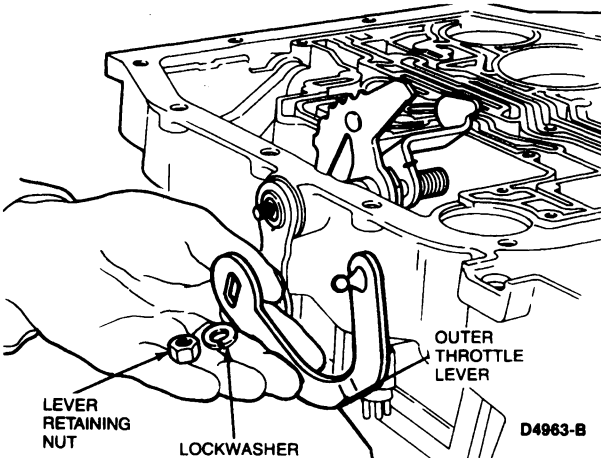
Disassembly

1. Grasp the outer throttle lever firmly and loosen the lever retaining nut.

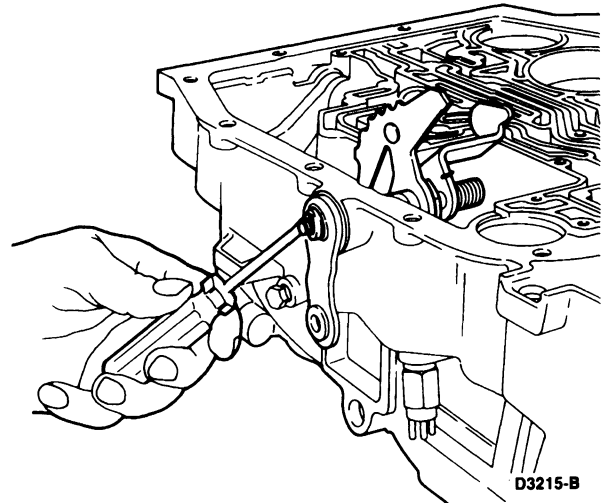
CAUTION: The outer throttle lever must be held in the position shown to prevent the inner throttle lever from rotating against the machined valve body surface. Failure to observe this precaution could result in damage to the valve body surface.



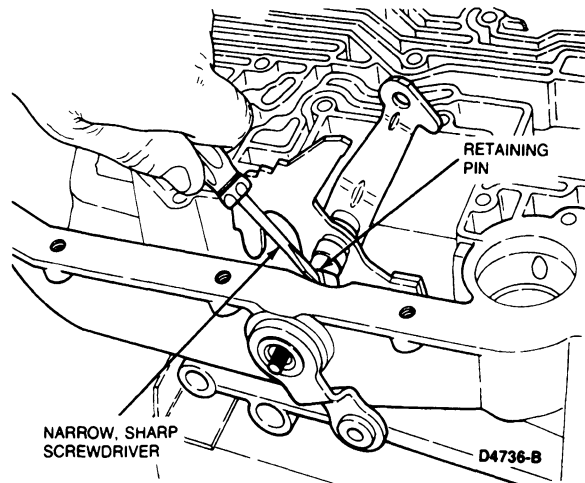
Remove the retaining nut, the lockwasher, and throttle lever.



2. Using a small screwdriver or awl, remove the seal from the outer manual lever counterbore. Discard seal.

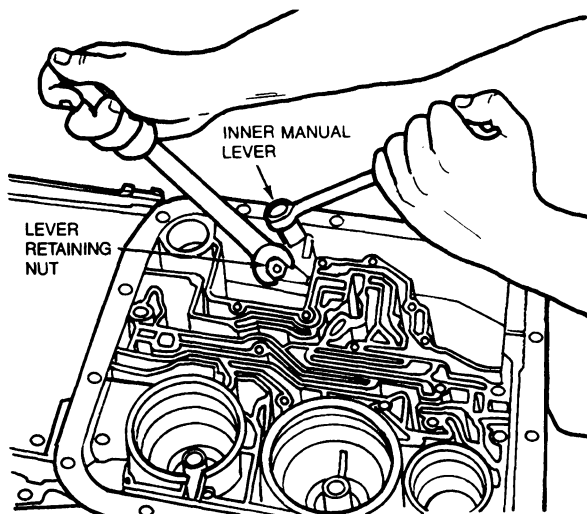


3. Using a narrow, sharp screwdriver, carefully remove the manual shaft retaining pin from the case.



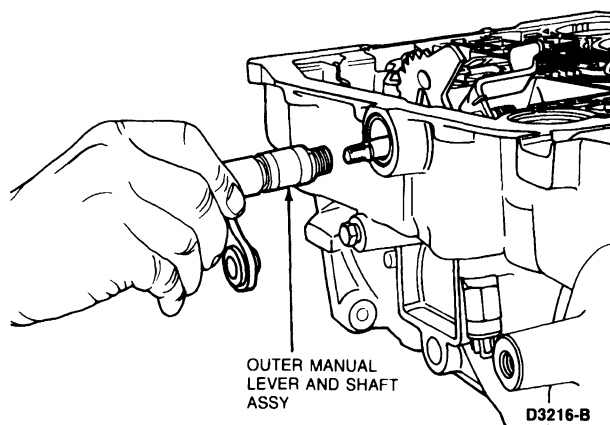
DISASSEMBLY (Continued)

4. Slide a 5/8-inch box end wrench over the inner manual lever, close to the bottom of the lever. Do not allow the wrench to contact the "rooster comb" area. Using a 2 mm wrench, remove the manual lever retaining nut while securely holding the inner manual lever.



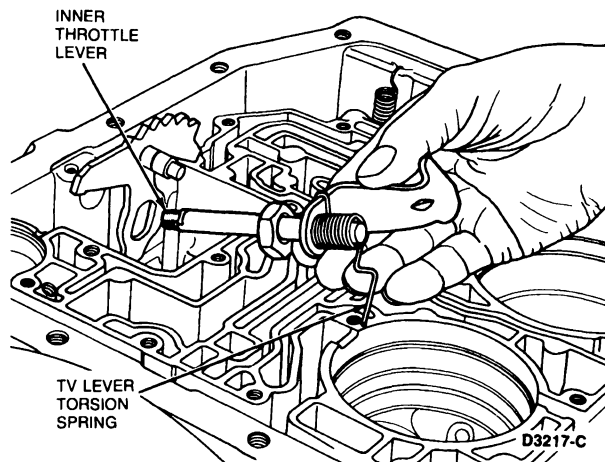
D4737-C

Thread the nut off the shaft and remove the lever.



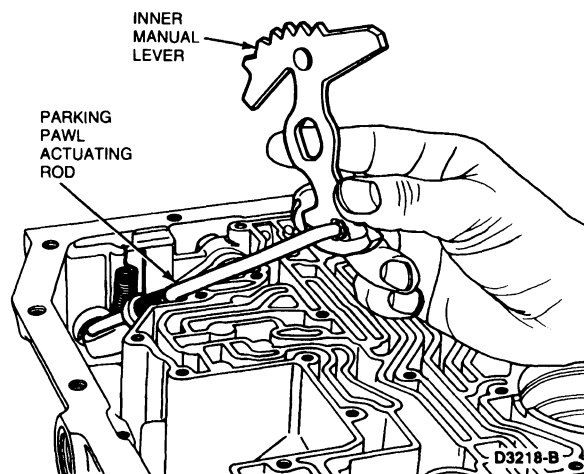
D3216-B

5. Remove the inner throttle lever and TV lever torsion spring.



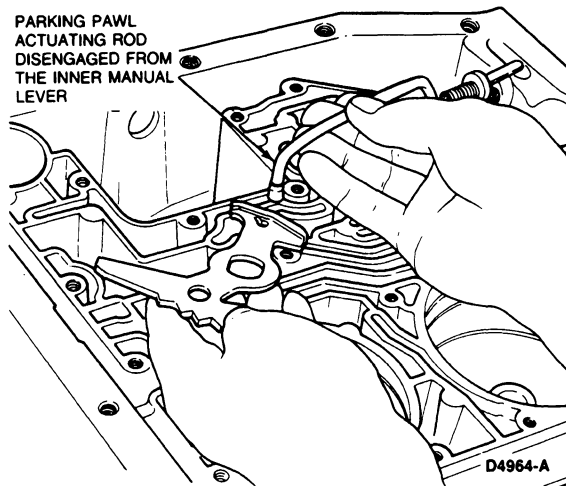
D3217-C

6. Remove the inner manual lever and parking pawl actuating rod as an assembly.



D3218-B

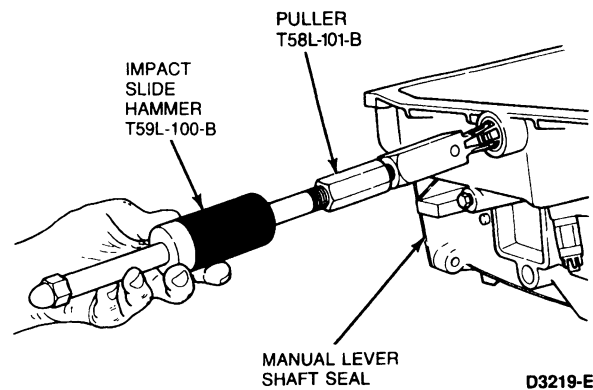
After removal, the rod may be disengaged from the lever.



D4964-A

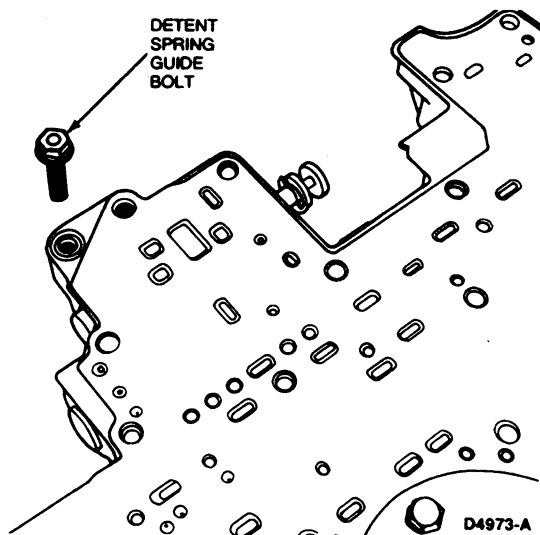
DISASSEMBLY (Continued)

7. Remove the manual lever shaft seal from the case using Puller T58L-101-B and Impact Slide Hammer T59L-100-B. Discard seal.

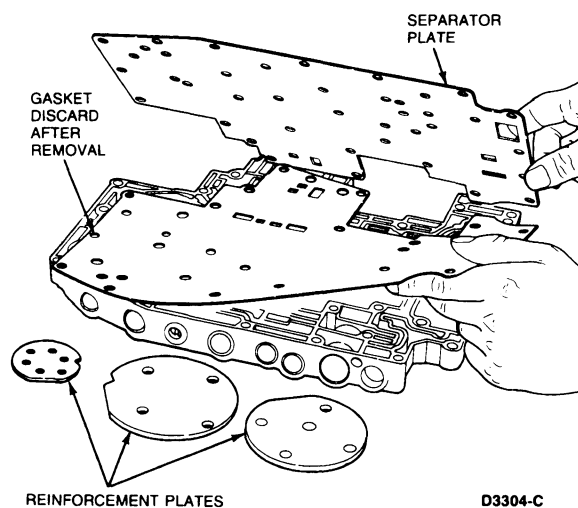
**Valve Body****Disassembly**

1. Remove and discard valve body gasket. Loosen and remove 11 bolts from reinforcement plates and detent spring guide bolt from the separator plate using a 10mm socket.

NOTE: When removing the 11 bolts, note the location of the two shoulder bolts. They must be installed in the same locations when assembling the valve body.



2. Remove separator plate, reinforcement plates and separator plate gasket. Discard gasket.



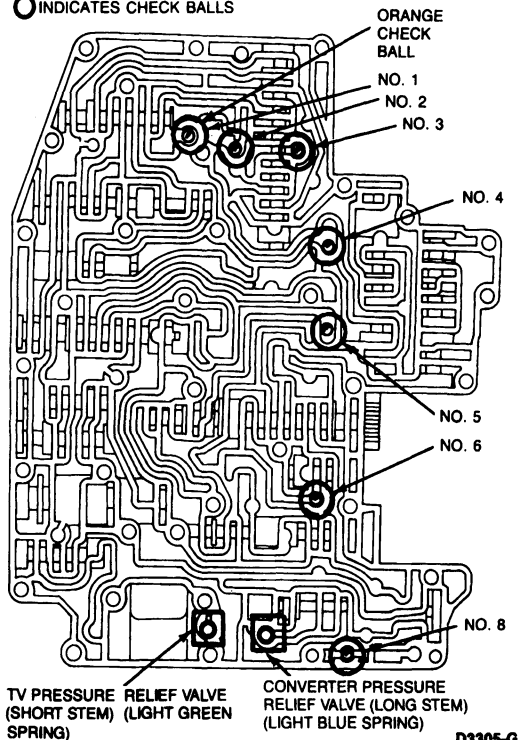
DISASSEMBLY (Continued)

3. Remove the two relief valves and seven check balls from the valve body. Note the location of the orange ball. It is not interchangeable with the six black balls.

NOTE: The check balls are numbered one through eight. Check ball number seven was eliminated in a previous production year. There are a total of seven check balls.

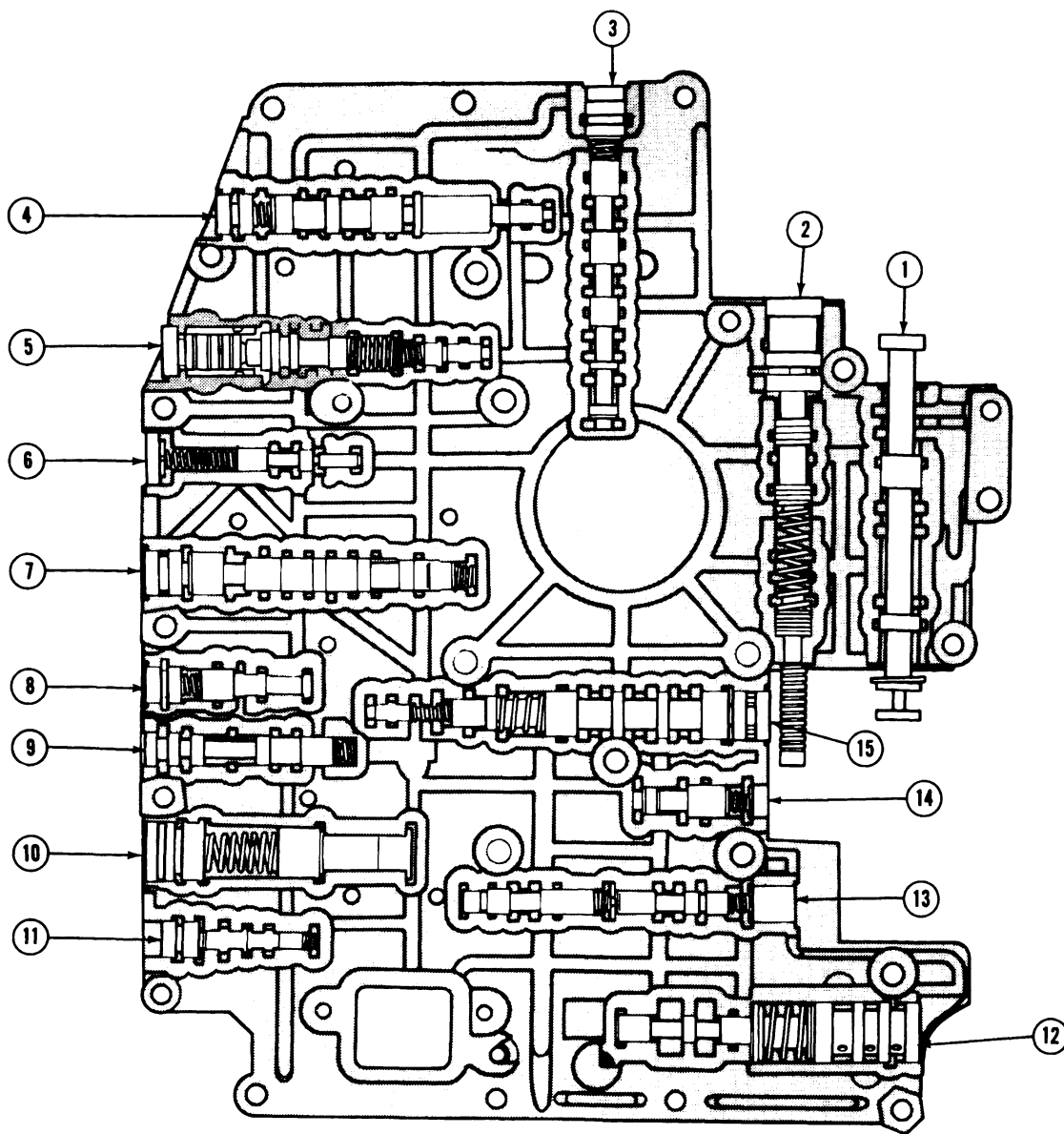
□ INDICATES RELIEF VALVE

○ INDICATES CHECK BALLS



4. The following procedural steps detail the removal and installation of the individual valves. Each valve body bore has been assigned a reference number on the assembled view. The illustrations have been assigned a corresponding reference number. Each set of illustrations contains the views necessary to remove and install the components contained in a particular valve body bore.

DISASSEMBLY (Continued)

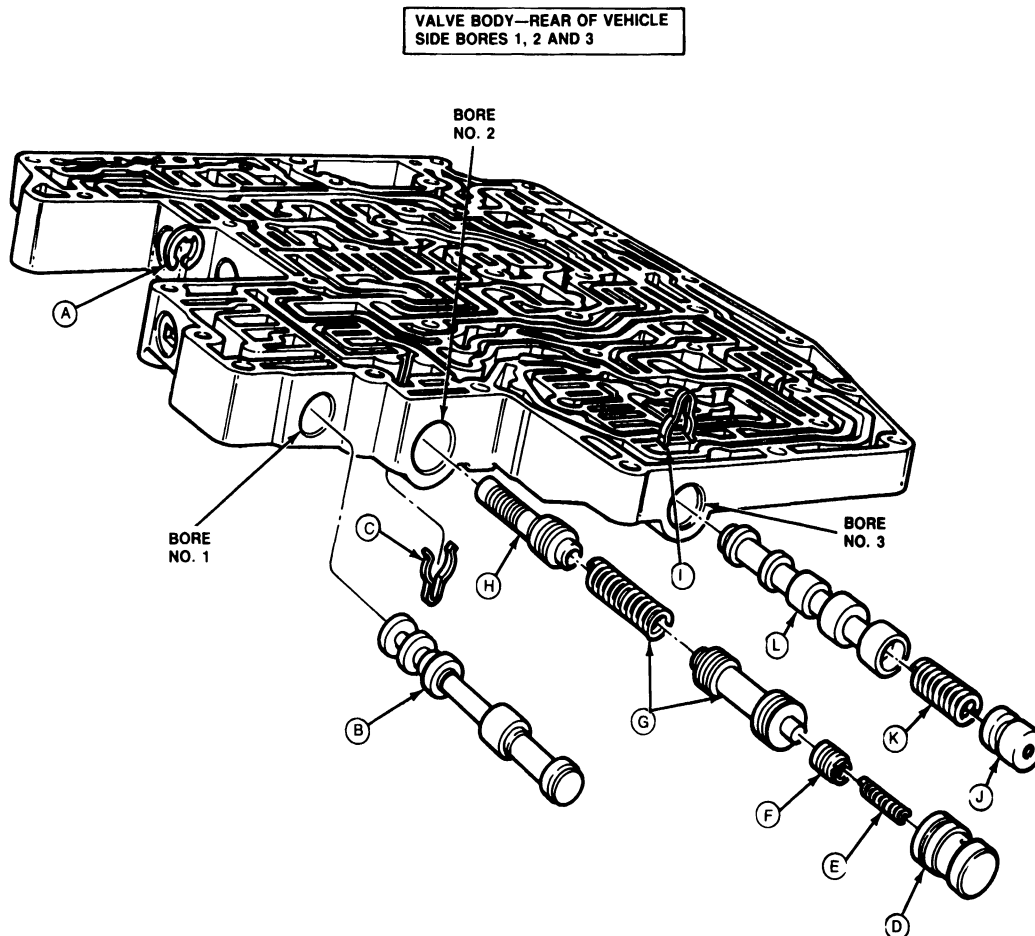


ITEM DESCRIPTION

1. MANUAL VALVE
2. THROTTLE SYSTEM VALVES
3. 2-3 BACKOUT VALVE
4. ORIFICE CONTROL VALVE/2-3 CAPACITY MODULATOR VALVE (FUNCTIONS ARE SEPARATED BY A SPRING RETAINING PLATE)
5. 3-4 SHIFT AND 3-4 MODULATOR VALVES
6. TV LIMIT VALVE
7. 1-2 SHIFT VALVE
8. OD SERVO REGULATOR VALVE
9. 3-4 SHUTTLE VALVE
10. 1-2 ACCUMULATOR VALVE
11. 1-2 CAPACITY MODULATOR VALVE
12. MAIN REGULATOR AND PRESSURE BOOST VALVES
13. 2-1 SCHEDULING VALVE/LOW SERVO MODULATOR VALVE (FUNCTIONS ARE SEPARATED BY A SPRING RETAINING PLATE)
14. 3-4 BACKOUT VALVE
15. 2-3 SHIFT, 3-2 CONTROL AND 2-3 TV MODULATOR VALVES

D3288-F

DISASSEMBLY (Continued)



BORE NO. 1	BORE NO. 2	BORE NO. 3
Ⓐ CLIP	Ⓒ CLIP	Ⓘ CLIP
Ⓑ MANUAL VALVE	Ⓓ THROTTLE SLEEVE	⓵ BORE PLUG
	Ⓔ PRELOAD SPRING	Ⓚ SPRING
	Ⓕ THROTTLE PLUG①	Ⓛ 2-3 BACK OUT VALVE
	Ⓖ THROTTLE CONTROL VALVE AND SPRING②	
	Ⓗ THROTTLE PLUNGER	

NOTES:

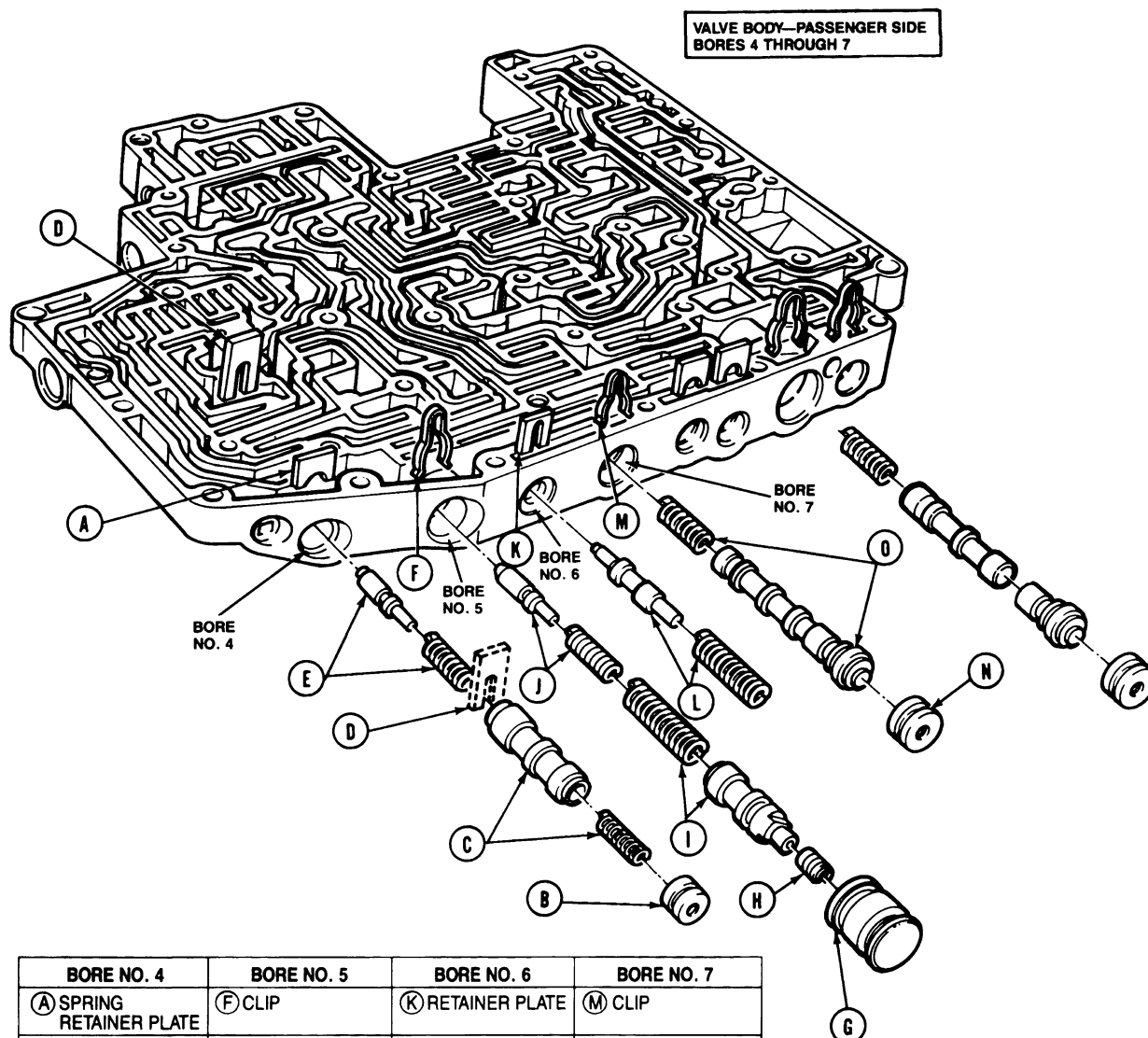
ALL BORE PLUGS HAVE A TAPPED HOLE IN THE CENTER, USE A M4 METRIC SCREW IN TAPPED HOLE FOR EASIER PLUG REMOVAL. THESE PLUGS MUST BE INSTALLED WITH THE TAPPED HOLE FACING OUTWARD.

① THE NOTCH IN THE THROTTLE PLUG FACES THE BOTTOM OF THE THROTTLE SLEEVE BORE.

② THE CHAMFERED STEM OF THE THROTTLE CONTROL VALVE FACES THE THROTTLE PLUNGER.

D6317-8

DISASSEMBLY (Continued)



BORE NO. 4	BORE NO. 5	BORE NO. 6	BORE NO. 7
(A) SPRING RETAINER PLATE	(F) CLIP	(K) RETAINER PLATE	(M) CLIP
(B) BORE PLUG ①	(G) SLEEVE	(L) TV LIMIT VALVE AND SPRING	(N) BORE PLUG
(C) ORIFICE CONTROL VALVE AND SPRING	(H) PLUG ②		(O) 1-2 SHIFT VALVE AND SPRING
(D) SPRING RETAINER PLATE ①	(I) 3-4 SHIFT VALVE AND SPRING		
(E) 2-3 CAPACITY MODULATOR VALVE AND SPRING	(J) 3-4 TV MODULATOR VALVE AND SPRING		

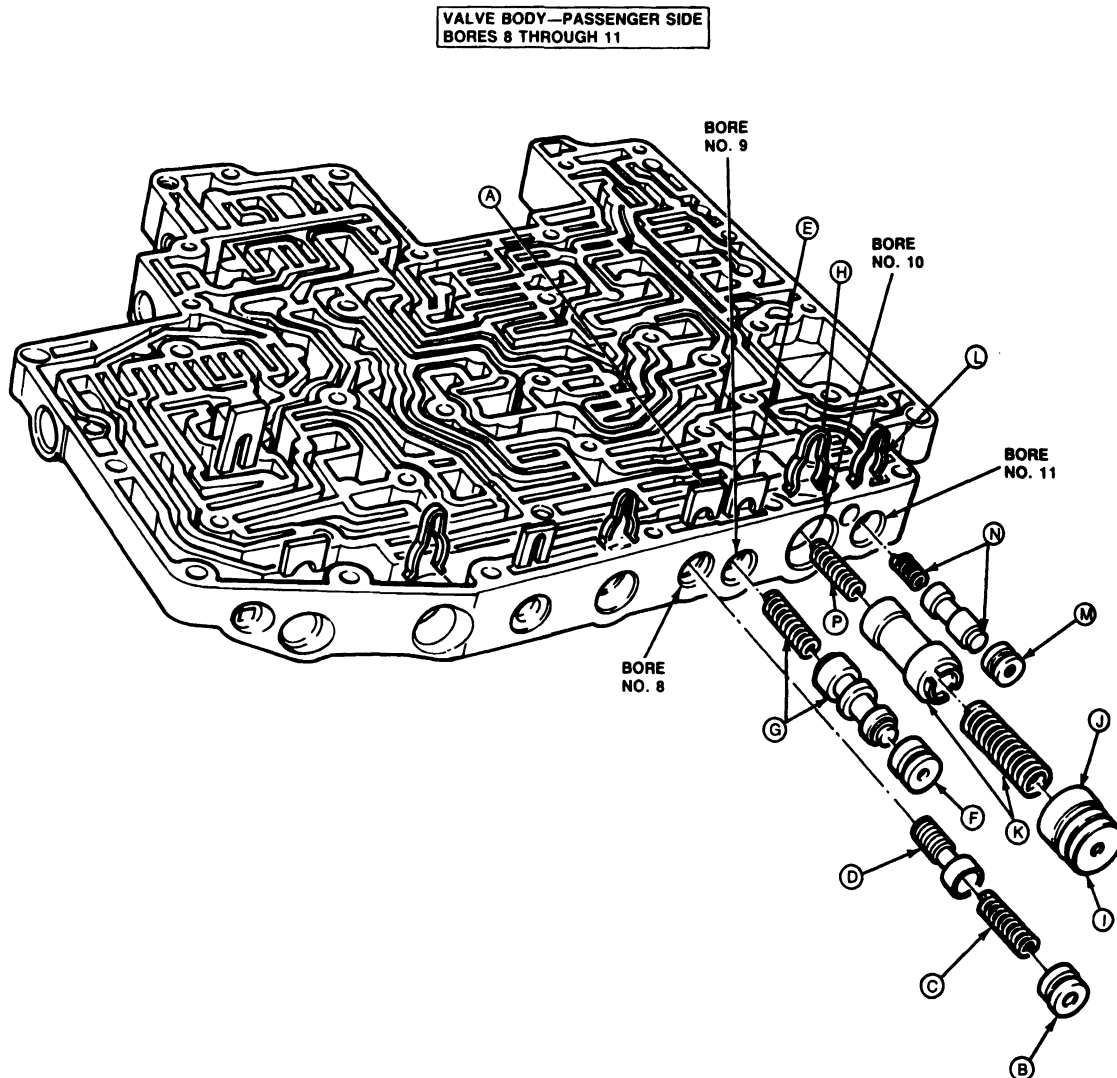
NOTES:

SOME BORE PLUGS HAVE A TAPPED HOLE IN THE CENTER. USE A M4 METRIC SCREW IN TAPPED HOLE FOR EASIER PLUG REMOVAL. THESE PLUGS MUST BE INSTALLED WITH THE TAP HOLE FACING OUTWARD.

- ① THE 2-3 CAPACITY MODULATOR VALVE RETAINER PLATE IS THICKER AND LONGER THAN THE OTHER PLATES. IT MUST BE INSTALLED IN THIS SLOT.
- ② THE NOTCH IN THE PLUG FACES THE BOTTOM OF THE SLEEVE BORE.

D7265-A

DISASSEMBLY (Continued)



BORE NO. 8	BORE NO. 9	BORE NO. 10	BORE NO. 11
(A) SPRING RETAINER PLATE	(E) RETAINER PLATE	(H) CLIP	(L) CLIP
(B) BORE PLUG	(F) BORE PLUG	(I) BORE PLUG	(M) BORE PLUG
(C) SPRING	(G) 3-4 SHUTTLE VALVE AND SPRING	(J) O-RING SEAL ^①	(N) 1-2 CAPACITY MODULATOR VALVE AND SPRING
(D) O.D. SERVO REGULATOR VALVE		(K) 1-2 ACCUMULATOR VALVE AND SPRING ^②	
		(P) 1-2 ACCUMULATOR VALVE SPRING ^③	

NOTES:

SOME BORE PLUGS HAVE A TAPPED HOLE IN THE CENTER, USE A M4 METRIC SCREW IN TAPPED HOLE FOR EASIER PLUG REMOVAL. THESE PLUGS MUST BE INSTALLED WITH THE TAP HOLE FACING OUTWARD.

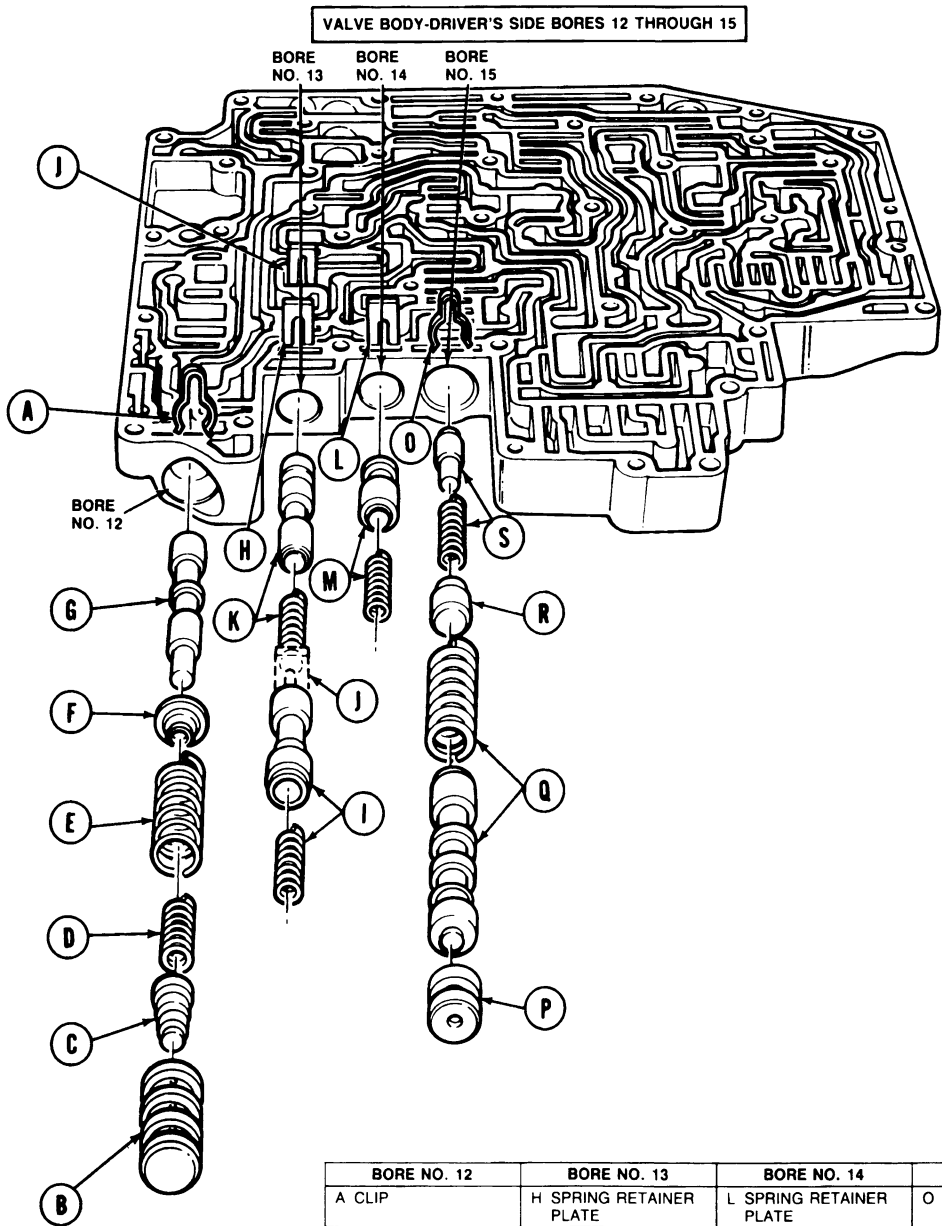
① WHEN INSTALLING THE 1-2 ACCUMULATOR VALVE BORE PLUG INTO THE BORE, THE O-RING SEAL MUST FACE TOWARD OUTSIDE OF THE VALVE BODY.

② THE 1-2 ACCUMULATOR VALVE AND VALVE BODY DIAMETER ARE NOT THE SAME FOR ALL MODELS.

③ THIS SPRING NOT USED ON ALL MODELS.

D6318-D

DISASSEMBLY (Continued)



BORE NO. 12	BORE NO. 13	BORE NO. 14	BORE NO. 15
A CLIP	H SPRING RETAINER PLATE	L SPRING RETAINER PLATE	O CLIP
B BOOST SLEEVE	I LOW SERVO MODULATOR VALVE AND SPRING	M 3-4 BACK OUT VALVE AND SPRING	P BORE PLUG
C BOOST VALVE	J SPRING RETAINER PLATE		Q 2-3 SHIFT VALVE AND SPRING
D BOOST VALVE SPRING	K 2-1 SCHEDULING VALVE AND SPRING		R 3-2 CONTROL VALVE
E MAIN REGULATOR VALVE SPRING			S 2-3 MODULATOR VALVE AND SPRING
F SPRING SEAT			
G MAIN PRESSURE REGULATOR VALVE			

NOTE:
ALL BORE PLUGS HAVE A TAPPED HOLE IN THE CENTER, USE A M4 METRIC SCREW IN TAPPED HOLE FOR EASIER PLUG REMOVAL. THESE PLUGS MUST BE INSTALLED WITH THE TAPPED HOLE FACING OUTWARD.

D6586-A

CLEANING AND INSPECTION

Converter and Fluid Cooler

Tools Required:

- Rotunda Torque Converter Cleaner 014-00028

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and **MUST** be removed from the system before the transmission is put back into service.

Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the converter, oil and oil cooler lines **MUST** be cleaned and flushed by using the Rotunda Torque Converter Cleaner 014-00028 or equivalent. **Under NO circumstances should an attempt be made to clean converters by hand agitation with solvent.**

Transmission

It is important to completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put into service. The cleaning of debris from the direct clutch check ball or check ball in clutch piston is often omitted. This omission can lead to a repeated servicing of the transmission.

Clean the parts with suitable solvent. Use moisture-free air to dry off all parts and clean out fluid passages.

The composition clutch plates, bands and synthetic seals should not be cleaned in a vapor degreaser or with any type of detergent solution. To clean these parts, wipe them off with a lint-free cloth. New clutch plates or bands should be soaked in clean specified transmission fluid 15 minutes before being assembled.

Main Control Valve Body

1. Clean all parts thoroughly in clean solvent, and blow dry with moisture-free compressed air.
2. Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valves for free movement. Inspect all mating surfaces for burrs or distortion. Inspect all plugs and valves for burrs and scores. **If needed, use crocus cloth to polish valves and plugs. Avoid rounding the sharp edges of the valves and plugs with the cloth.**
3. Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight in their respective bores.
4. Roll the manual valve on a flat surface to check for bent condition.
5. Replace the valve body-to-screen gasket.

Low / Reverse Servo

1. Inspect the servo body for cracks and the piston bore for excessive wear.
2. Check fluid passages for obstructions.
3. Inspect the band for distortion. Inspect the band ends for cracks.
4. Inspect servo spring for distortion.
5. Inspect the band lining for excessive wear and bonding to the metal band.
6. Replace damaged seals.

Overdrive Servo

Repeat the low / reverse servo procedure.

CLEANING AND INSPECTION (Continued)**Extension Housing**

1. Inspect the housing for cracks. Inspect the gasket surface for burrs or warpage.
2. Inspect the bushing for scores or wear. Replace, if required.
3. Inspect the rear seal for hardness, cracks or wear. If the seal shows wear or deterioration, replace the seal.
4. Inspect the seal counterbore and remove all burrs and scores with crocus cloth.
5. Check for obstructions.

Governor

1. Inspect the governor valves and bores for scores. Minor scores may be removed from the valves with crocus cloth. Replace the governor if the valves or body is deeply scored.
2. Inspect the AOD governor screen for obstructions. The screen must be free of foreign material. If contaminated, clean thoroughly in a suitable solvent and blow dry with compressed air.
3. Check for free movement of the valves in the bores. The valves should slide freely of their own weight in the bores when dry. Inspect fluid passages in the valve body and counterweight for obstructions and contaminants. **All fluid passages must be clean.**
4. Check the mating surface of the governor valve and the counterweight for burrs or scratches.

Pump

1. Inspect the mating surfaces of the pump body and cover for burrs.
2. Inspect the drive and driven gear bearing surface for scores and check gear teeth for burrs.
3. Check fluid passages for obstructions.
4. If any parts are worn or damaged, replace the pump as a unit. Minor burrs and scores may be removed with crocus cloth.
5. Check the large seal ring groove of the pump body for damage. Check the gasket mating surface of the pump body for damage.

Clutches**Reverse Clutch**

1. Inspect the drum band surface, the bushing and thrust surfaces for scores. Minor scores may be removed with crocus cloth. **Badly scored parts must be replaced.**
2. Inspect the clutch piston bore and the piston inner and outer bearing surfaces for scores. Check the air bleed ball valve in the clutch piston for free movement. Check the orifice to make sure it is not plugged.
3. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.
4. Inspect the clutch plates for wear, scoring and fit on the clutch hub splines. Replace all plates that are badly heat distressed, worn or do not move freely in the hub splines.
5. Inspect the clutch pressure plate for scores on the clutch plate bearing surface. Check the clutch release spring(s) for distortion.
6. Inspect the check ball for freedom of movement and proper seating.

Forward Clutch

1. Inspect the clutch cylinder thrust surfaces, piston bore and clutch plate splines for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.
2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the check balls for freedom of movement and proper seating. AOD has two check balls in the forward clutch cylinder, not the piston.
3. Inspect the composition clutch plates, steel clutch plates, and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.
4. Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear.
5. Check the splines on the stator support for wear. Replace if excessively worn. Inspect the bushing in the stator support for scores.

Intermediate Friction Clutch

1. Inspect the clutch cylinder piston bore in the rear face of the pump and clutch plate splines for scoring or burrs. Minor burrs may be removed with crocus cloth. Replace the case if it is badly scored or damaged.

CLEANING AND INSPECTION (Continued)

2. Clean out all fluid passages. Inspect the clutch piston for scoring and replace if necessary.
3. Check the piston return springs for distortion. Check the piston return spring retainer for flatness.
4. Inspect the composition clutch plates, steel clutch plates and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.
5. Check the clutch hub splines for wear. Clutch hub splines are attached to the reverse clutch drum.

Direct Clutch

1. Inspect the clutch cylinder thrust surfaces, piston bore and clutch plate splines for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.
2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating. Follow the direct clutch piston check ball leakage procedure.
3. Check the clutch release springs and retainer for distortion and cracks. Replace the springs and retainer if it is distorted or cracked.

4. Inspect the friction clutch plates, springs and retainer, steel clutch plates and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored or polished.
5. Check the clutch plates on the clutch hub splines.
6. Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear.
7. Check the splines on the direct driveshaft for wear. Replace the shaft if the splines are excessively worn.

Direct Clutch Piston Check Ball

Inspect the piston check ball for freedom of movement. Improper seating of check ball will cause leakage. Check for leakage by turning the piston upside down (flat side of piston facing you), allowing the check ball to seat in the piston. Pour a small quantity of solvent over the check ball. If solvent drips past the check ball, replace the piston.

One-Way Roller Clutch

1. Inspect the outer and inner races for scores or damaged surface areas where the rollers contact the races. If the intermediate one-way roller clutch inner race is damaged, the reverse clutch hub must be replaced.
2. Inspect the rollers and springs for excessive wear or damage.
3. Inspect the spring and roller case for bent or damaged spring retainers.

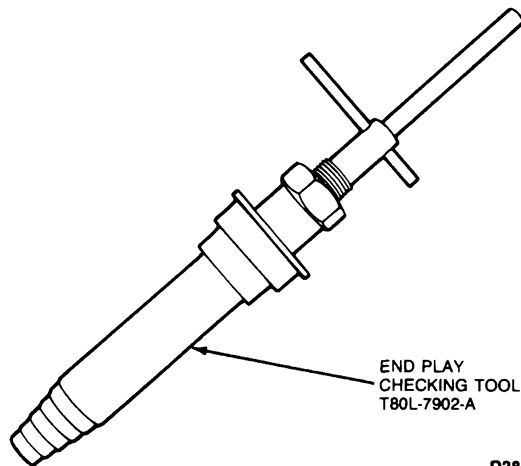
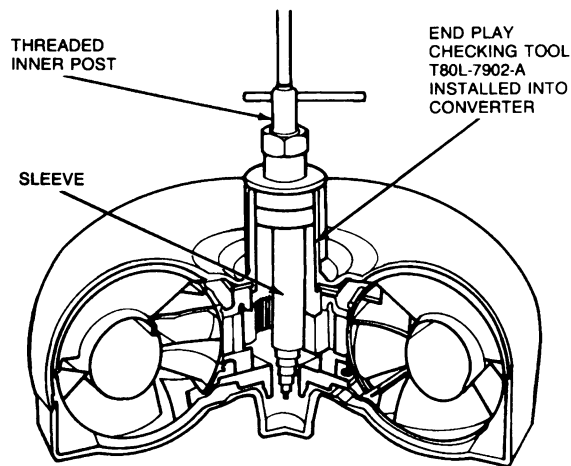
Converter End Play, One-Way Clutch Check**Tools Required:**

- End Play Checking Tool T80L-7902-A
- Bracketry TOOL-4201-C

End Play Check

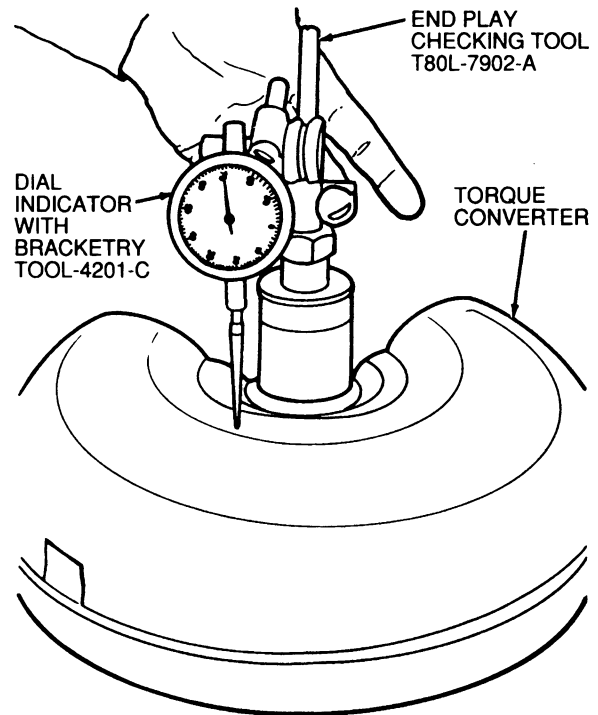
1. Insert End Play Checking Tool T80L-7902-A into the converter pump drive hub until it bottoms.
2. Expand the sleeve in the turbine spline by tightening the threaded inner post until the tool is securely locked in to the spline.

CLEANING AND INSPECTION (Continued)



D2876-D

3. Attach Dial Indicator with Bracketry TOOL-4201-C or equivalent to the tool. Position the indicator button on the converter pump drive hub, and set the dial face at zero.
4. Lift the tool upward as far as it will go and note the indicator reading. The indicator reading is the total end play which the turbine and stator share. Replace the converter unit if the total end play exceeds the limits indicated in Specifications.
5. Loosen the threaded inner post to free the tool and remove the tool from the converter.



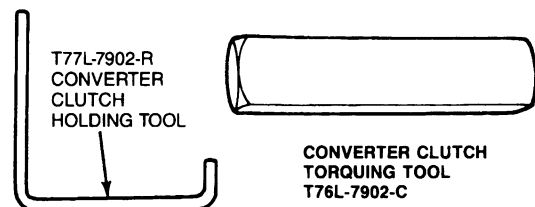
D3453-D

Converter One-Way Roller Clutch Check

Tools Required:

- Converter Clutch Torquing Tool T76L-7902-C
- Converter Clutch Holding Tool T77L-7902-R

1. Insert the Converter Clutch Holding Tool T77L-7902-R, in one of the grooves in the stator thrust washer.

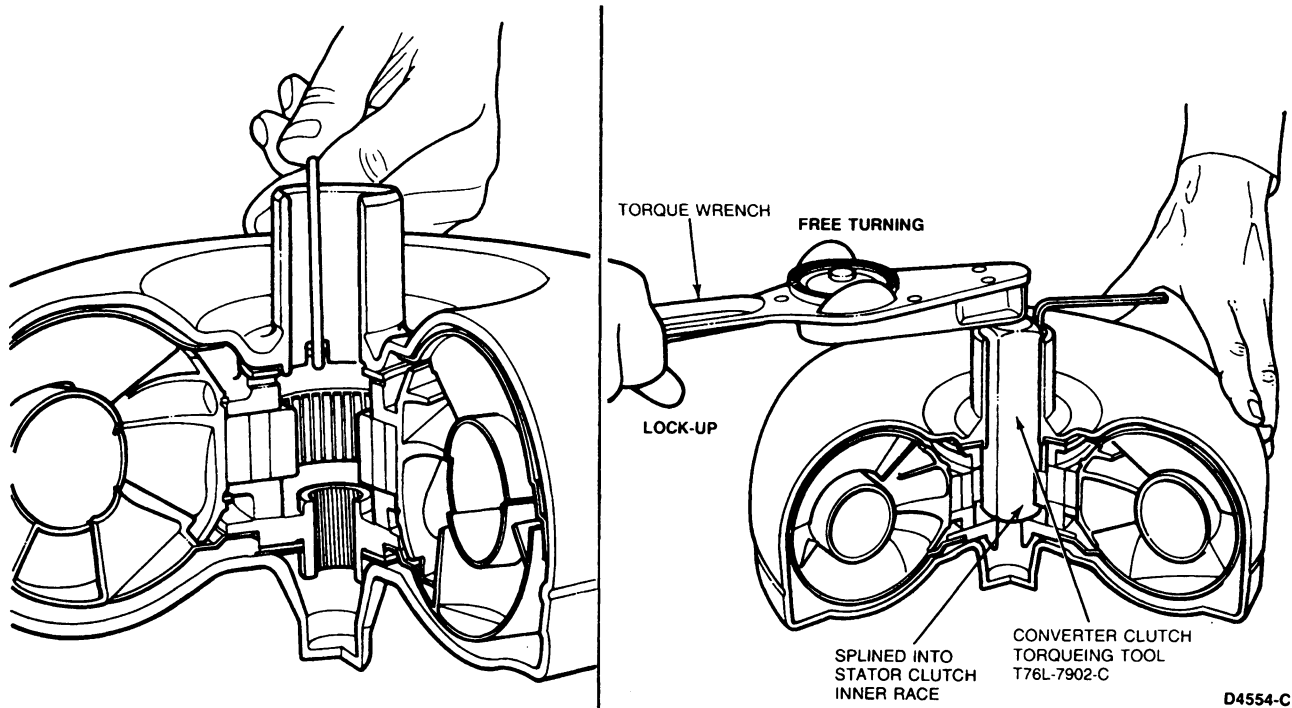


D2877-J

2. Insert Converter Clutch Torquing Tool T76L-7902-C in converter pump drive hub to engage one-way roller clutch inner race.
3. Attach a torque wrench to the one-way roller clutch tightening tool. With the one-way roller clutch holding tool held stationary, turn the torque wrench counterclockwise. The converter one-way clutch should lock up and hold a 13 N·m (10 lb-ft) force. The converter one-way clutch should rotate freely in a clockwise direction. Try the clutch for lock up and hold in at least five different locations around the converter.

CLEANING AND INSPECTION (Continued)

4. If the clutch fails to lock up and hold a 13 N·m (10 lb-ft) torque, replace the converter unit.



Converter Damper / Hub Assembly Weld Check
Tools Required:

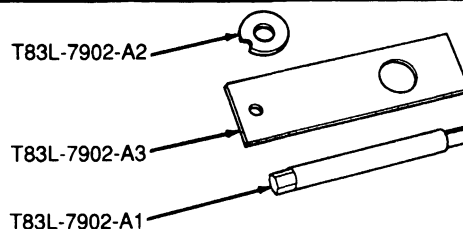
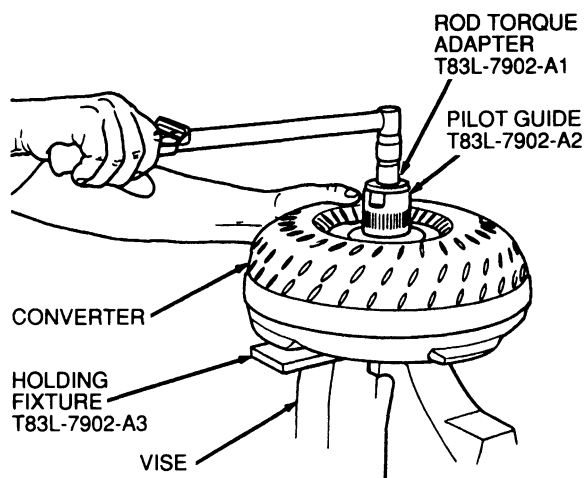
- Converter Checking Tool T83L-7902-A
- Rod Torque Adapter T83L-7902-A1
- Pilot Guide T83L-7902-A2
- Holding Fixture T83L-7902-A3

1. Position Holding Fixture T83L-7902-A3 in a vise and clamp tight.
2. Place the converter on top of the holding fixture aligning the pilot hub and one stud in the appropriate holes.

3. Spline Rod Torque Adapter T83L-7902-A1 into the converter, making sure the splines engage the damper assembly.
4. Install Pilot Guide T83L-7902-A2, over the rod torque adapter turning tool and onto the impeller hub.
5. Hold the converter snug to the holding fixture with one hand when tightening.
6. Turn the shaft clockwise and counterclockwise applying approximately 67.7 N·m (50 lb-ft) torque with a 3/4-inch drive socket and torque wrench.
7. The shaft should not turn more than four degrees.

CLEANING AND INSPECTION (Continued)

8. If there is a grinding noise and / or if the shaft turns more than four degrees, the converter damper assembly, welds, rivets or reaction hub are broken. Replace the torque converter.

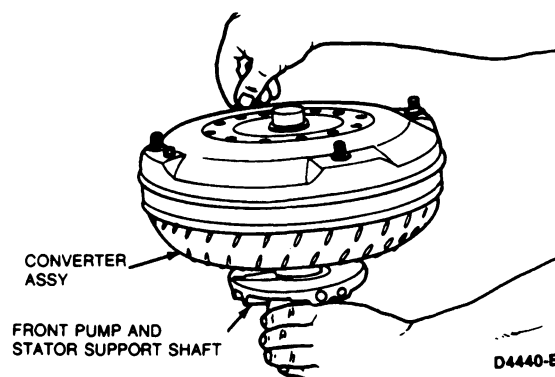


CONVERTER CHECKING TOOL T83L-7902-A	ROD TORQUE ADAPTER	T83L-7902-A1
	PILOT GUIDE	T83L-7902-A2
	HOLDING FIXTURE	T83L-7902-A3

D4445-D

Stator to Impeller Interference Check

1. Position the front pump assembly on a bench with the spline end of the stator shaft pointing up.
2. Mount a converter on the pump with the splines on the one-way clutch inner race, engaging the mating splines of the stator support. The converter hub will then engage the pump drive gear.
3. Hold the pump stationary, and try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.
4. If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the converter.



D4440-B

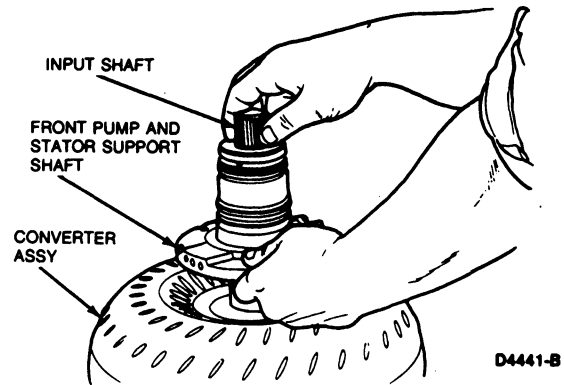
Stator to Turbine Interference Check

1. Position the converter on the bench, front side down.
2. Install a front pump assembly to engage the mating splines of the stator support and stator, and pump drive gear lugs.
3. Install the input shaft, engaging the splines with the turbine hub.

CLEANING AND INSPECTION (Continued)

4. Hold the pump stationary and attempt to rotate the turbine with the input shaft. The turbine should rotate freely in both directions without any signs of interference or scraping noise.
5. If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. In such cases, the converter must be replaced.

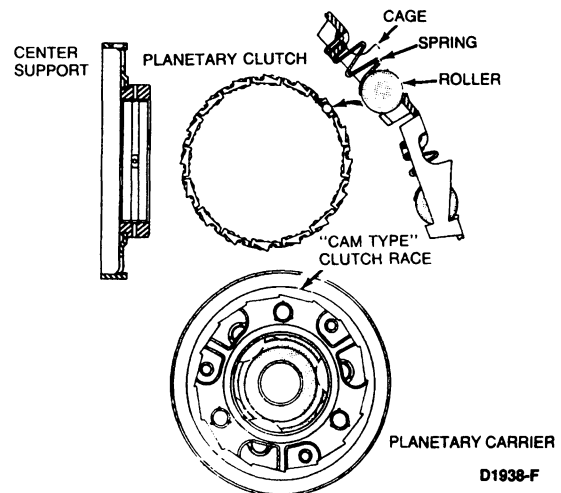
The converter crankshaft pilot should be checked for nicks or damaged surfaces that could cause interference when installing the converter into the crankshaft. Check the converter front pump drive hub for nicks or sharp edges that would damage the pump seal.



D4441-B

Planetary Carrier and Center Support

1. Inspect the clutch outer race, inner race, band surface, pinion gears, bearings and thrust washer for roughness.
2. Inspect the center support bushing for roughness.
3. Inspect one-way roller clutch, springs, rollers and springs.



D1938-F

Stator Support

1. Inspect the stator support splines for burrs and wear.
2. Check the bushing of the stator support for wear or scoring.
3. Check the front pump support seal.
4. Check seal rings for damage.

Transmission Case

Inspect case for cracks and stripped threads. Inspect gasket surfaces and mating surfaces for burrs. Check vent for obstructions, and check all fluid passages for obstructions and leakage.

Inspect the case bushing for scores. Check all parking linkage parts for wear or damage.

If a transmission case thread is damaged, service kits may be purchased from local jobbers. To service a damaged thread, the following procedures should be carefully followed:

1. Drill out the damaged threads, **using the same drill size as the thread OD**. For example, use a 5/16-inch drill for a 5/16-18 thread.

CLEANING AND INSPECTION (Continued)

2. Select the proper special tap and tap the drilled hole. The tap is marked for the size of the thread being serviced. The special tap marked 5 / 16 18 will not cut the same thread as a standard 5 / 16 18 tap. It does cut a thread large enough to accommodate the insert, and after the insert is installed the original thread size (5 / 16 18) is restored.
3. Select the proper coil inserting tool. These tools are marked with the thread size being serviced. Place the insert on the tool and adjust the sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is one-half turn below the face.
4. Working through the insert, bend the insert tang straight up and down until it breaks off at the notch.
5. Improperly installed inserts can be removed with the extractor tool. Place the extractor tool in the insert so that the blade rests against the top coil one-quarter to one-half turn away from the end of the coil. Tap the tool sharply with a hammer so that the blade cuts into the insert. Exert downward pressure on the tool and turn it counterclockwise until the insert is removed.

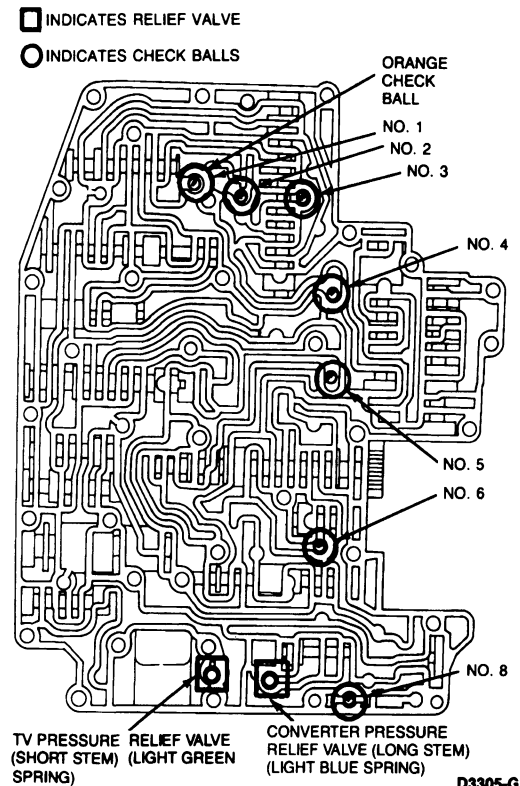
These tools are marked with the thread size being serviced. Place the insert on the tool and adjust the sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is one-half turn below the face.

ASSEMBLY**Subassemblies****Valve Body****Assembly**

1. Install the seven body check balls.

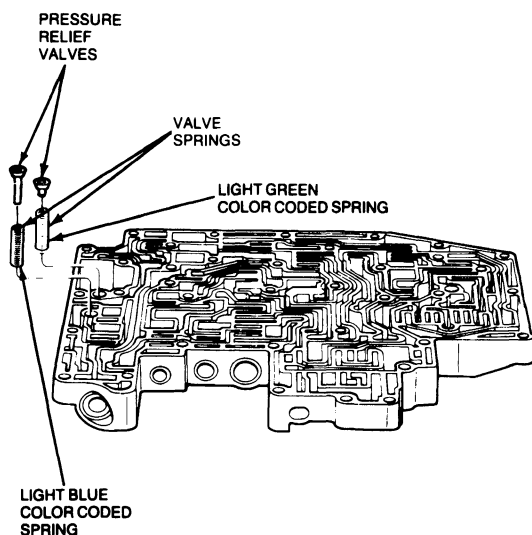
Note the location of the orange ball. This ball is larger than the others and must be positioned as shown.

NOTE: The check balls are labeled one through eight. Check ball seven was eliminated in a previous production year. There are a total of seven check balls.



ASSEMBLY (Continued)

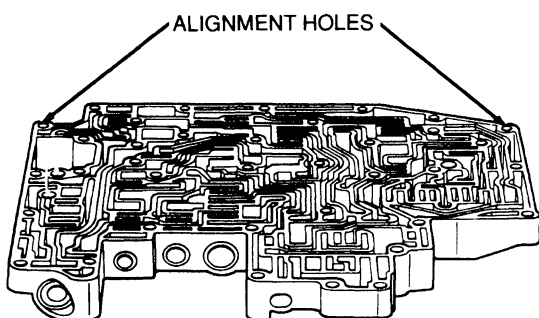
2. Install the pressure relief valves.



D3336-D

3. Note the location of the alignment holes. These two holes are smaller than the other bolt holes to ensure proper alignment of the gasket and separator plate with valve body. These two holes also align the valve body gasket and valve body assembly with the case.

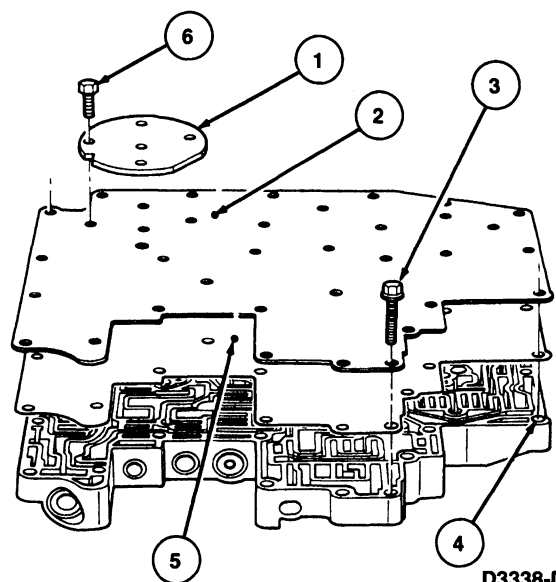
CAUTION: The two shoulder bolts must be installed at alignment holes only.



D3337-C

4. Use a new separator plate gasket. Slide the gasket and the separator plate over the two alignment holes. Position the three reinforcement plates and loosely install the 11 retaining bolts. Loosely install the detent spring guide bolt. (This bolt is the same as the short valve body assembly-to-case retaining bolts.)

CAUTION: Do not use a shoulder bolt at the detent spring guide or damage to valve body casting will result.

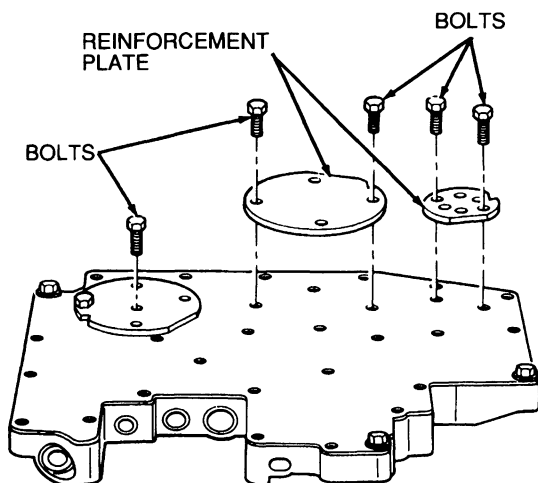


D3338-D

Item	Part Number	Description
1	7F282	Reinforcement Plate
2	7A008	Separator Plate
3	—	Detent Spring Guide Bolt
4	—	Alignment Hole
5	7D100	Separator Gasket
6	—	Bolts

TD3338E

5. Starting at the center (large) reinforcement plate and working outward, tighten the 11 retaining bolts to 9-14 N·m (80-123 lb-in). Tighten the detent spring guide bolt to 9-11 N·m (80-97 lb-in). Install shoulder bolts.



D3355-D

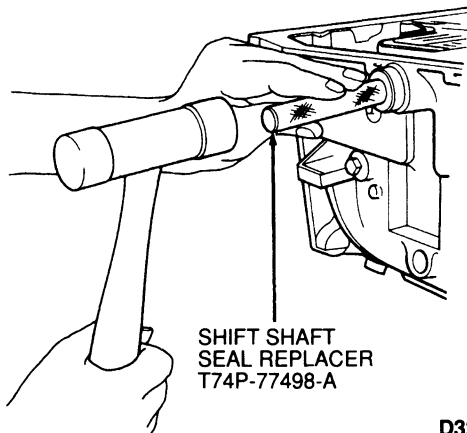
ASSEMBLY (Continued)**Manual and Throttle Linkage****Tools Required:**

- Shift Shaft Seal Replacer T74P-77498-A

Assembly

To assemble the manual throttle linkages, reverse the disassembly except for the following:

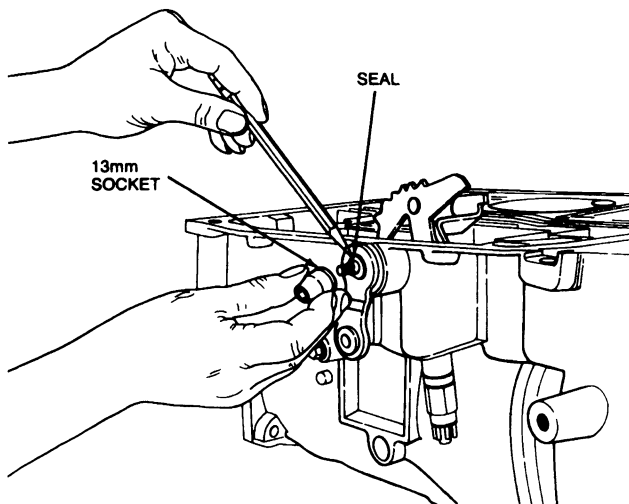
1. Install a new manual lever seal using Shift Shaft Seal Replacer T74P-77498-A.



D3258-D

2. Before installing the outer throttle lever, install a new seal in the outer manual lever. To seat the seal, a 13mm thin wall socket may be used. Position the ratchet end of the socket against the seal.

NOTE: The seal identification number must face outward.



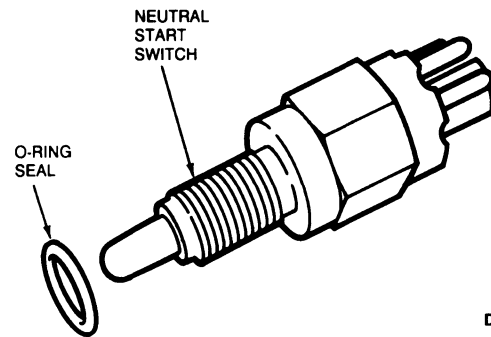
D3354-C

Neutral Start Switch**Tools Required:**

- Neutral Start Switch Socket T74P-77247-A

Installation

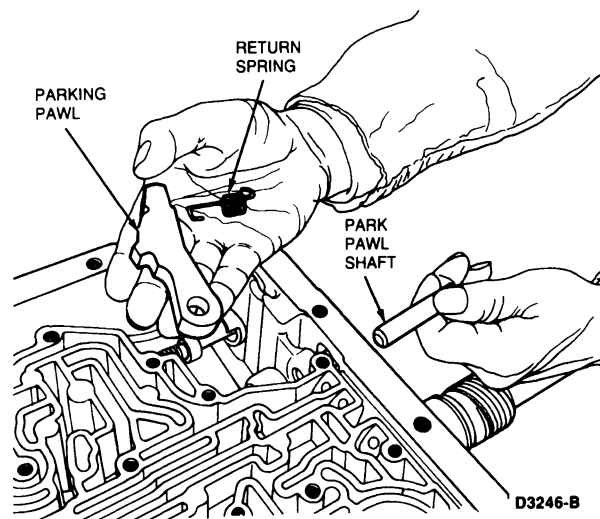
1. Install a new seal on the neutral start switch.
2. Install the switch in the case using the Neutral Start Switch Socket T74P-77247-A. Tighten to 11-15 N·m (8-11 lb-ft).



D3210-B

Parking Pawl**Installation**

1. Hook the squared end of the spring into the notch on the park pawl.
2. Hold pawl and spring in place and hook curved end of spring into the recess in the case.
3. Install the park pawl shaft.



D3246-B

Governor**Assembly**

1. If removed, install the clip and spring on the governor valve.
2. Install governor valve in governor body.
3. Install the sleeve in the governor body with the points outward.

ASSEMBLY (Continued)

4. Install the plug in the sleeve with the knurled face inward.
5. Position the cover and install the retaining screws. Tighten the retaining screws to 2.3-3.4 N·m (21-30 lb-in).

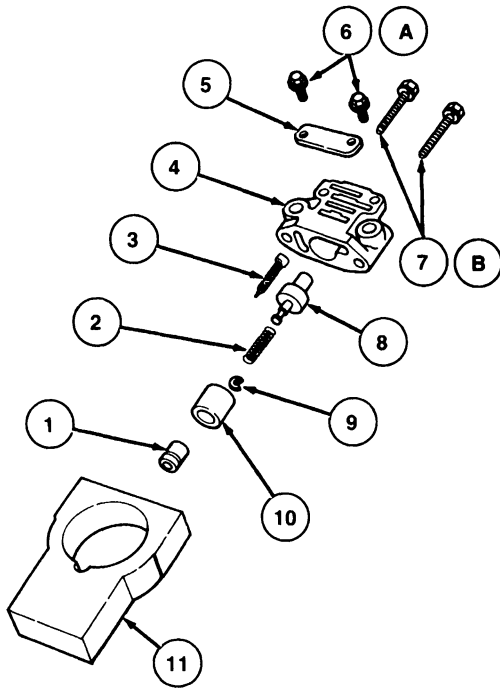
NOTE: The steel band (brass colored) goes inward and the top of the screen faces outward.

6. Install the screen in the body.

NOTE: The finished face of the governor body should be flush with the face of the counterweight. (If it is not, the body is installed backwards.)

7. Position the governor body on the counterweight and install the retaining screws.

Tighten retaining screws to 6-7 N·m (54-61 lb-in).



D3249-D

Item	Part Number	Description
1	7A303	Governor Plug
2	7A302	Governor Valve Spring
3	7E242	Governor Oil Screen
4	7C063	Governor Body Assy
5	7A301	Governor Valve Body Cover
6A	N800274	Governor Cover Bolt (2 Req'd)

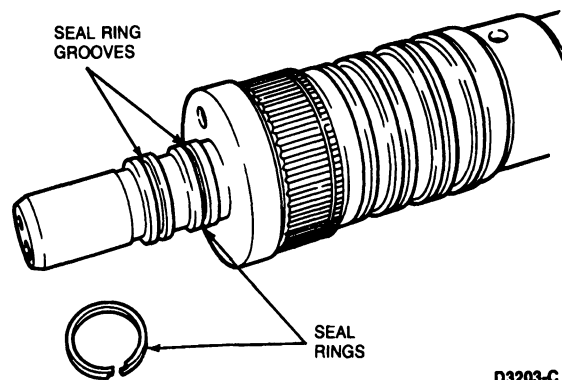
(Continued)

Item	Part Number	Description
7B	N800273	Governor Counterweight Bolts (2 Req'd)
8	7C054	Governor Valve
9	—	E-Clip, Part of 7C054 Governor Valve
10	7A304	Governor Sleeve
11	7A189	Governor Counterweight
A		Tighten to 2.3-3.4 N·m (21-30 Lb-in)
B		Tighten to 6-7 N·m (54-61 Lb-in)

TD3249D

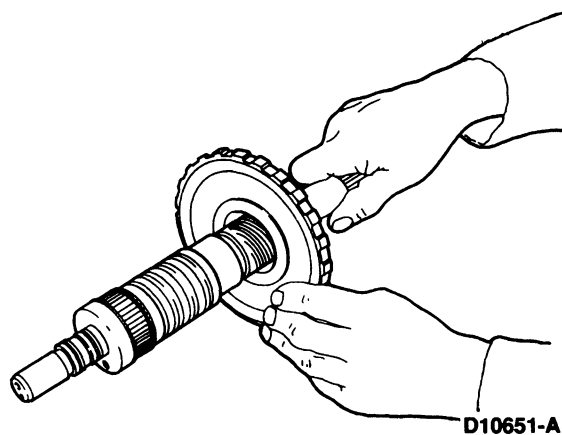
Output Shaft**Assembly**

1. Install two direct clutch seal rings.



D3203-C

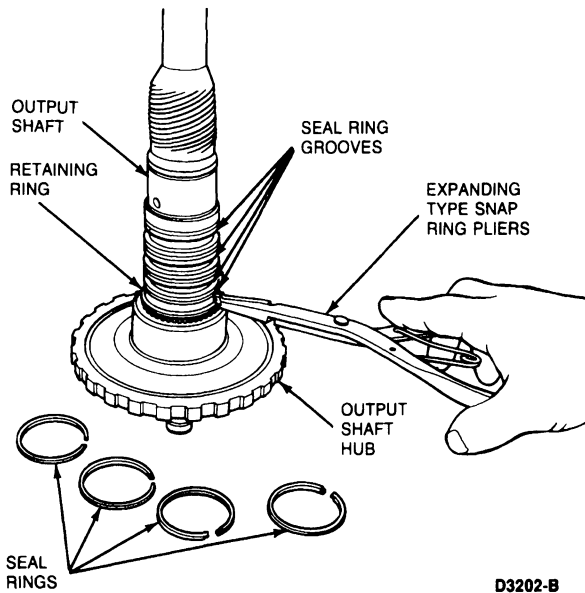
2. Install output shaft hub.



D10651-A

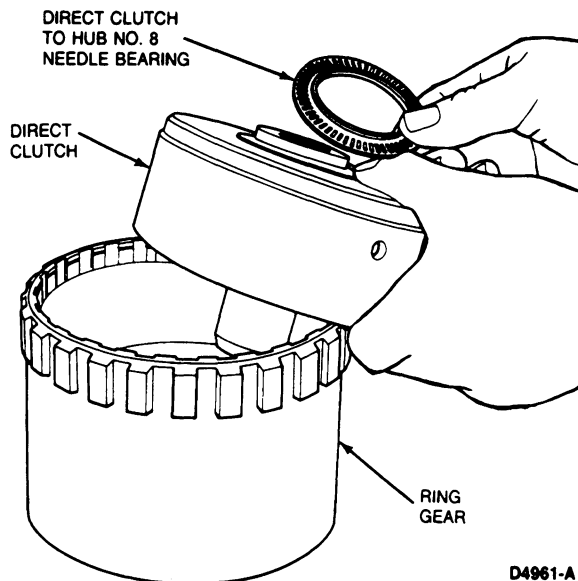
ASSEMBLY (Continued)

3. Install four output shaft seal rings and hub-to-output shaft retaining ring.



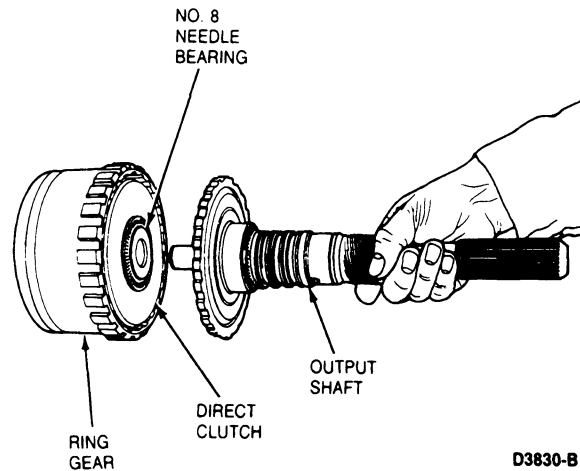
D3202-B

4. Install direct clutch and No. 8 needle bearing.



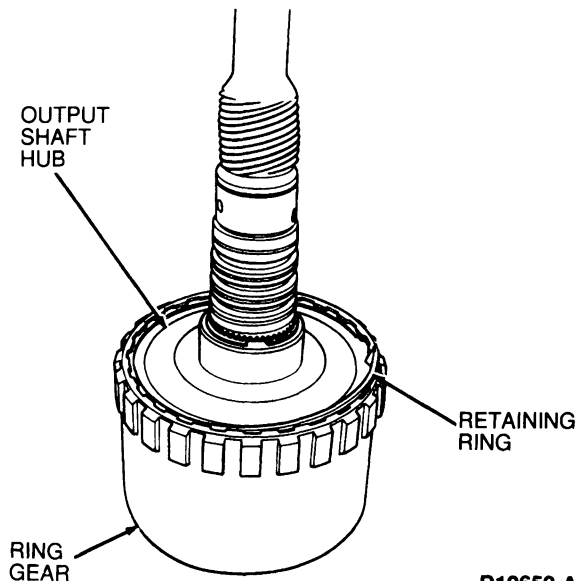
D4961-A

5. Install output shaft and hub assembly to ring gear.



D3830-B

6. Install output shaft-to-ring gear retaining ring.



D10652-A

Direct Clutch**Tools Required:**

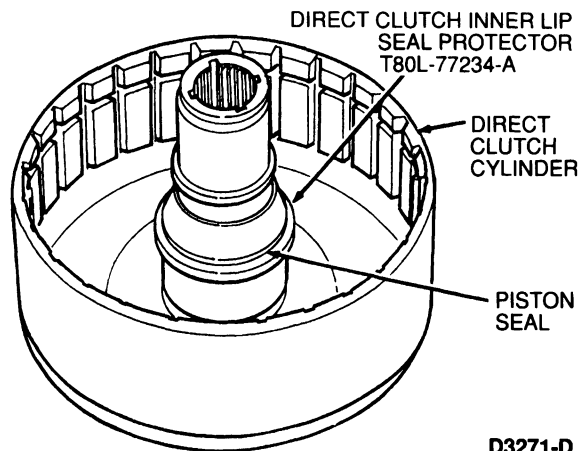
- Clutch Spring Compressor T65L-77515-A
- Direct Clutch Inner Lip Seal Protector T80L-77234-A
- Direct Clutch Outer Lip Seal Protector T80L-77254-A
- Air Nozzle TOOL-7000-DE

Assembly

1. Install the inner piston seal on the clutch cylinder hub as follows:
 - a. Position Direct Clutch Inner Lip Seal Protector T80L-77234-A over the clutch cylinder hub.
 - b. Lubricate the seal and the seal protector with petroleum jelly.

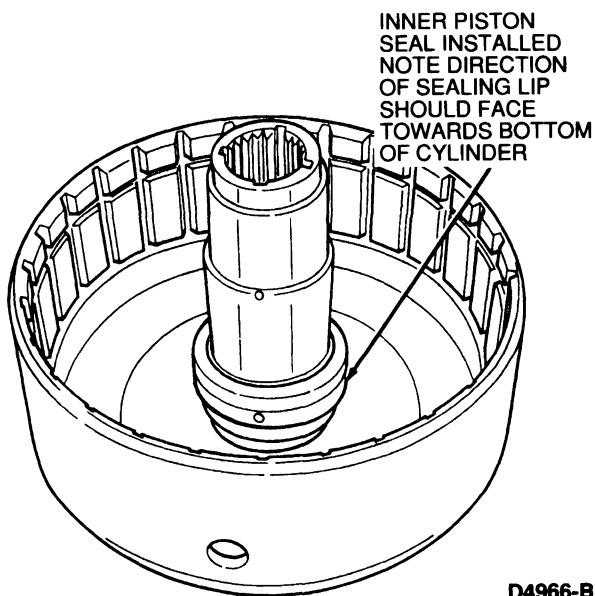
ASSEMBLY (Continued)

- c. Position the seal over the installer tool with the sealing lip facing down.



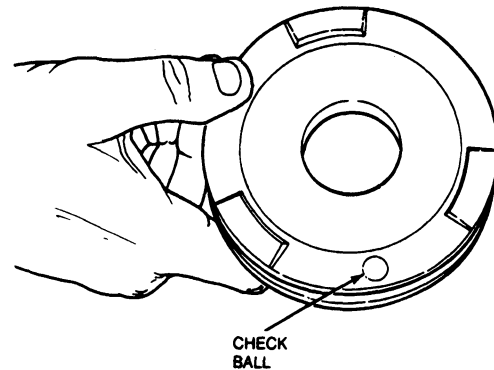
D3271-D

- d. Push the seal down until it snaps off the end of the protector onto the clutch hub.
- e. Remove the seal protector from the clutch hub.
- f. Slide the seal up until it seats in the seal groove.



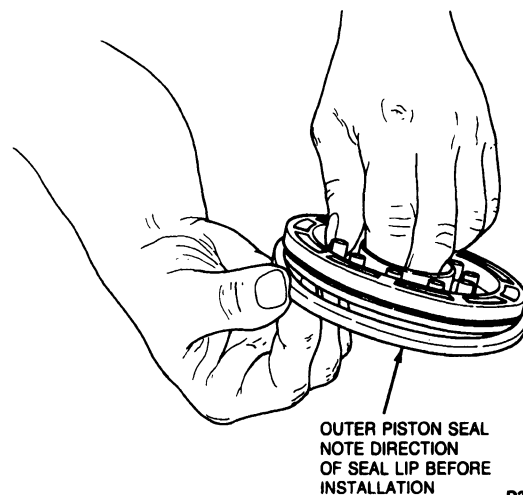
D4966-B

2. Inspect the piston check ball. Ensure the ball is present and moves freely. Check for leakage by performing the Direct Clutch Piston Check Ball Leakage procedure as outlined.



D4738-B

3. Install the outer clutch piston seal. Note the direction of the sealing lip before installation. The lip points away from the spring posts.

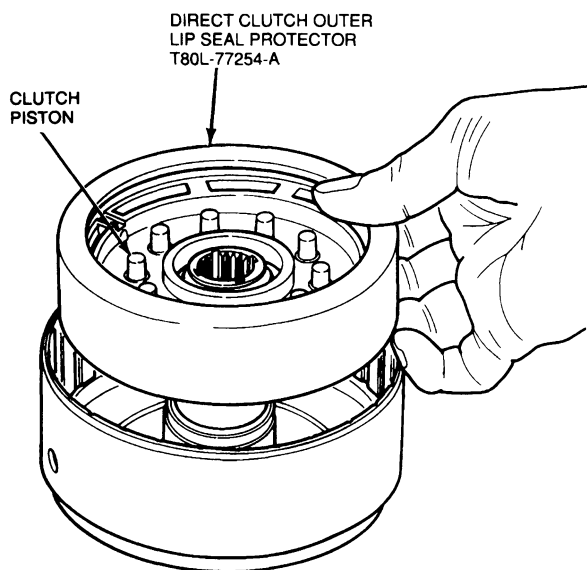


D3272-B

4. Install the clutch apply piston as follows:
- a. Coat the piston seals, the clutch cylinder sealing area and the piston inner seal area with petroleum jelly.

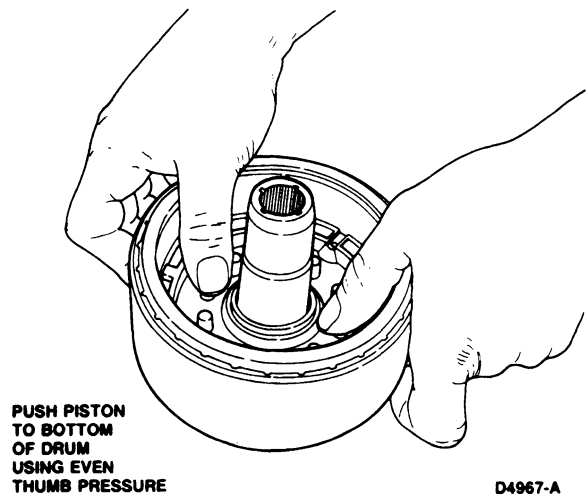
ASSEMBLY (Continued)

- b. Install the piston in the Direct Clutch Outer Lip Seal Protector T80L-77254-A.



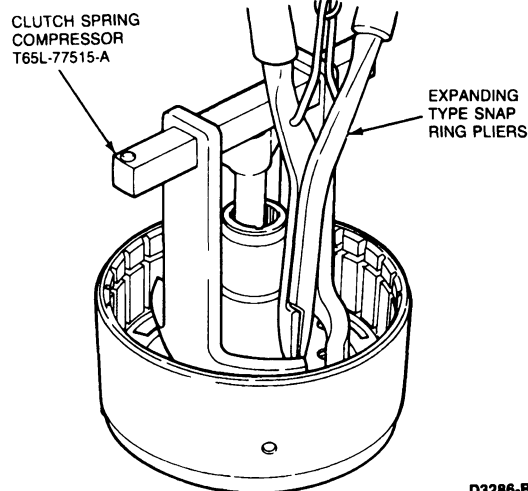
D3273-D

- c. Position the tool in the clutch drum and push the piston to the bottom of the drum using even thumb pressure.



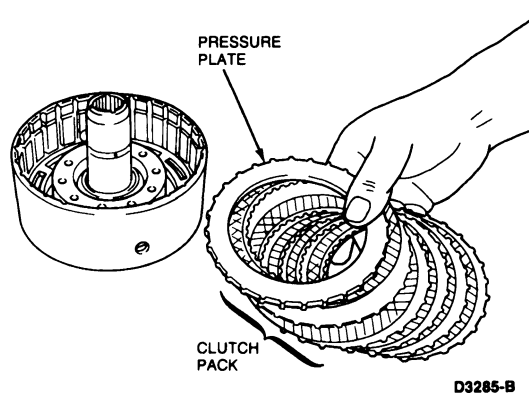
D4967-A

5. Install the piston spring and retainer assembly and retaining ring using Clutch Spring Compressor T65L-77515-A.



D3286-B

6. Install the clutch pack.



D3285-B

7. Install the clutch pack selective retaining ring and check the clearance between the ring and the pressure plate using a feeler gauge. The pressure plate should be held downward as the clearance is checked.



D3274-B

ASSEMBLY (Continued)

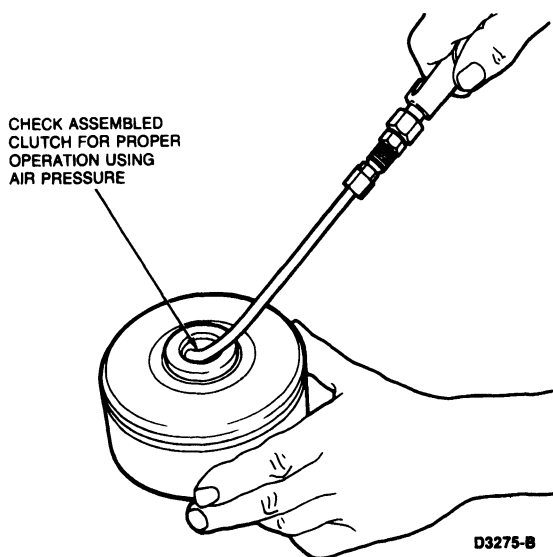
The clearance should be: 1.52-2.34mm (0.060-0.092 inch).

If the clearance is not within limits, selective snap rings are available in the following thicknesses:

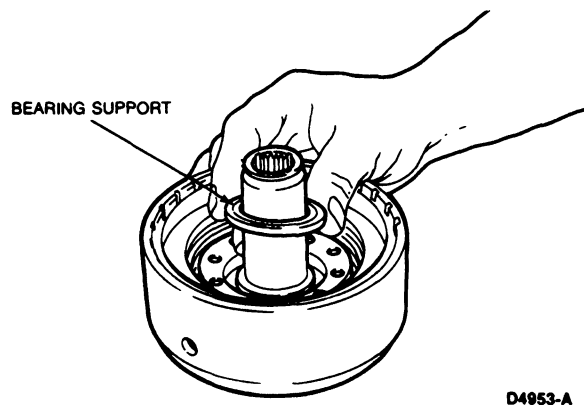
- 1.27-1.37mm (0.050-0.054 inch).
- 1.62-1.72mm (0.064-0.068 inch).
- 1.98-2.08mm (0.078-0.082 inch).
- 2.33-2.43mm (0.092-0.096 inch).

Install the correct size snap ring and check the clearance.

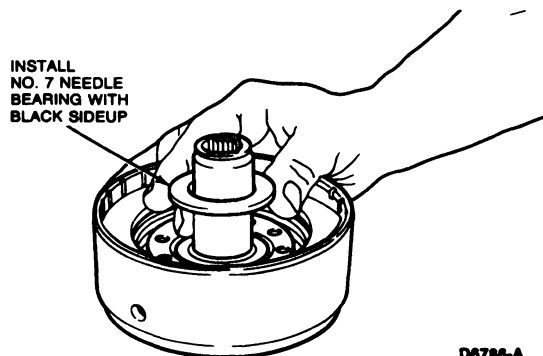
8. Check the clutch for proper operation using Air Nozzle TOOL-7000-DE or equivalent. The clutch should be heard and felt to apply smoothly and without leakage.



9. Install No. 7 needle bearing support.



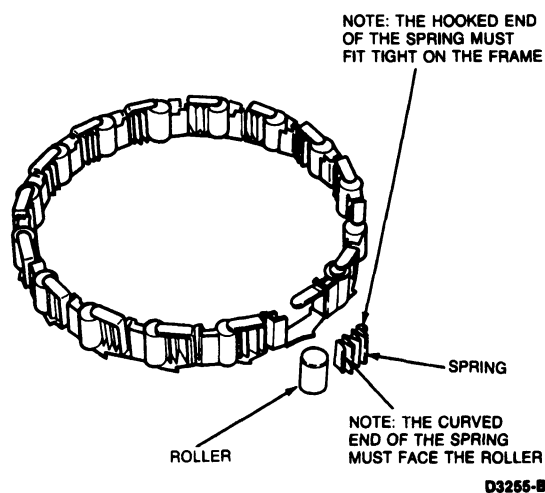
10. Install No. 7 needle bearing (black side up).



Center Support and Planetary One-Way Roller Clutch

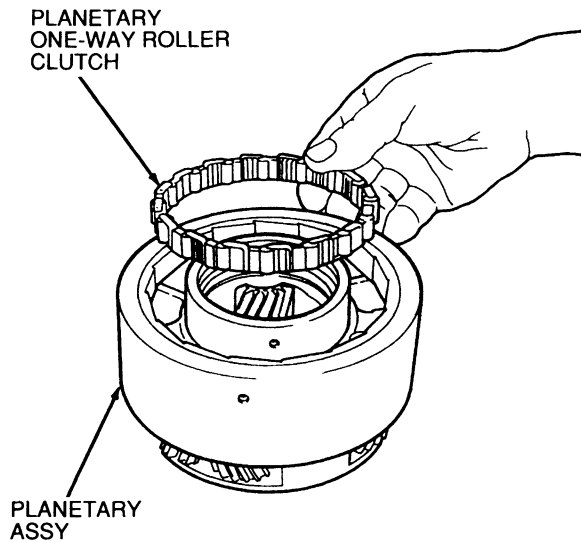
Assembly

1. If necessary, assemble the one-way roller clutch.



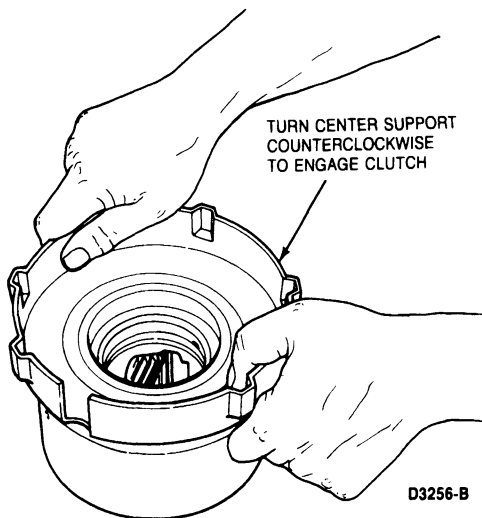
ASSEMBLY (Continued)

2. Install the one-way roller clutch in the planetary carrier.



D3242-C

3. Install the center support into the one-way roller clutch by rotating the center support counterclockwise.
Lubricate the clutch races and the clutch assembly with petroleum jelly to aid in assembly.



D3256-B

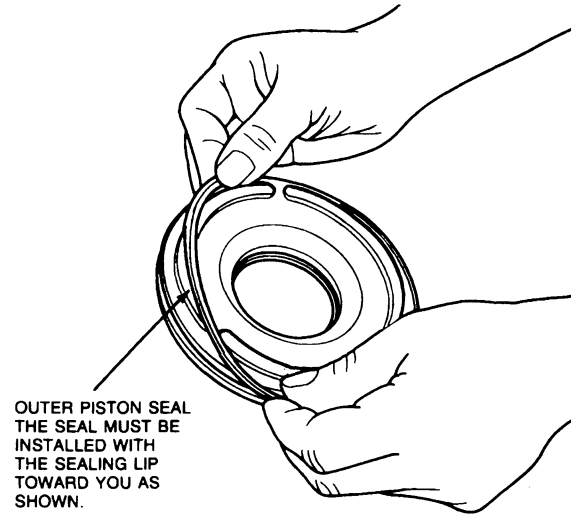
Forward Clutch**Tools Required:**

- Clutch Spring Compressor T65L-77515-A
- Forward Clutch Outer Lip Seal Protector T68P-7D158-A

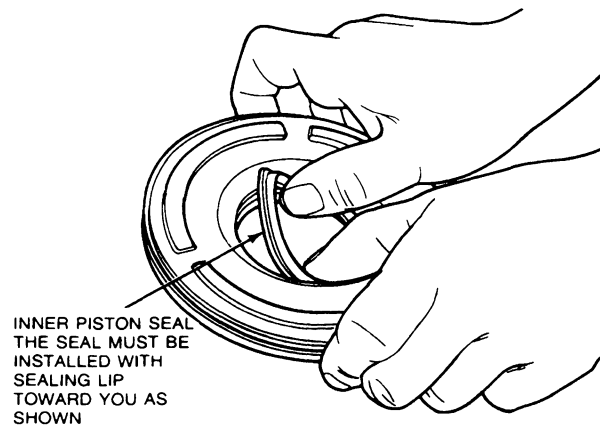
- Forward Clutch Inner Lip Seal Protector T80L-77140-A
- Forward Clutch Spring Compressor Extension T80L-77515-A
- Air Nozzle TOOL-7000-DE

Assembly

1. Install new seals on the clutch piston. Note the direction of the sealing lip before installation.



D3250-C

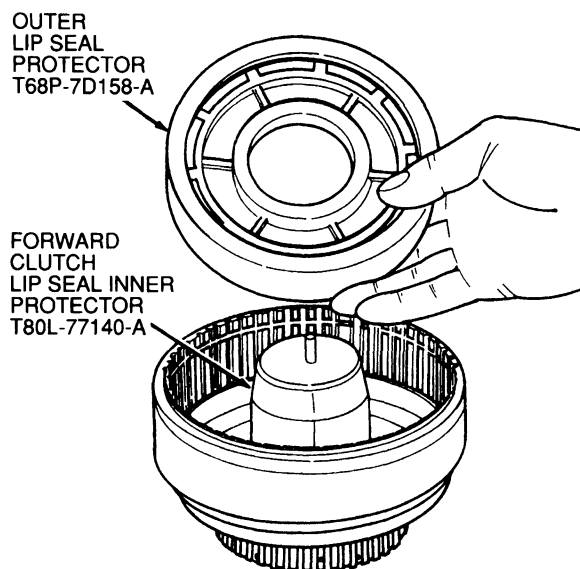


D4969-B

2. Install the clutch piston as follows:
- Coat the piston seals and the clutch drum sealing area with petroleum jelly.
 - Install the Forward Clutch Inner Lip Seal Protector T80L-77140-A over the clutch cylinder hub.

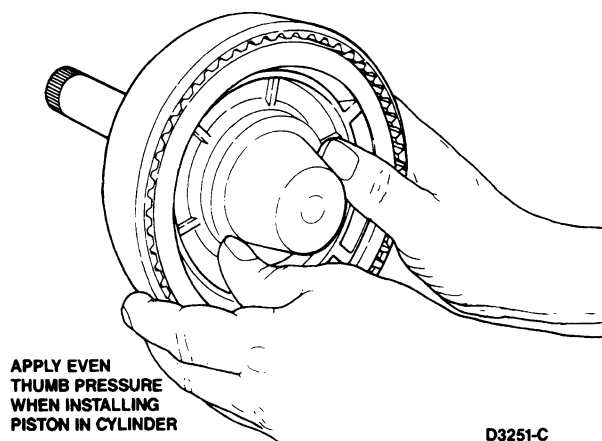
ASSEMBLY (Continued)

- c. Install the piston in the Outer Lip Seal Protector, T68P-7D158-A.



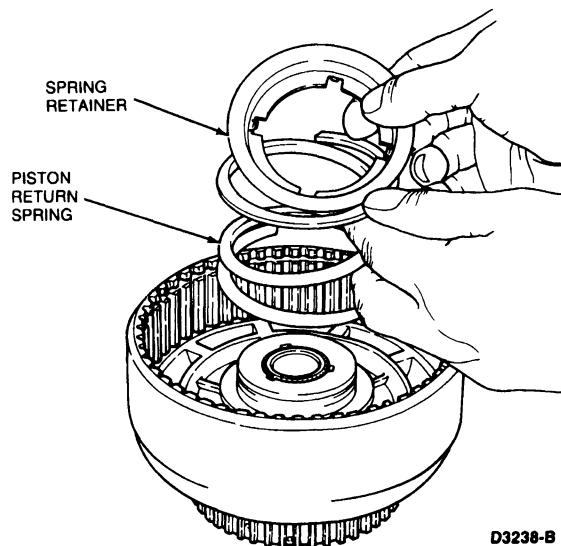
D4970-D

- d. Position the seal protector and piston in the clutch drum. Push the piston to the bottom of the drum using even thumb pressure.



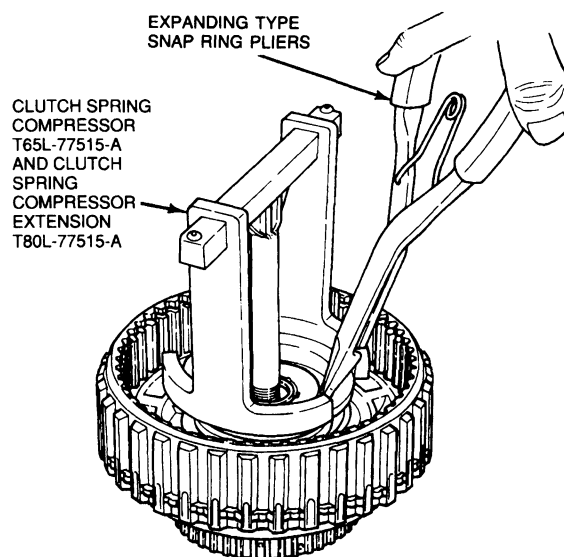
D3251-C

3. Install the piston return spring, the spring retainer and the retaining ring.



D3238-B

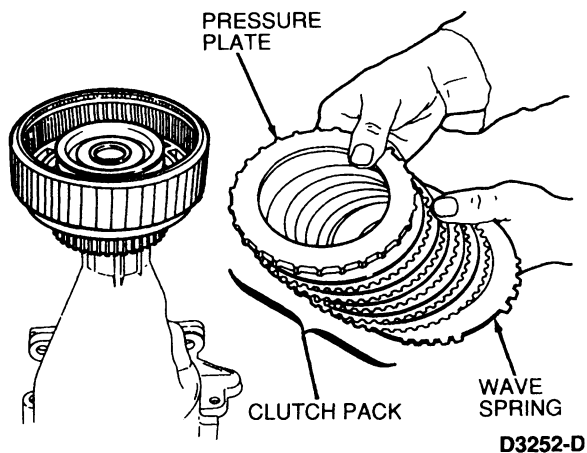
Compress the piston return spring using Clutch Spring Compressor T65L-77515-A and Forward Clutch Spring Compressor Extension T80L-77515-A.



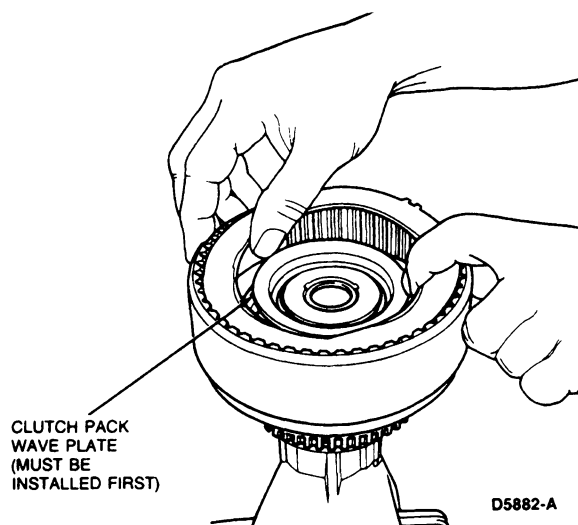
D4954-D

ASSEMBLY (Continued)

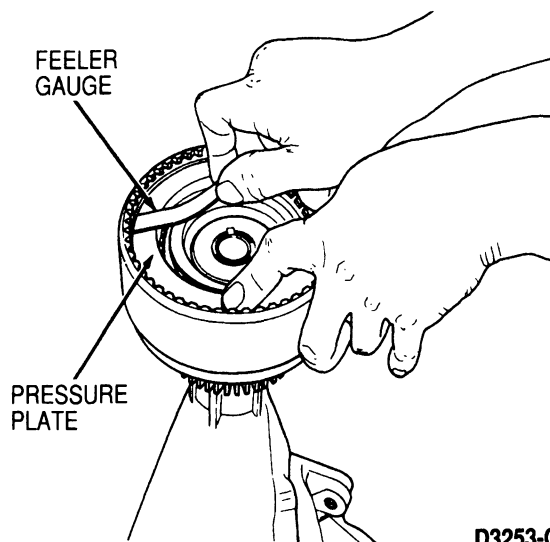
4. Install the clutch pack.



NOTE: The wave plate must be installed first.



5. Install the clutch pack retaining ring and check the clearance between the ring and the pressure plate using a feeler gauge. The pressure plate should be held downward as the clearance is checked.



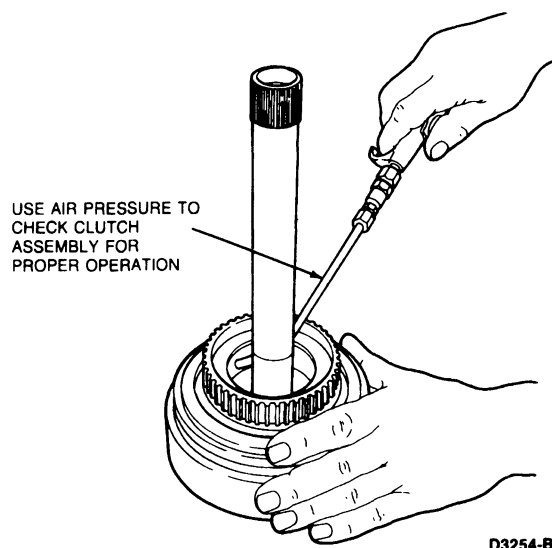
The clearance should be 1.27-2.26mm (0.050-0.089 inch)

If the clearance is not within specification, selective snap rings are available in the following thicknesses:

- 1.27-1.37mm (0.060-0.064 inch).
- 1.87-1.98mm (0.074-0.078 inch).
- 2.23-2.33mm (0.088-0.092 inch).
- 2.59-2.69mm (0.102-0.106 inch).

Install the correct size snap ring and recheck the clearance.

6. Check the clutch for proper operation using Air Nozzle TOOL-7000-DE or equivalent. The clutch should be heard and felt to apply smoothly and without leakage.



**Reverse Clutch
Tools Required:**

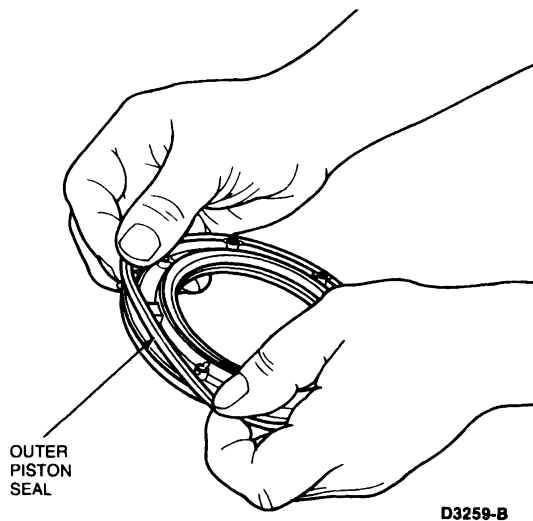
ASSEMBLY (Continued)

- Clutch Spring Compressor T65L-77515-A
- Reverse Clutch Outer Seal Protector T80L-77403-A
- Reverse Clutch Inner Seal Protector T80L-77403-B
- Reverse Clutch Spring Compressor Plate T80L-77405-A
- Air Nozzle TOOL-7000-DE

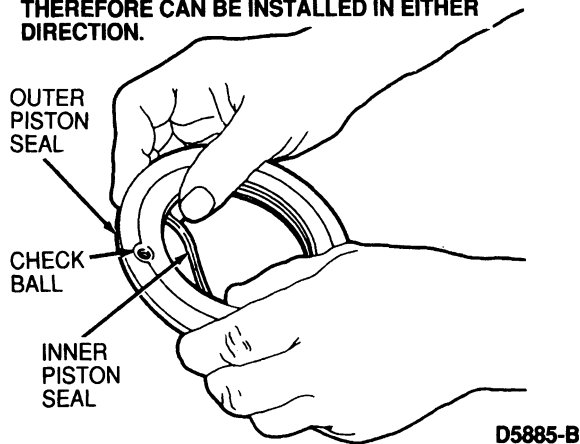
Assembly

1. Install new seals on the clutch piston. Because the seals are square cut, the direction of installation is not important.

NOTE: The piston check ball must be present and moving freely.



NOTE: THE SEALS ARE SQUARE AND THEREFORE CAN BE INSTALLED IN EITHER DIRECTION.

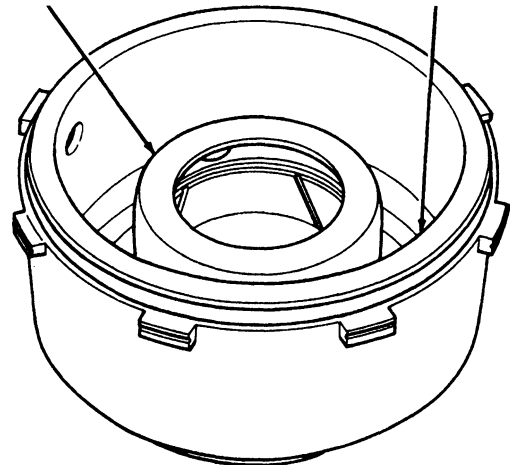


2. Install the clutch piston as follows:

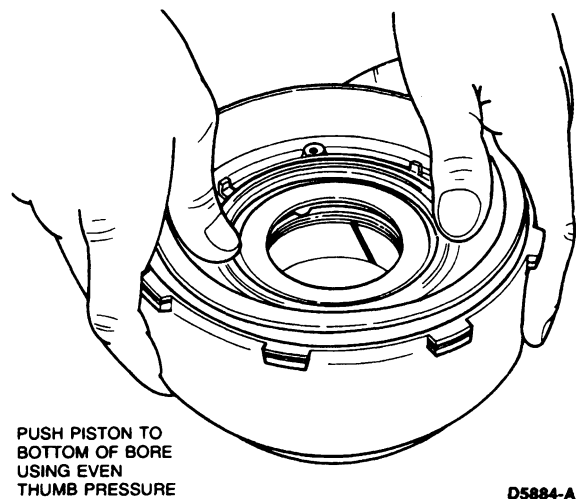
- a. Coat the piston seals and clutch drum sealing area with petroleum jelly.
- b. Install Reverse Clutch Inner Seal Protector T80L-77403-B and Reverse Clutch Outer Seal Protector T80L-77403-A in the clutch drum.

REVERSE CLUTCH
INNER SEAL
PROTECTOR
T80L-77403-B

REVERSE CLUTCH
OUTER SEAL
PROTECTOR
T80L-77403-A

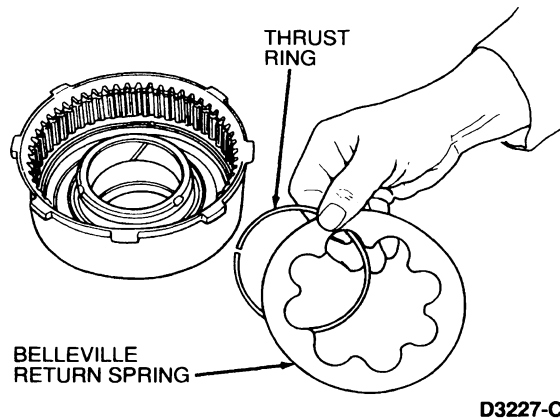


- c. Coat the piston seals, the clutch drum sealing area and the seal protector with petroleum jelly.
- d. Position the piston and push it to the bottom of the drum using even thumb pressure.

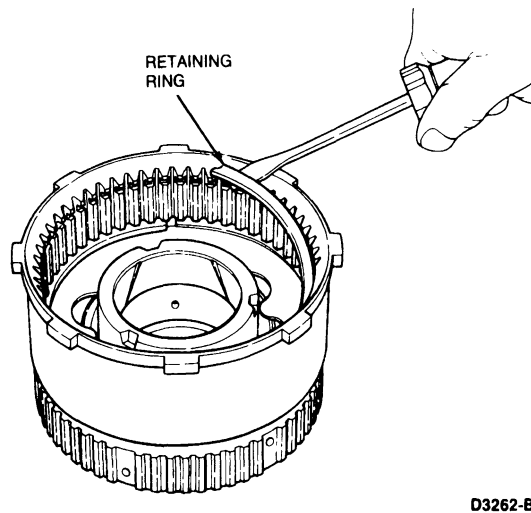


ASSEMBLY (Continued)

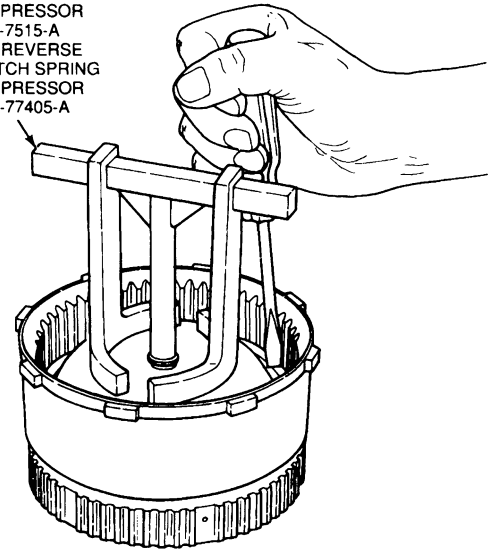
3. Install the piston thrust ring and the piston return spring.



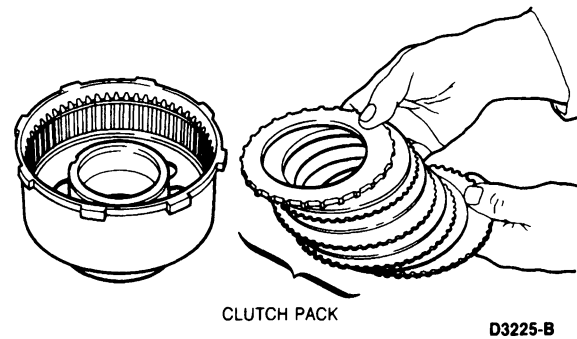
4. Install the wave snap ring (with points down) using Clutch Spring Compressor T65L-77515-A and Reverse Clutch Spring Compressor T80L-77405-A.



CLUTCH SPRING COMPRESSOR
T65L-7515-A
AND REVERSE
CLUTCH SPRING COMPRESSOR
T80L-77405-A

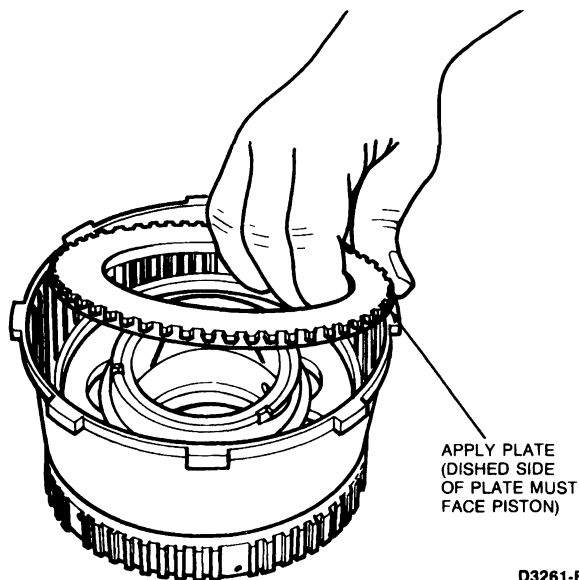


5. Install the clutch pack.



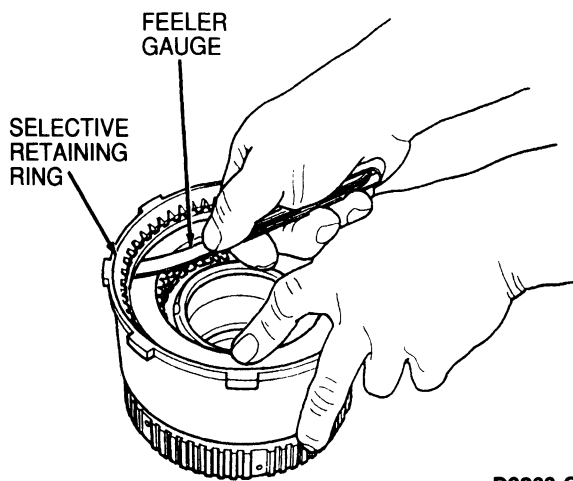
ASSEMBLY (Continued)

NOTE: The apply plate must be installed first. Note that the dished side of the plate must face the piston.



D3261-B

6. Install the clutch pack retaining ring and check the clearance between the ring and the pressure plate using a feeler gauge. The pressure plate should be held downward as the clearance is checked.



D3263-C

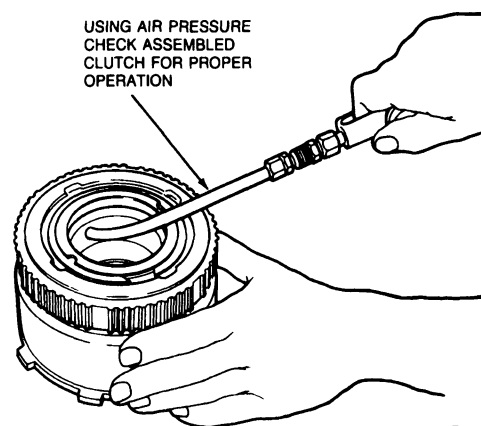
The clearance should be 1.02-1.91mm (0.040-0.075 inch).

If the clearance is not within specification, selective snap rings are available in the following thicknesses:

- 1.27-1.37mm (0.060-0.064 inch).
- 1.87-1.98mm (0.074-0.078 inch).
- 2.23-2.33mm (0.088-0.092 inch).
- 2.59-2.69mm (0.102-0.106 inch).

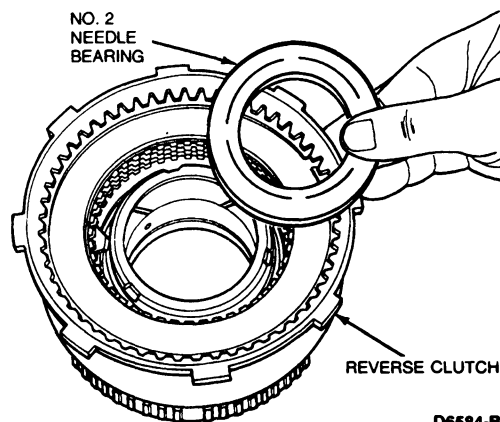
Install the correct size snap ring and check the clearance.

7. Check the clutch for proper operation using Air Nozzle TOOL-7000-DE or equivalent. The clutch should be heard and felt to apply smoothly and without leakage.



D3264-B

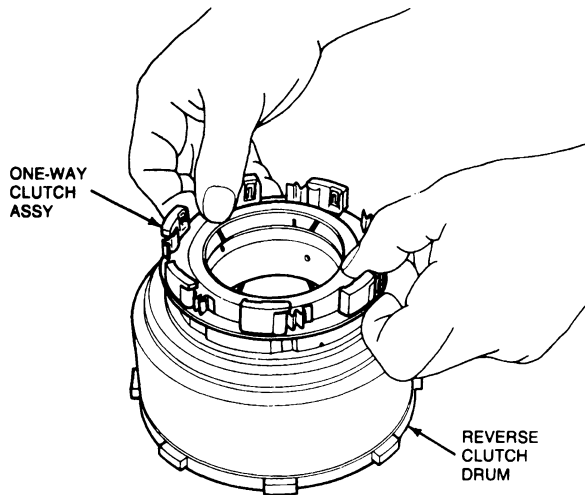
8. Install the No. 2 needle bearing.



D6584-B

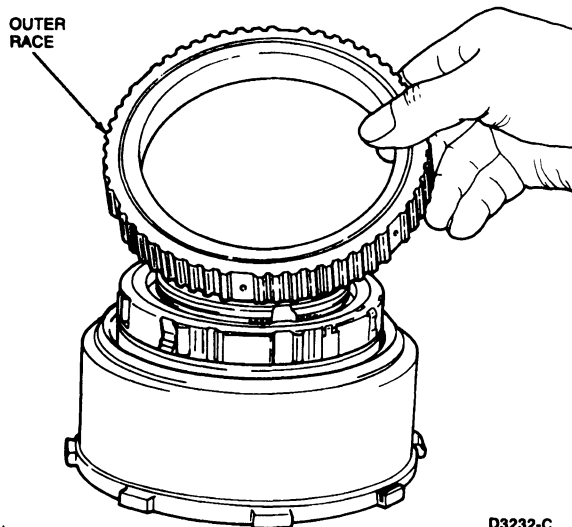
ASSEMBLY (Continued)**Intermediate One-Way Clutch****Assembly**

1. Install one-way clutch to inner race.



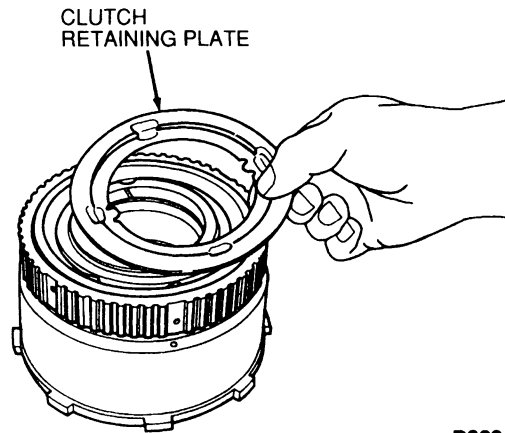
D3233-B

2. Install clutch outer race on clutch while turning counterclockwise.



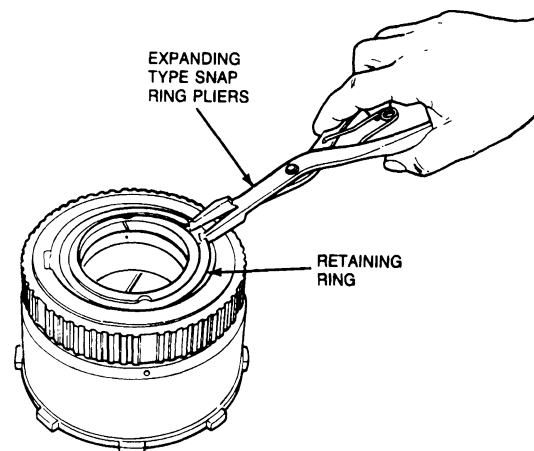
D3232-C

3. Install clutch retaining plate.



D3231-C

4. Using snap ring pliers, install retaining ring.



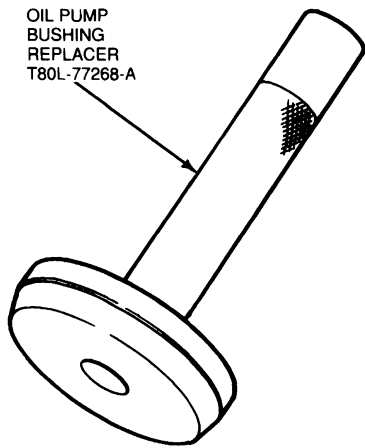
D3230-B

Pump Bushing**Tools Required:**

- Oil Pump Bushing Replacer T80L-77268-A

ASSEMBLY (Continued)**Installation**

Install the bushing using Oil Pump Bushing Replacer T80L-77268-A.



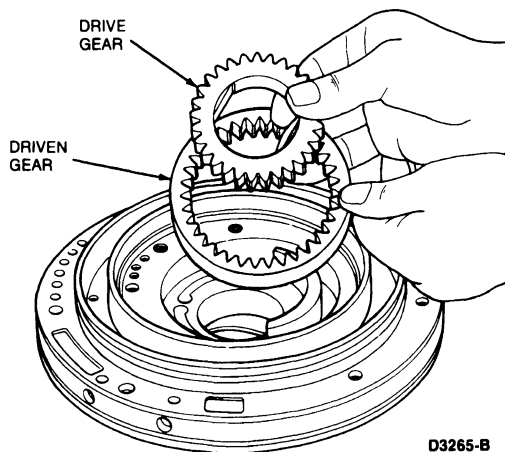
D4974-C

Pump and Intermediate Clutch Piston**Tools Required:**

- Lip Seal Protector T80L-77005-A

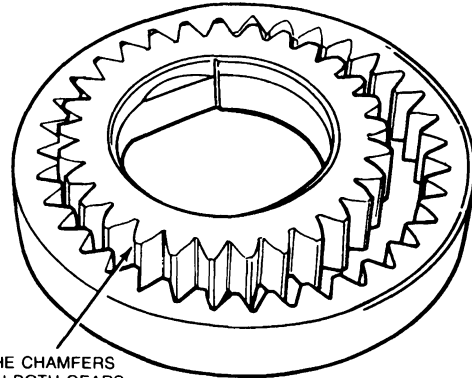
Assembly

1. Install the drive and driven pump gears in the pump body.



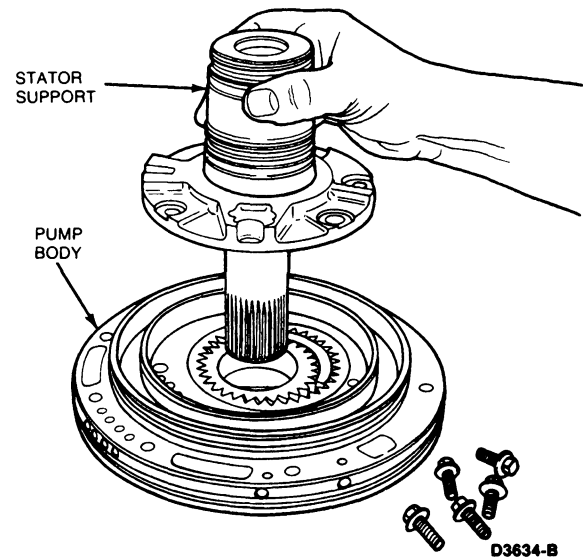
D3265-B

NOTE: Chamfers on both gears face into the pump body.



D6313-A

2. Position the stator support to the pump body and install the retaining bolts. Tighten to 16-22 N-m (12-16 lb-ft).

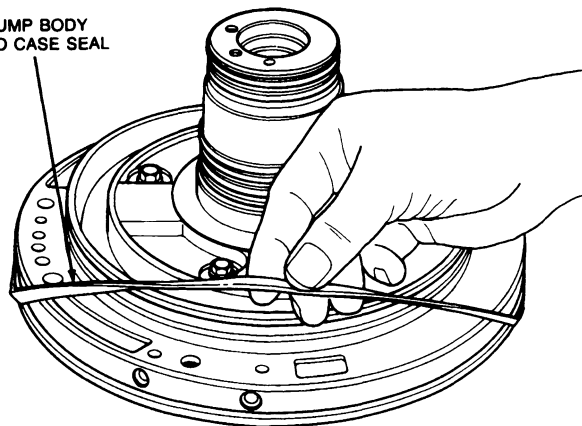


D3634-B

ASSEMBLY (Continued)

3. Install new pump-to-case seal.

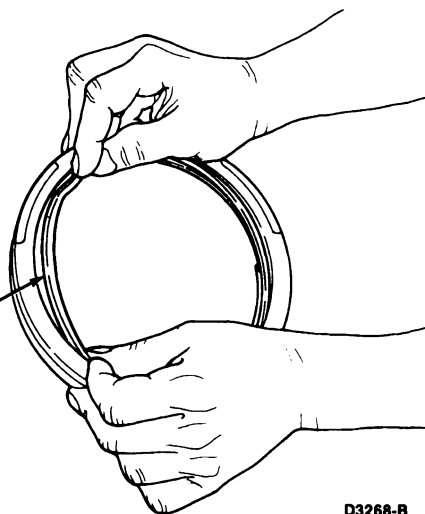
PUMP BODY
TO CASE SEAL



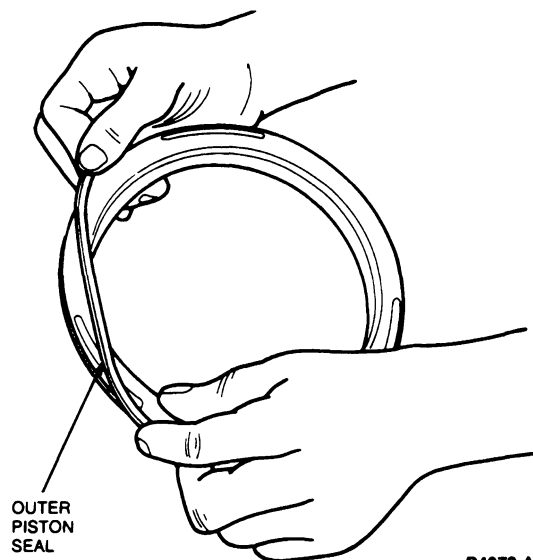
D3267-B

4. Install new seals on the clutch piston. Note the direction of the sealing lip before installation. The lips point away from the spring posts.

INNER
PISTON
SEAL



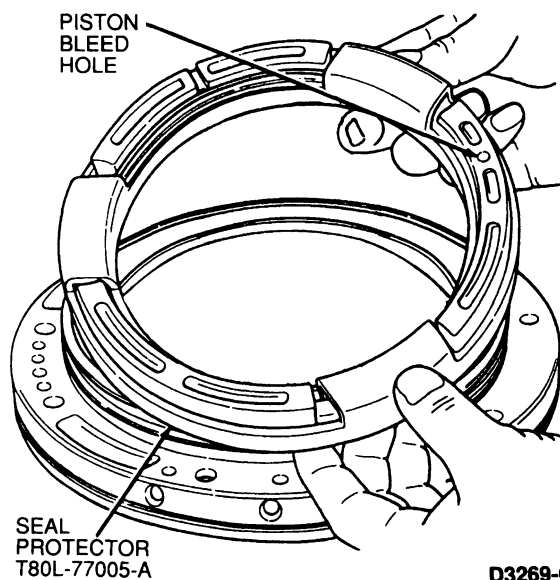
D3268-B



D4972-A

5. Install the clutch piston as follows:
- Coat the piston seals and the pump body sealing area with petroleum jelly.
 - Install the piston in Lip Seal Protector T80L-77005-A.

PISTON
BLEED
HOLE

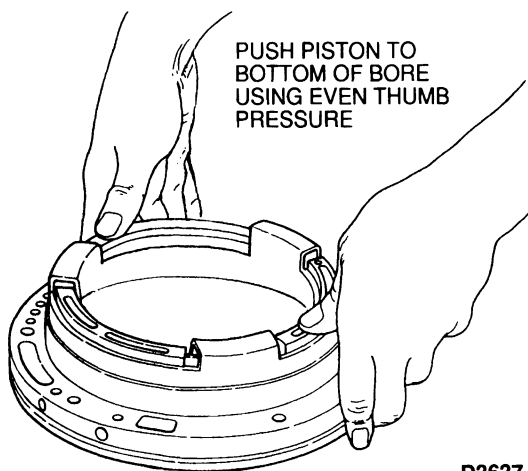


D3269-C

ASSEMBLY (Continued)

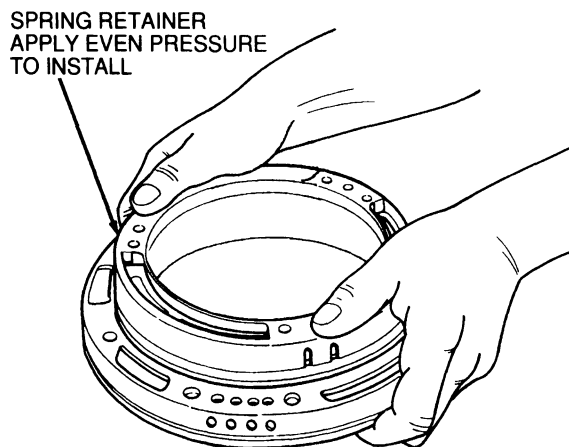
- c. Install the piston in the pump body and push to the bottom of the bore by exerting even thumb pressure on the piston.

CAUTION: The piston bleed hole must be located at 12 o'clock position (toward top of transmission).



D3637-C

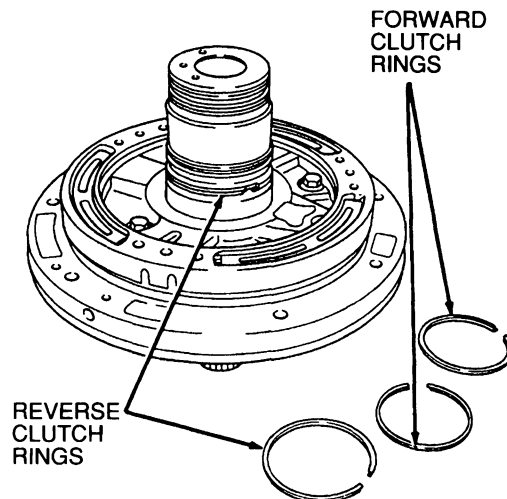
6. Snap the spring retainer assembly into place on the pump body. Use even pressure.



D3270-C

7. Install the pump seal rings.

NOTE: Stator support seal rings are the largest rings and are for the reverse clutch. These rings are closest to the pump. Stator support seal rings are for the forward clutch. These rings are farthest from the pump body.



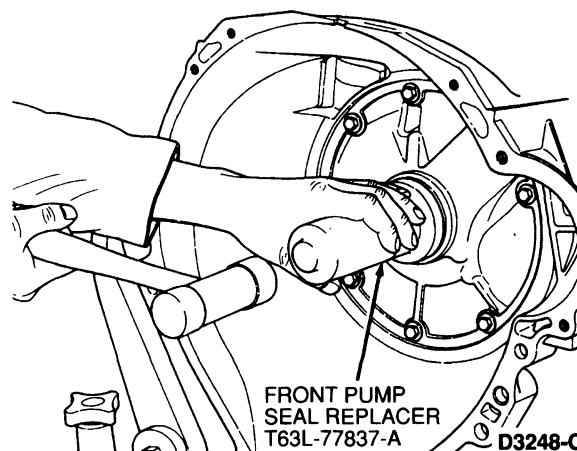
D3633-E

Pump Seal**Tools Required:**

- Front Pump Seal Replacer T63L-77837-A

Installation

Install the seal using Front Pump Seal Replacer T63L-77837-A.



D3248-C

Case Bushing**Tools Required:**

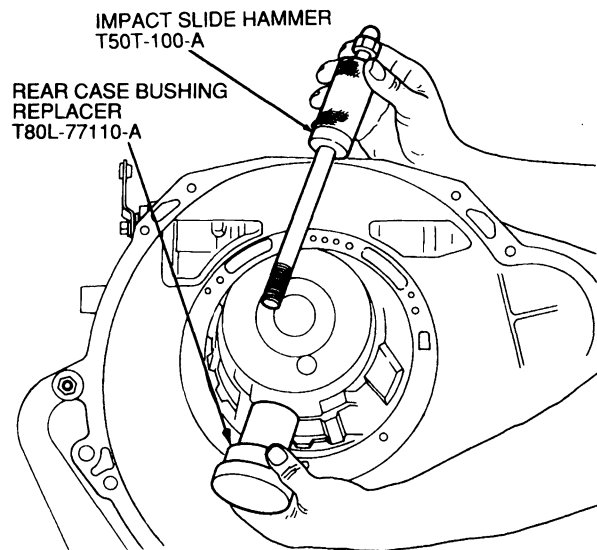
- Thread Impact Slide Hammer T50T-100-A
- Rear Case Bushing Replacer T80L-77110-A

Installation

1. Position the replacement bushing on Rear Case Bushing Replacer T80L-77110-A and install in the bushing bore through the front of the case.

ASSEMBLY (Continued)

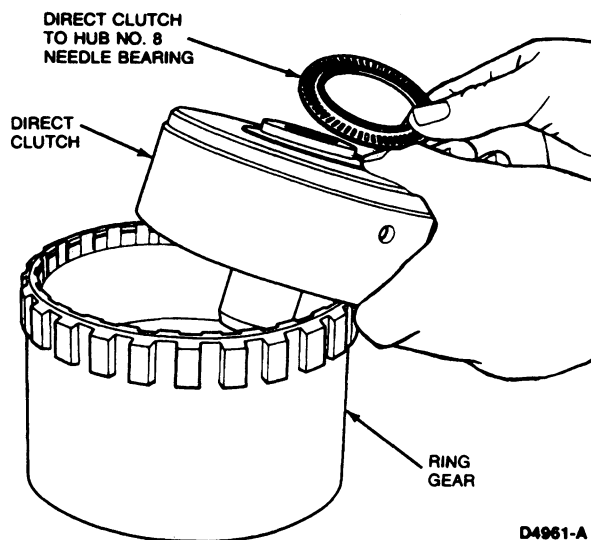
2. Thread Impact Slide Hammer T50T-100-A into the bushing installer through the back of the case and install the bushing.



D3349-D

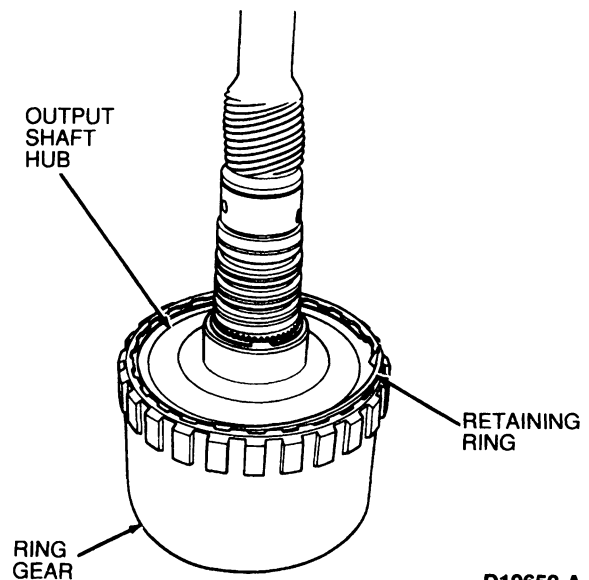
Transmission, Assembly

1. Install the output shaft needle bearing No. 9 in the transmission case.
2. Install the No. 8 needle bearing to the back of the direct clutch drum.



D4961-A

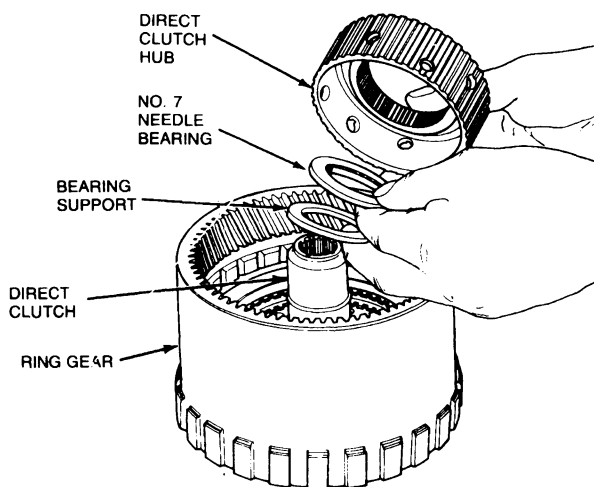
3. Install direct clutch on output shaft.
4. Install output shaft ring gear over top of direct clutch onto output shaft hub. Lock into place with snap ring.



D10652-A

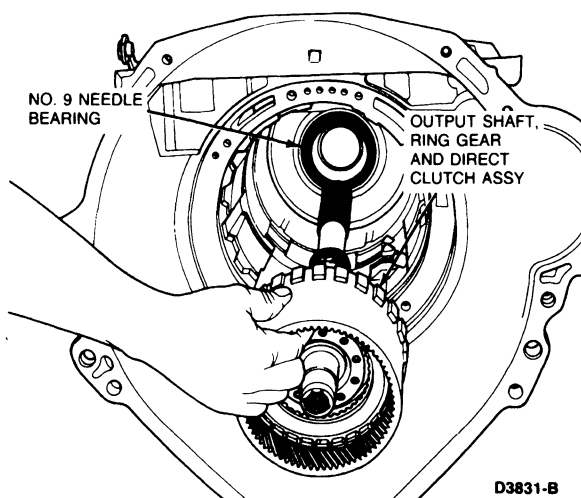
ASSEMBLY (Continued)

5. Install the bearing support, No. 7 needle bearing and direct clutch hub in the direct clutch.



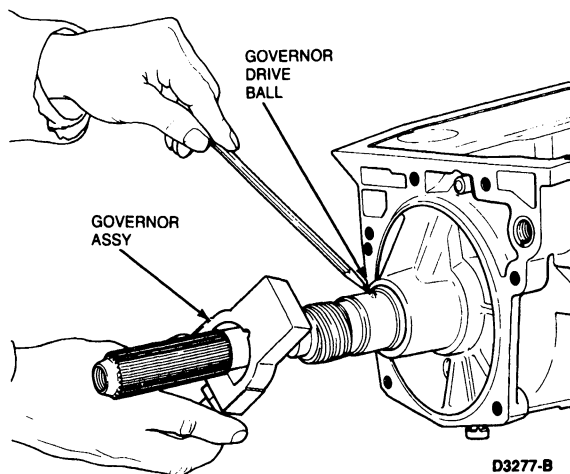
D3276-C

6. Install the output shaft, the ring gear and the direct clutch as an assembly.



D3831-B

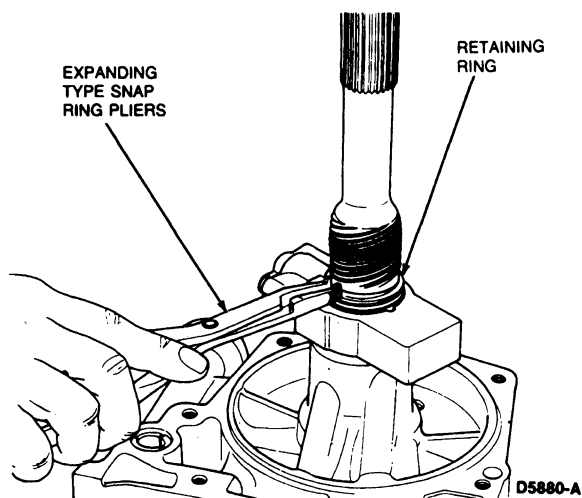
7. Install the governor drive ball and the governor assembly.



D3277-B

NOTE: Ensure that the face of the governor body is about flush with the counterweight. The cover and retaining screws must face toward the case (forward).

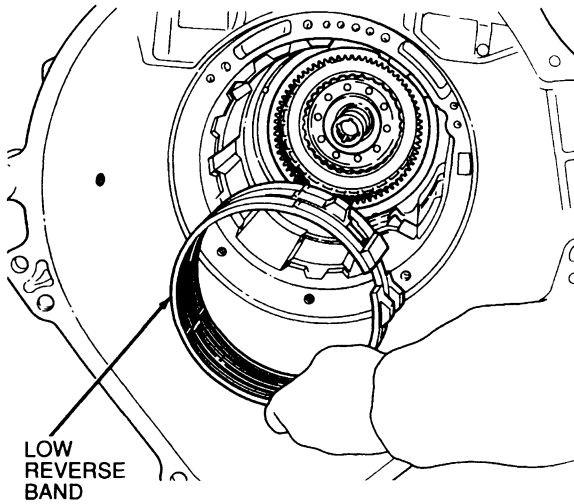
8. Install the governor retaining ring.



D5880-A

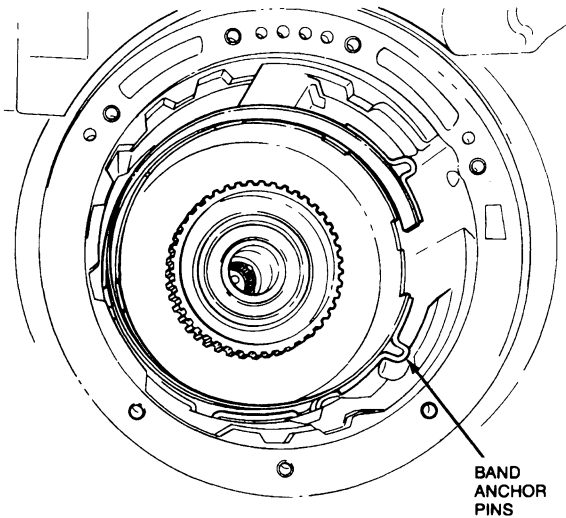
ASSEMBLY (Continued)

9. Install the low / reverse band.



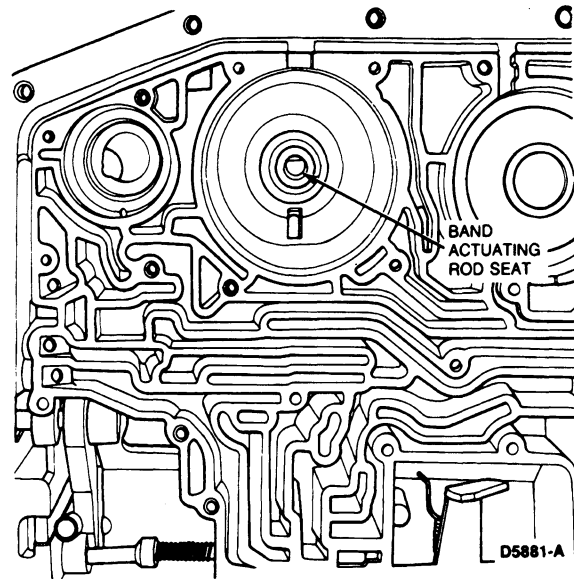
D3183-C

NOTE: Ensure the band is seated on the anchor pins.



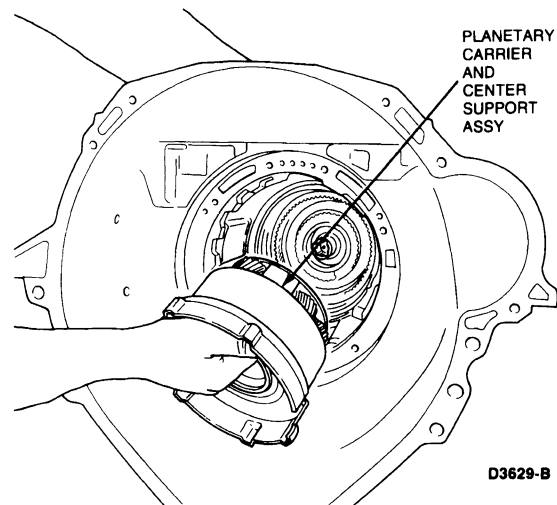
D8835-A

NOTE: When properly installed, the center of the band actuating rod seat can be seen through the servo piston bore.



D5881-A

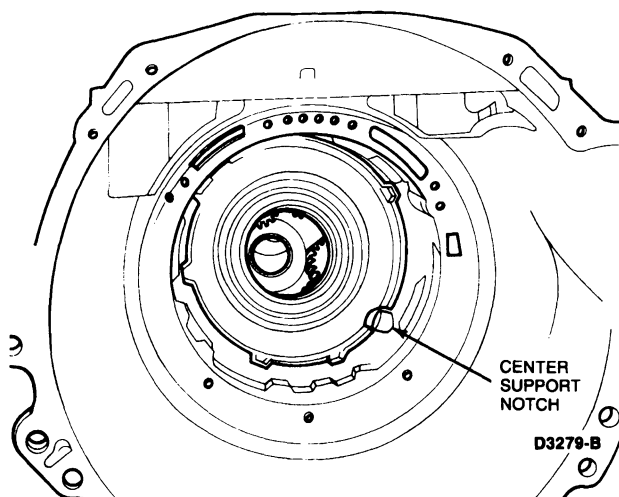
10. Install the center support and planetary assembly. Rotate the output shaft, if necessary, to align the planet carrier splines with the direct clutch hub splines.



D3629-B

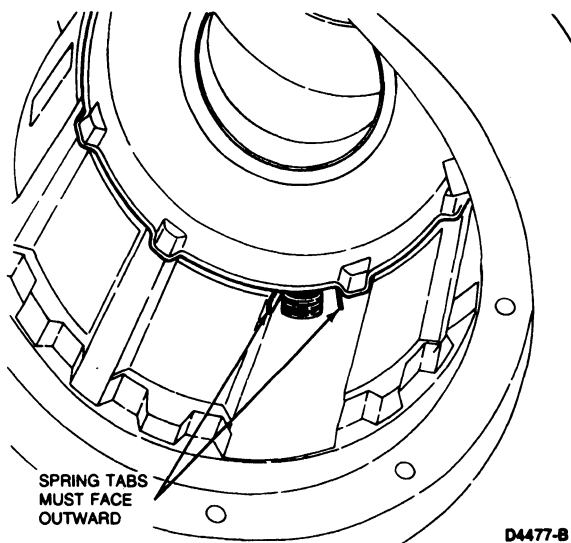
ASSEMBLY (Continued)

NOTE: The planetary carrier and center support assembly cannot be installed unless the notch cut in the center support is aligned with the overdrive band anchor pin.

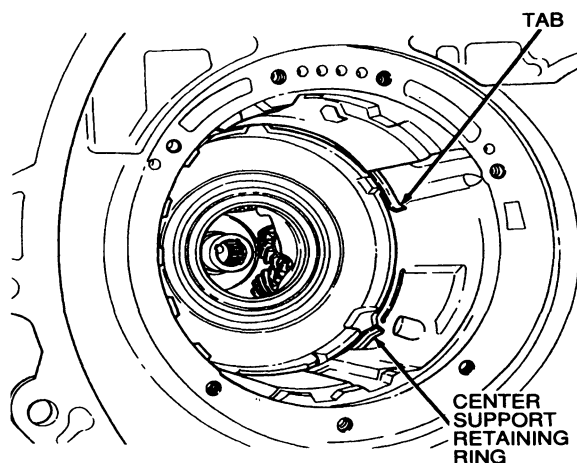


11. Install the center support anti-clunk spring using a hammer handle or wooden dowel.

NOTE: Spring tabs must face outward.

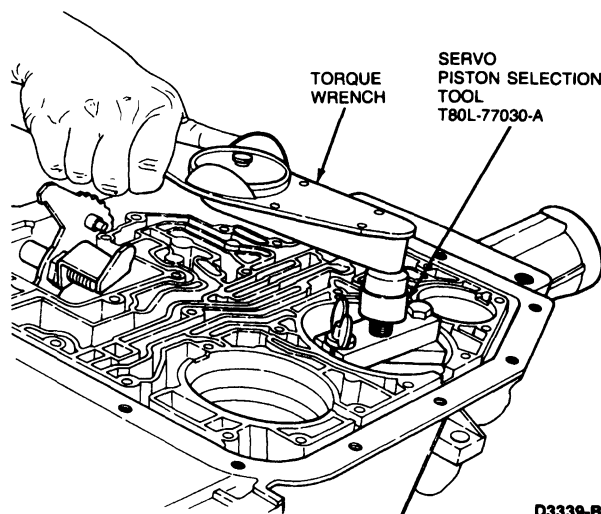


12. Install the center support retaining ring.



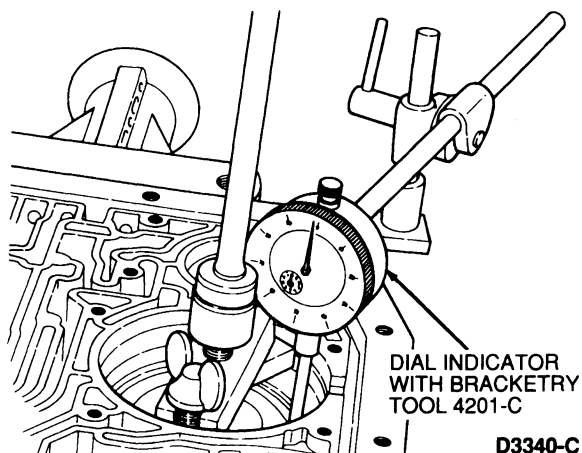
D3180-C

13. To determine the correct length of the low / reverse servo piston, proceed as follows:
- Lubricate the low / reverse piston seal to facilitate assembly and to prevent damage to the seal.
 - Install the low / reverse servo piston and return spring. Do not install the piston cover or retaining ring.
 - Install Servo Piston Selection Tool T80L-77030-A. Tighten the band apply bolt on Servo Piston Selection Tool T80L-77030-A to 5.6 N·m (50 lb-in).



ASSEMBLY (Continued)

- d. Attach Dial Indicator with Bracketry TOOL-4201-C or equivalent and position the indicator stem on the flat portion of the piston. Zero the dial indicator.



- e. Thread the bolt out of the selector tool until the piston stops against the bottom of the tool.
- f. Read the amount of piston travel on the dial indicator.
- If the travel is 2.845-6.020mm (0.112-0.237 inch), the piston length is within specification.
 - If the travel is not within specification, selective pistons are available in the following lengths:

ID

74.56mm (2.936 inch) 1 groove

75.92mm (2.989 inch) 2 grooves

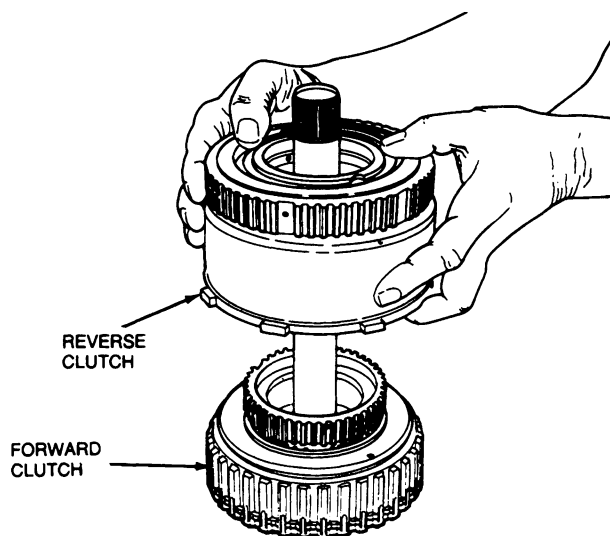
77.29mm (3.043 inch) 3 grooves

Length of rod measured from piston surface to end of rod.

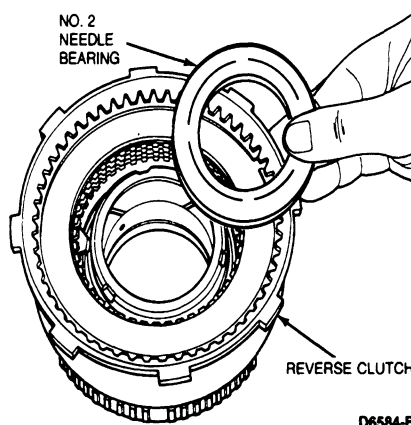
Select the proper rod to bring the servo piston travel within specification.

- g. Lubricate the cover seal to facilitate assembly and to prevent damage to the seal.

- h. Remove the servo selection tool and dial indicator.
- i. Install the servo cover and retaining ring.
14. Install the reverse clutch on the forward clutch.

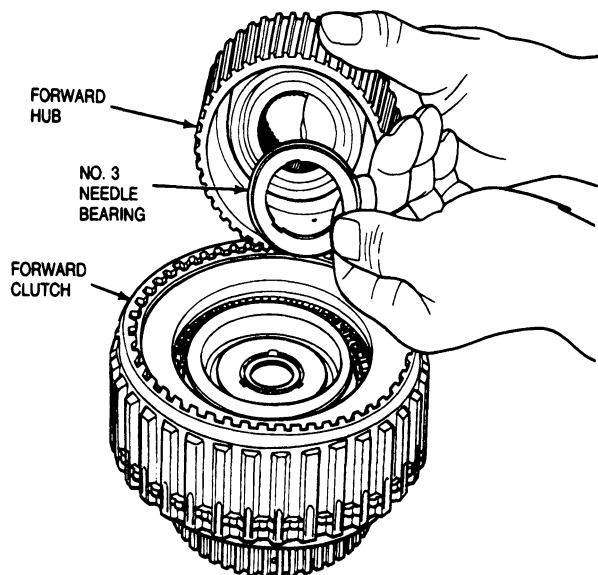


NOTE: Ensure the No. 2 needle bearing is in position.



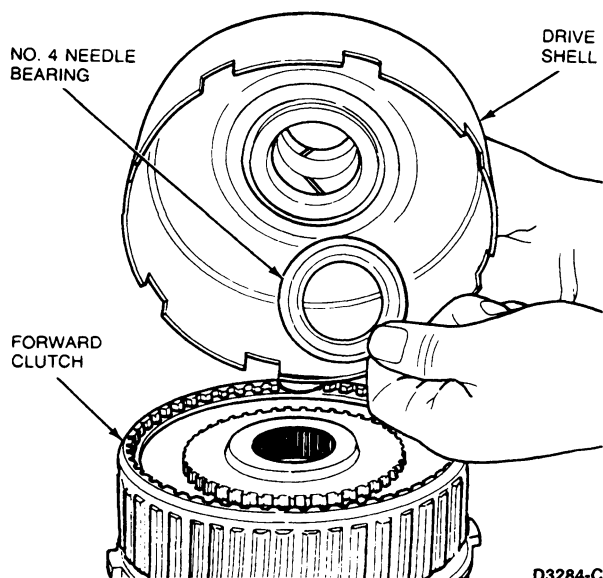
ASSEMBLY (Continued)

15. Install the No. 3 needle bearing and forward clutch hub in the forward clutch.



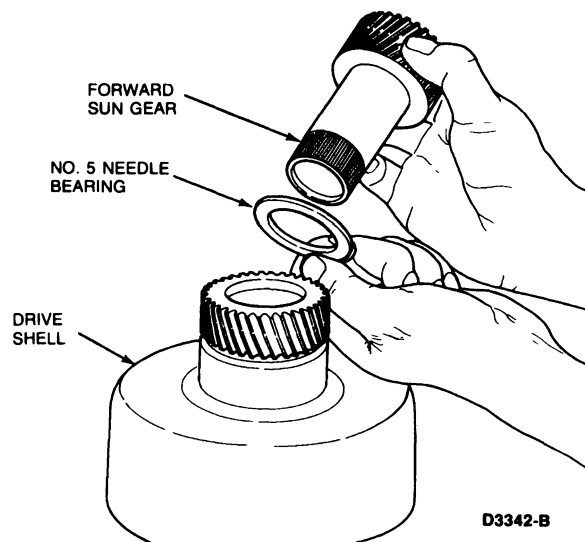
D3832-C

16. Position the No. 4 needle bearing on the forward clutch hub and install the drive shell.



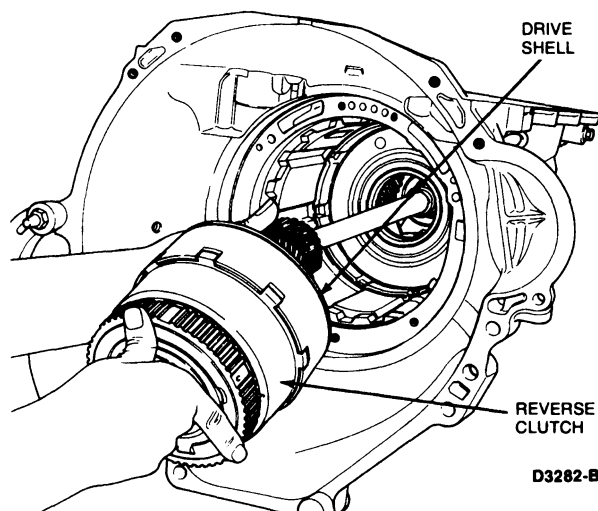
D3284-C

17. Install the No. 5 needle bearing and forward sun gear on the drive shell.



D3342-B

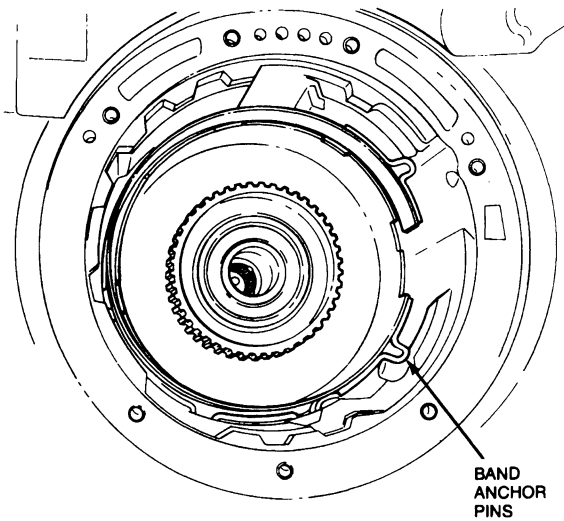
18. Install the drive shell, forward clutch and reverse clutch as an assembly. Rotate the output shaft, as necessary, to aid the engagement of the sun gear with the planetary gears.



D3282-B

ASSEMBLY (Continued)

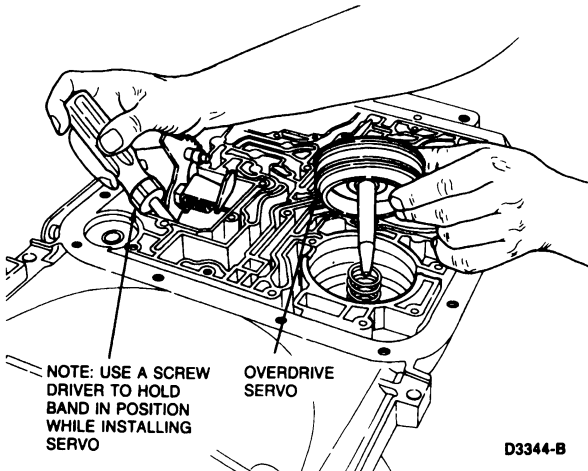
19. Install the overdrive band. Make sure the band anchor is properly positioned on the anchor pin.



D8835-A

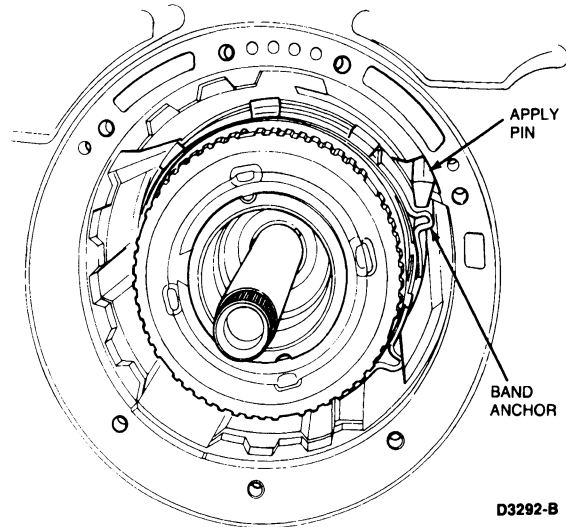
20. Lubricate the overdrive servo cover seals to facilitate assembly and to prevent damage to the seal.

21. Install the overdrive servo.



D3344-B

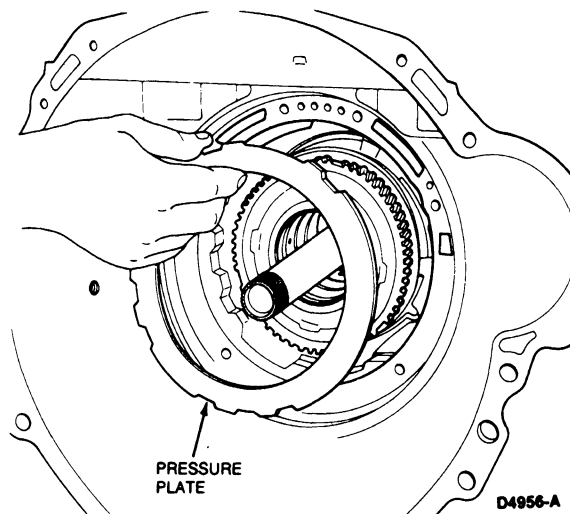
22. With the overdrive servo installed, inspect the apply pin and band for proper position and engagement. If the band anchor and apply pin are not properly engaged, remove the servo and reposition the band as necessary.



D3292-B

23. Install the intermediate clutch pack components in the following order:

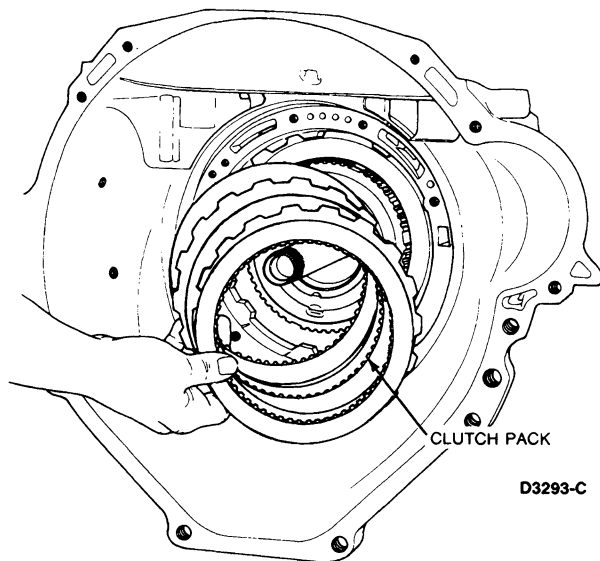
- a. Pressure plate.



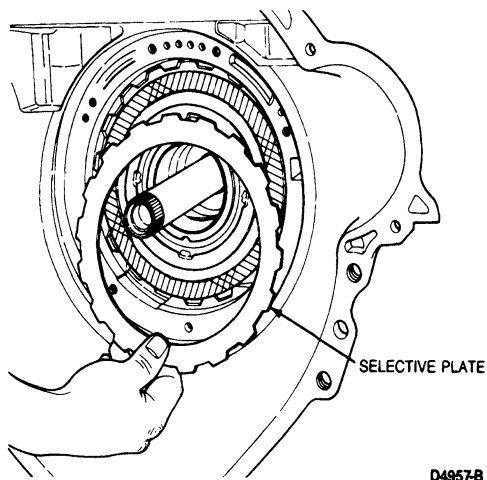
D4956-A

ASSEMBLY (Continued)

b. Clutch pack.



c. Selective steel plate.



NOTE: Maintain a downward pressure on the clutch pack while measuring depth.

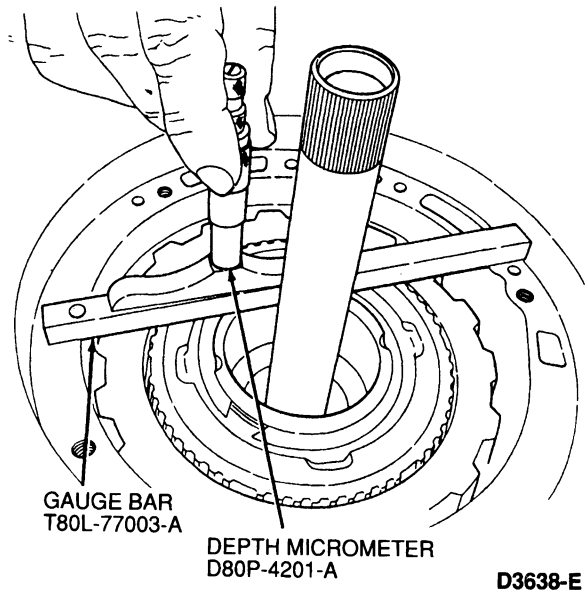
24. Measure the intermediate clutch clearance using a Depth Micrometer D80P-4201-A and Gauge Bar T80L-77003-A or equivalent. Set the end play tool across the pump case mounting. Locate the micrometer end play gauge bar and read the depth. The depth at the intermediate clutch separator plate is 41.5-41.8mm (1.634-1.636 inches).

Check the clearance again 180 degrees opposite to ensure the average depth is within tolerance.

If the depth is not within tolerance, the following size selective steel separator plates are available:

- 1.80-1.7mm (0.071-0.067 inch).
- 2.05-1.95mm (0.081-0.077 inch).
- 2.31-2.20mm (0.091-0.087 inch).
- 2.56-2.46mm (0.101-0.097 inch).

Install the correct plate and check the clearance.

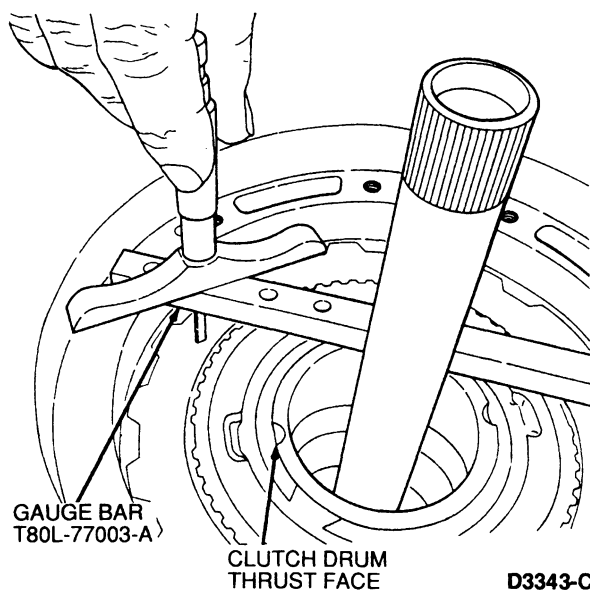


25. Position the Depth Micrometer D80P-4201-A on Gauge Bar T80L-77003-A so that the depth is measured at the reverse clutch drum thrust face. Check the end play 180 degrees opposite to determine the average depth. The following chart shows the proper selective thrust washer for various depth measurements.

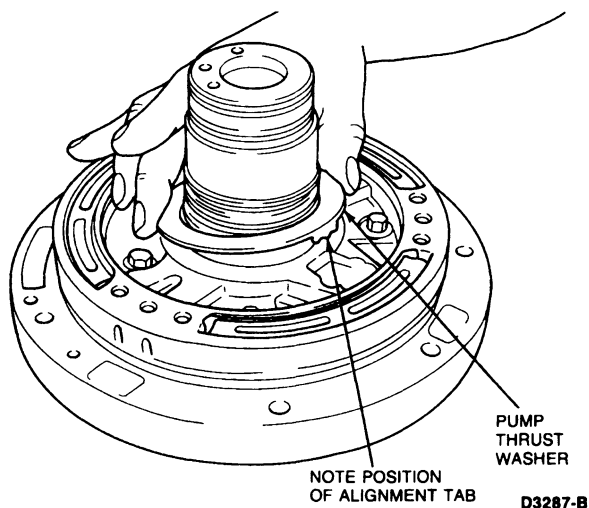
Depth	Washer No.	Washer Size	Washer Color
37.668-38.113mm (1.483-1.500 inch)	1	1.27-1.37mm (0.050-0.054 inch)	Green
38.114-38.540mm (1.501-1.517 inch)	2	1.72-1.82mm (0.068-0.072 inch)	Yellow
38.541-38.970mm (1.518-1.534 inch)	3	2.15-2.16mm (0.085-0.089 inch)	Natural
38.971-39.408mm (1.535-1.551 inch)	4	2.59-2.67mm (0.102-0.106 inch)	Red
39.409-39.827mm (1.552-1.568 inch)	5	3.02-3.12mm (0.119-0.123 inch)	Blue

TD3840C

ASSEMBLY (Continued)

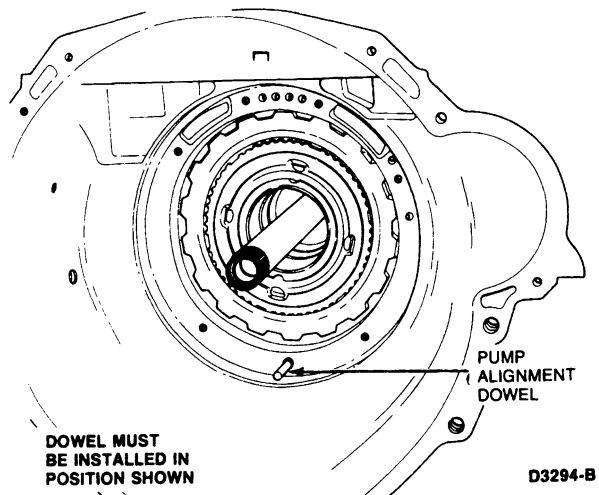


26. Install the selective washer determined in Step 20 on the pump. Use petroleum jelly to hold it in place.

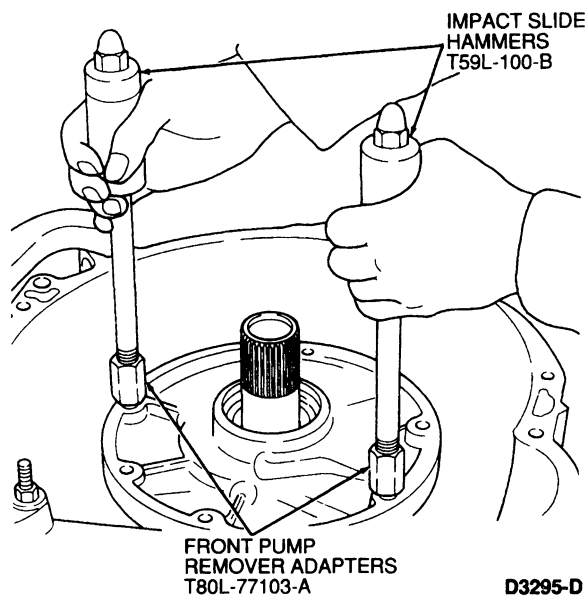


27. Install pump alignment dowel. The alignment dowel can be fabricated by removing the head from a M8-1.25 bolt. Install the dowel only a few threads in the position shown.

28. Install a new pump gasket.

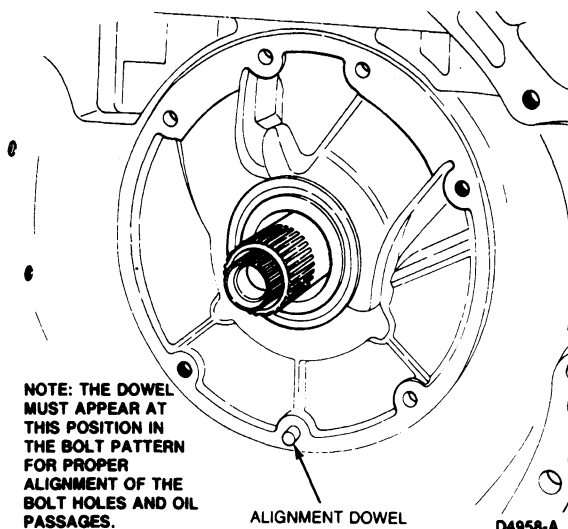


29. Using Impact Slide Hammer T59L-100-B and Pump Puller Adapters T89T-70010-A, lower the pump assembly into the case.



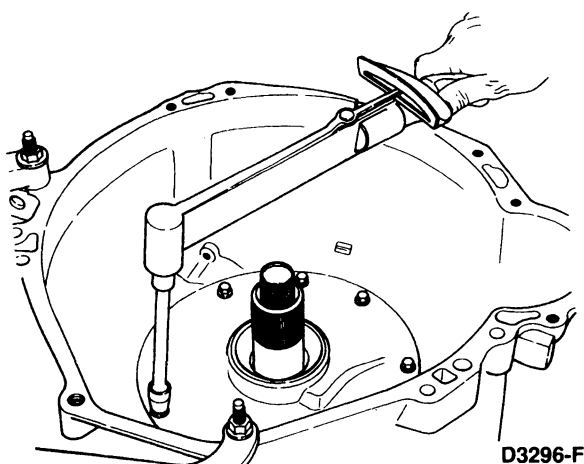
ASSEMBLY (Continued)

NOTE: The dowel must appear at this position in the bolt pattern for proper alignment of the bolt holes and oil passages.

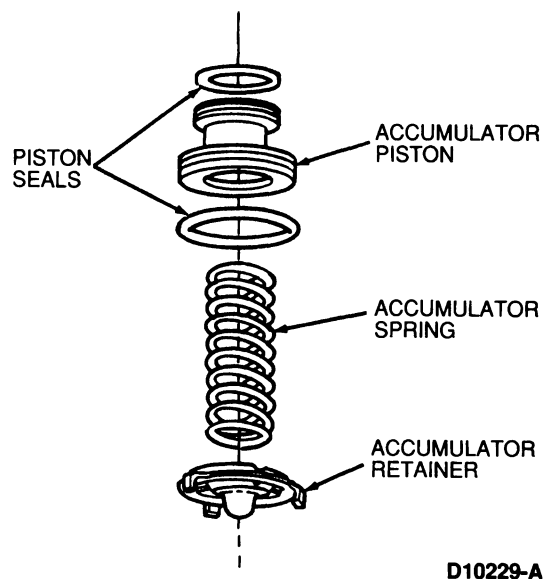


NOTE: Clean seven retaining bolts with a wire brush to remove loose particles of sealant. Apply a coating of Threadlock and Sealer EOAZ-19554-AA (ESE-M4G204-A) or equivalent, to bolt threads before reinstallation.

30. Remove the alignment dowel and install the seven pump retaining bolts. Alternately tighten the bolts a few turns at a time to draw the pump into the case. Tighten the retaining bolts to 22-27 N-m (16-20 lb-ft).

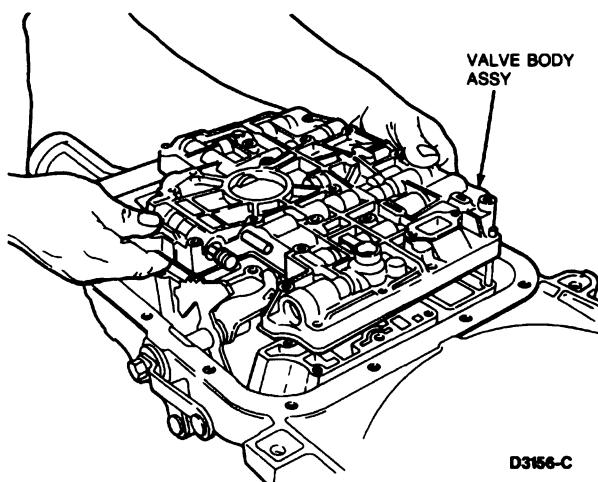


31. Assemble the 2-3 accumulator.



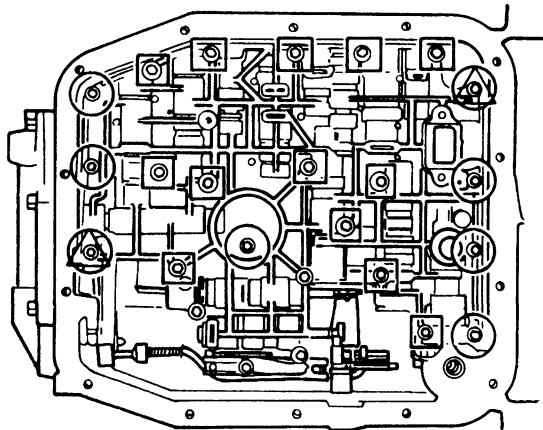
32. Install a new valve body gasket and the valve body assembly.

NOTE: Ensure the manual and throttle levers are properly positioned before installing the valve body retaining bolts.



ASSEMBLY (Continued)

33. Install two shoulder bolts.



- INDICATES A SHORT BOLT
 □ INDICATES A LONGER BOLT
 △ INDICATES A SPECIAL SHOULDER BOLT

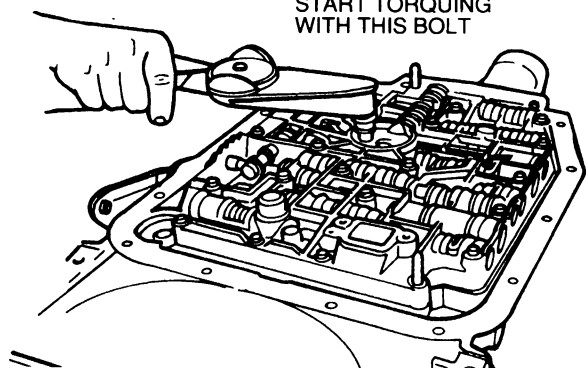
D10650-A

NOTE: Two different length bolts are used. The shorter bolts are used at the four front, one center and three rear locations. Refer to the illustration.

34. Loosely install valve body retaining bolts using an 8mm socket, starting at the center and working outward. Tighten bolts to 9-11 N·m (80-97 lb-in).

TIGHTEN THE ATTACHING BOLTS TO 9-11 N·m (80-97 IN-LB). START IN THE CENTER AND WORK OUTWARD.

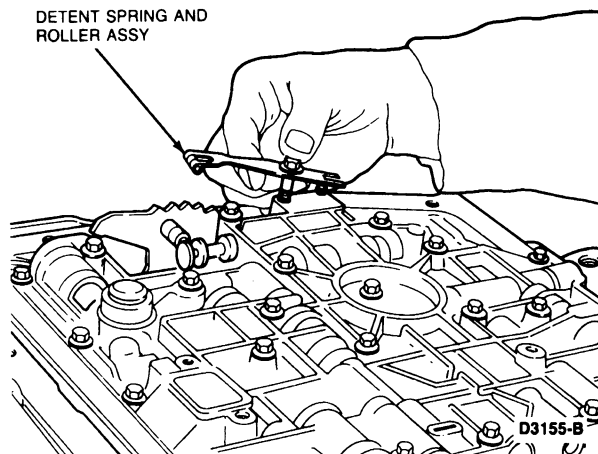
START TORQUING
WITH THIS BOLT



D10647-A

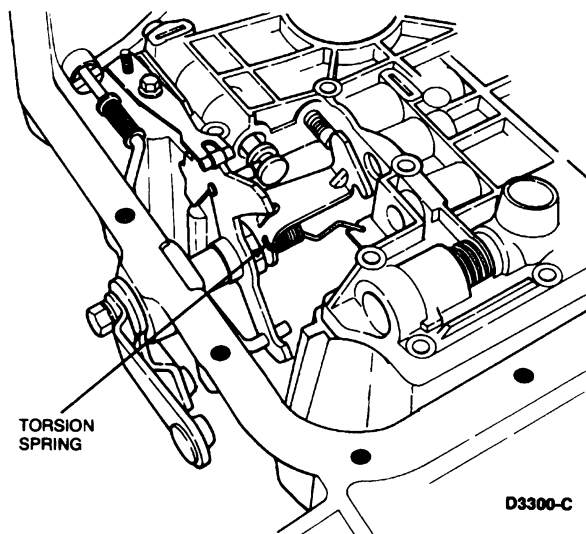
35. Install the detent spring and roller assembly (long bolt). Tighten the bolts to 9-11 N·m (80-97 lb-in).

DETENT SPRING AND
ROLLER ASSY



D3155-B

36. Position the TV lever torsion spring against the separator plate V-notch. This spring pushes the throttle lever in the direction of wide-open throttle.

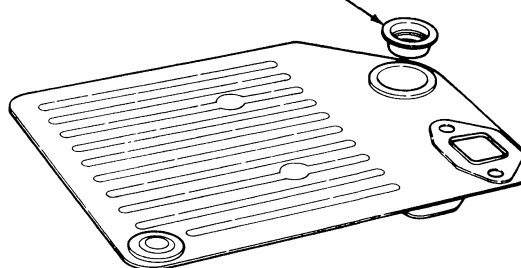


TORSION
SPRING

D3300-C

37. Install the filter grommet.

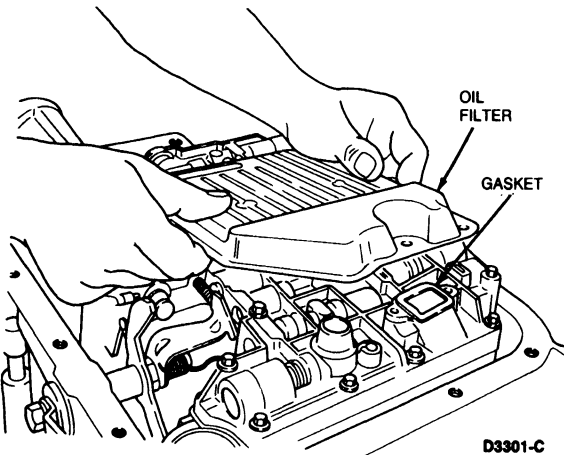
FILTER
GROMMET



D3311-B

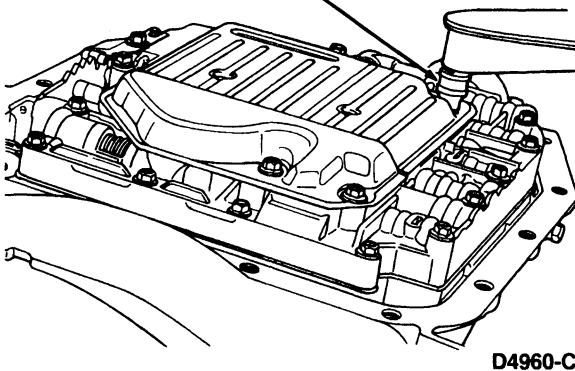
ASSEMBLY (Continued)

38. Install a new filter gasket and the filter on the valve body.

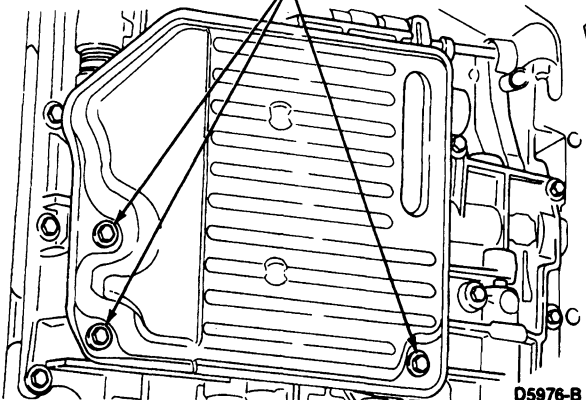


39. Install the filter retaining bolts. Tighten the retaining bolts to 9-14 N·m (80-123 lb-in).

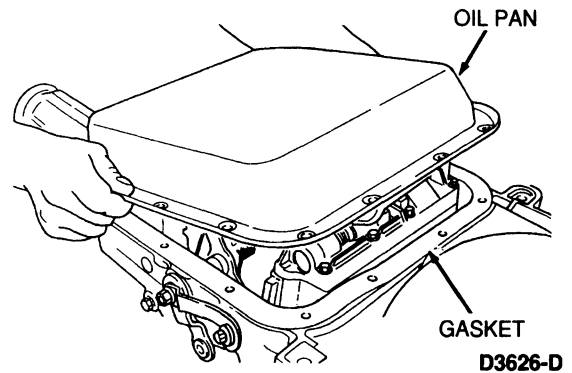
TIGHTEN RETAINING
BOLTS TO 9-14 N·m
(80-123 LB-IN)



FILTER RETAINING BOLTS

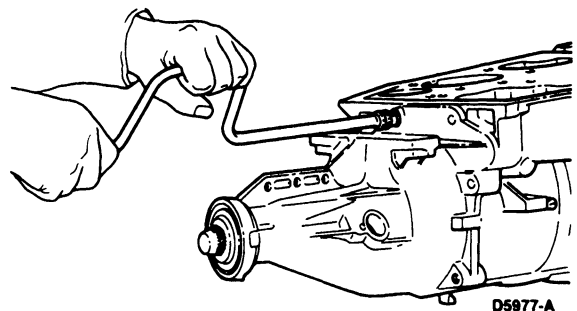
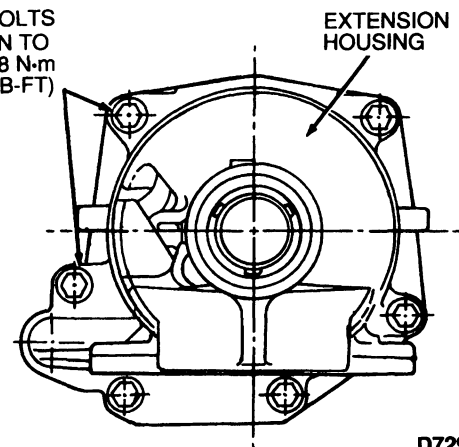


40. Install a new pan gasket and install the oil pan using a 10mm socket. Tighten the retaining bolts to 8-13.5 N·m (71-119 lb-in).



41. Clean the mounting surface on the transmission and on the extension housing. Remove any sealant from the bolts and the case bolt holes. Install stud bolt in hole 6. Position a new gasket on the transmission. Coat bolts with Threadlock and Sealant E0AZ-19554-AA (ESE-M4G204-A) or Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent. Tighten the retaining bolts to 24.3-29.8 N·m (18-22 lb-ft).

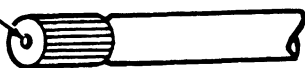
STUD BOLTS
TIGHTEN TO
24.3-29.8 N·m
(18-22 LB-FT)



ASSEMBLY (Continued)**42. Install the direct driveshaft.**

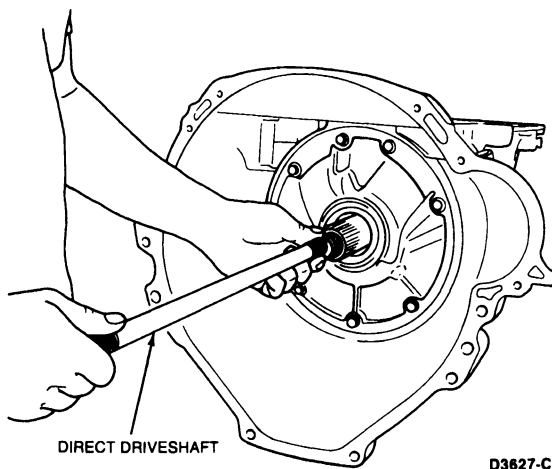
NOTE: Some models may have a yellow drill point on one end of the direct driveshaft. The end having the yellow drill point must face the converter.

YELLOW COLOR
DRILL POINT



THIS END TO
CONVERTER

D10649-A



DIRECT DRIVESHAFT

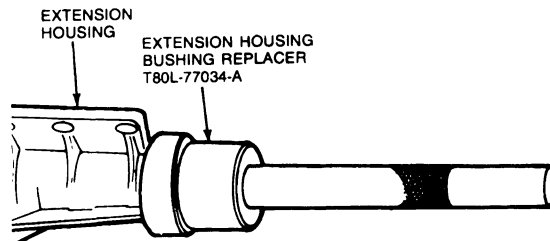
D3627-C

Extension Housing Bushing**Tools Required:**

- Extension Housing Bushing Replacer T80L-77034-A

Installation

1. Install the extension housing bushing using Extension Housing Bushing Replacer T80L-77034-A.
2. Install the extension housing seal as outlined.



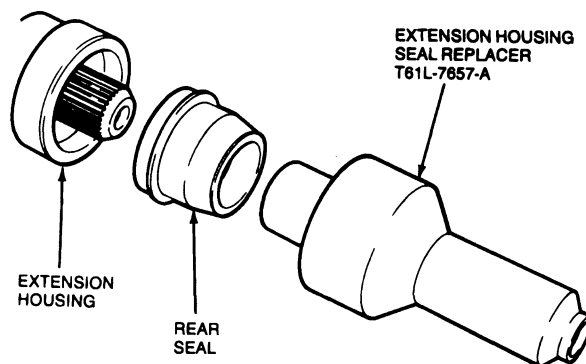
D3347-B

Extension Housing Seal**Tools Required:**

- Extension Housing Seal Replacer T61L-7657-A

Installation

Install the extension housing seal using Extension Housing Seal Replacer T61L-7657-A.

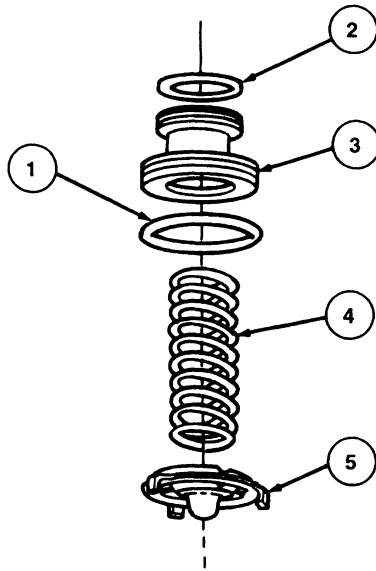


D2042-D

Accumulators and Servos**Disassembly and Assembly****2-3 Accumulator**

Install new seals on the accumulator piston and lubricate. Ensure the diagonal cuts are properly aligned.

ASSEMBLY (Continued)



D10229-B

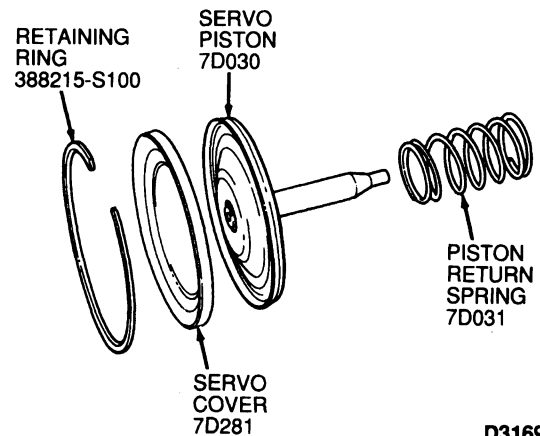
Item	Part Number	Description
1	7F249	2-3 Accumulator Valve Large Seal
2	7F250	2-3 Accumulator Valve Small Seal
3	7F251	2-3 Accumulator Valve
4	7F285	2-3 Accumulator Valve Return Spring
5	7B264	2-3 Accumulator Retainer

TD 10229B

Low-Reverse Servo

Inspect the sealing edge on both the servo cover and the apply piston. Replace the cover or piston, if necessary.

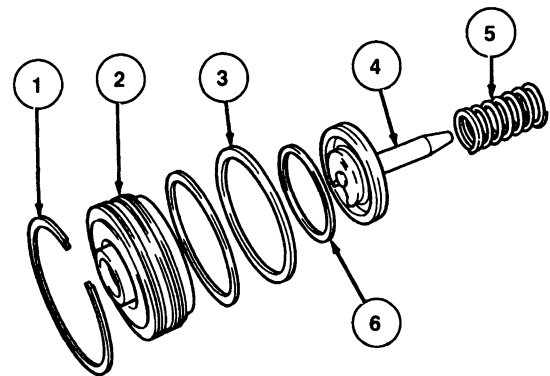
NOTE: The length of the rod attached to the piston may vary in length from transmission to transmission. Three possible lengths may be encountered. A single groove rod indicates the shortest possible length, while two and three groove piston rods indicate successively longer rods. For assembly purposes, it is important to determine which length piston rod was used in the manufacturing of the transmission.



D3169-C

Overdrive Servo

1. Pull the overdrive servo piston out of the piston cover.
2. Install new seals on the piston and cover.
3. Lubricate the piston seal with transmission fluid to prevent damage and to facilitate assembly.
4. Install the piston in the cover.

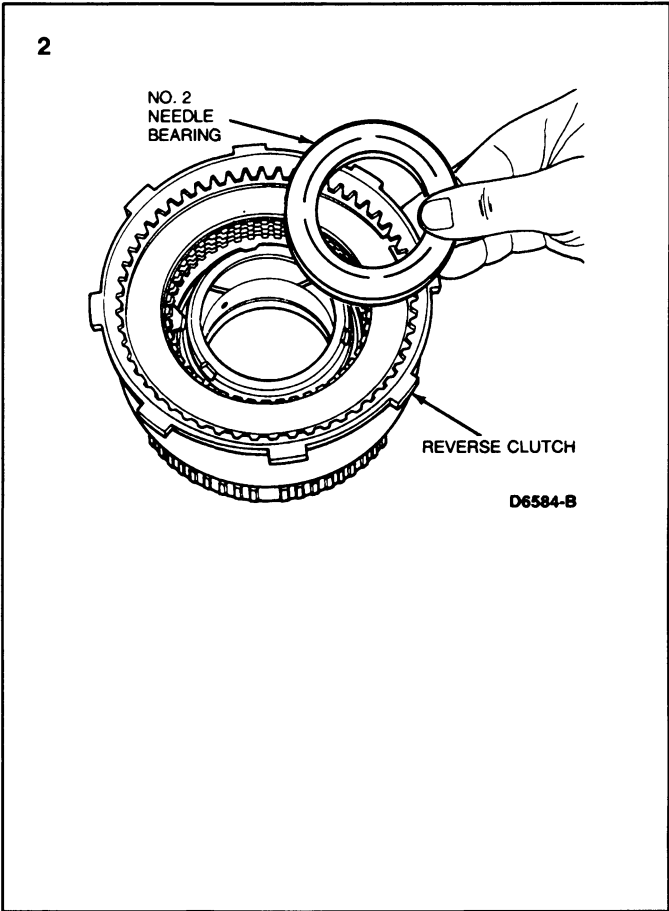
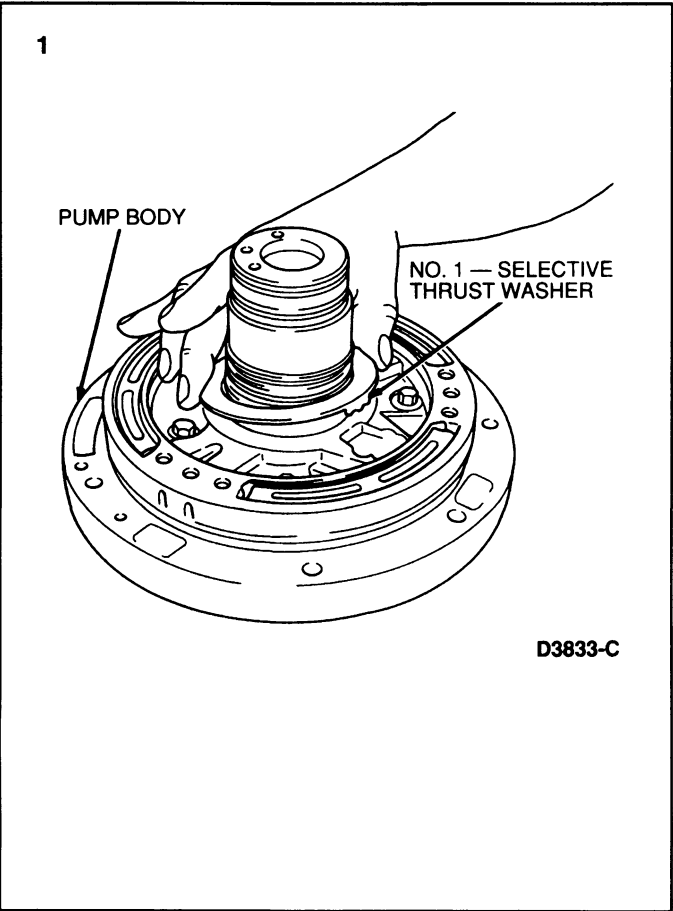
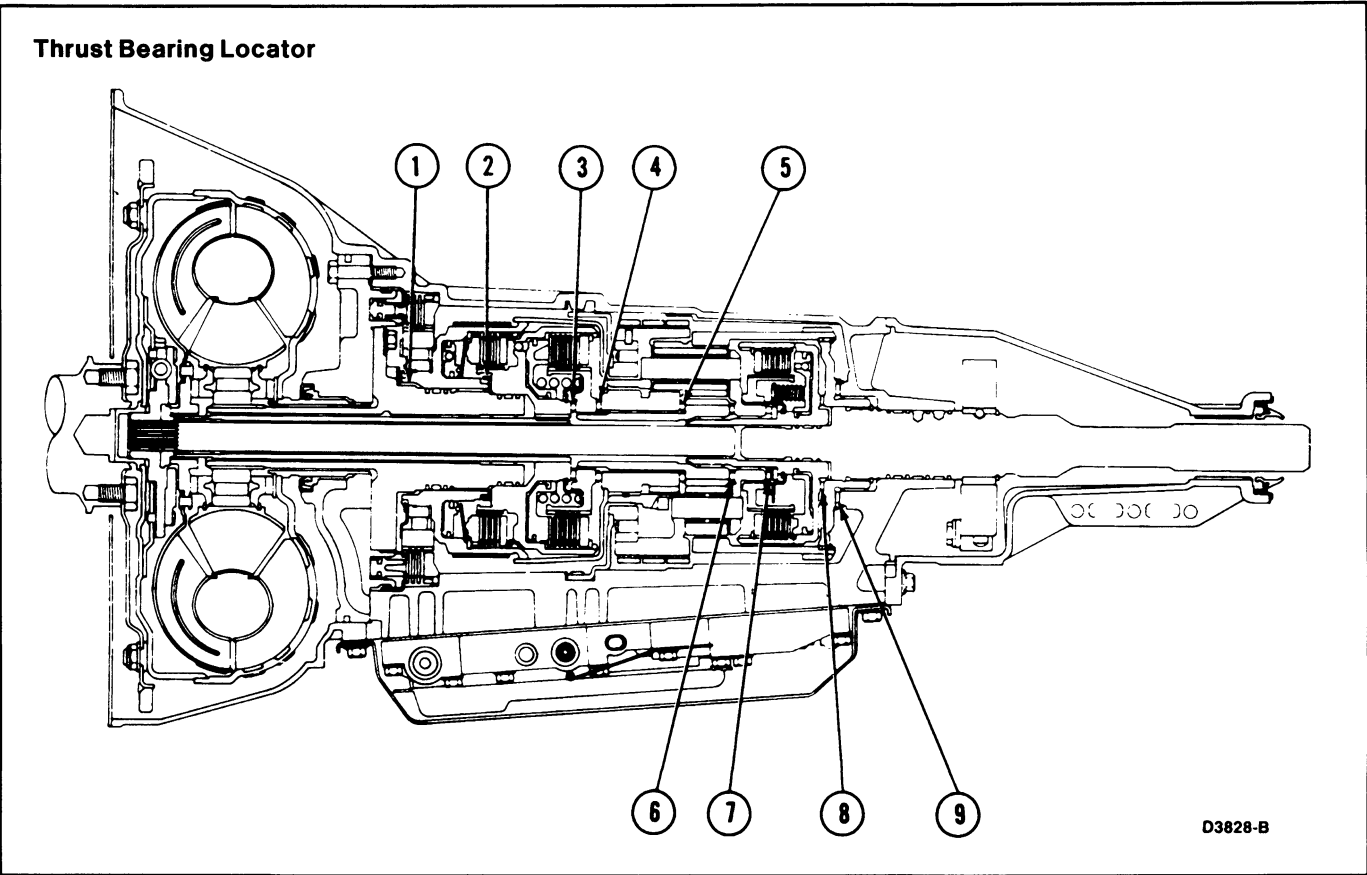


D3162-C

Item	Part Number	Description
1	388216	O/D Servo Retaining Ring
2	7F204	O/D Servo Cover
3	388515	O/D Servo Cover Seal Rings (2 Req'd)
4	7F200	O/D Servo Piston
5	7F201	O/D Servo Piston Return Spring
6	—	O/D Servo Piston Seal Ring, Part of 7F200 Servo Piston

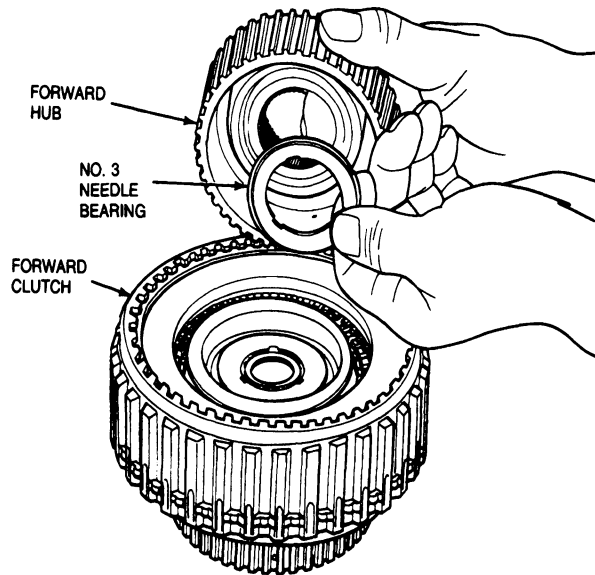
TD3162C

ASSEMBLY (Continued)



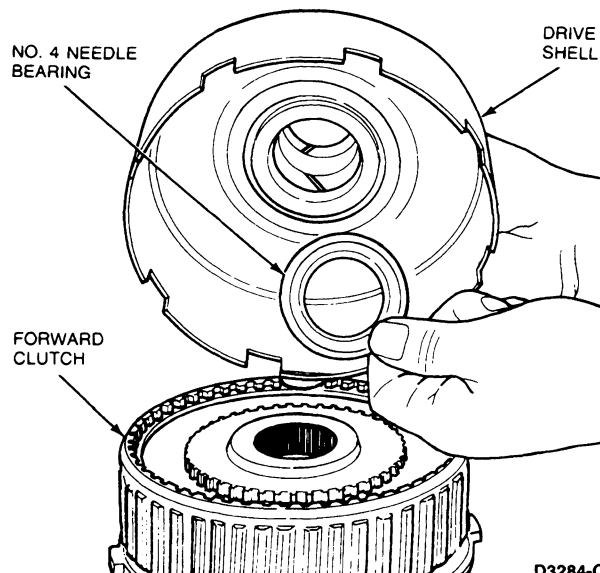
ASSEMBLY (Continued)

3



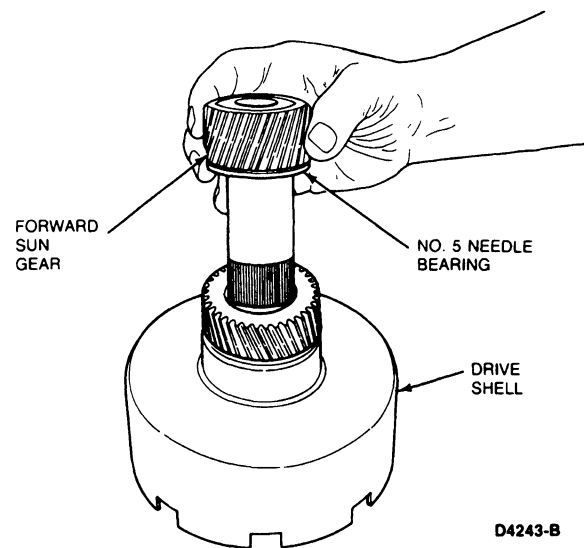
D3832-C

4



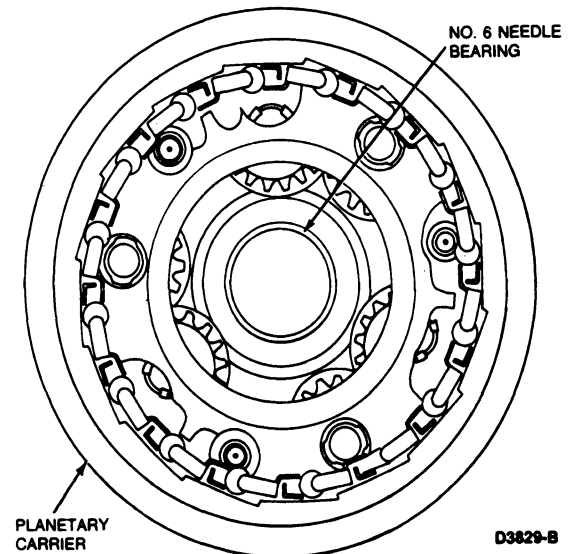
D3284-C

5

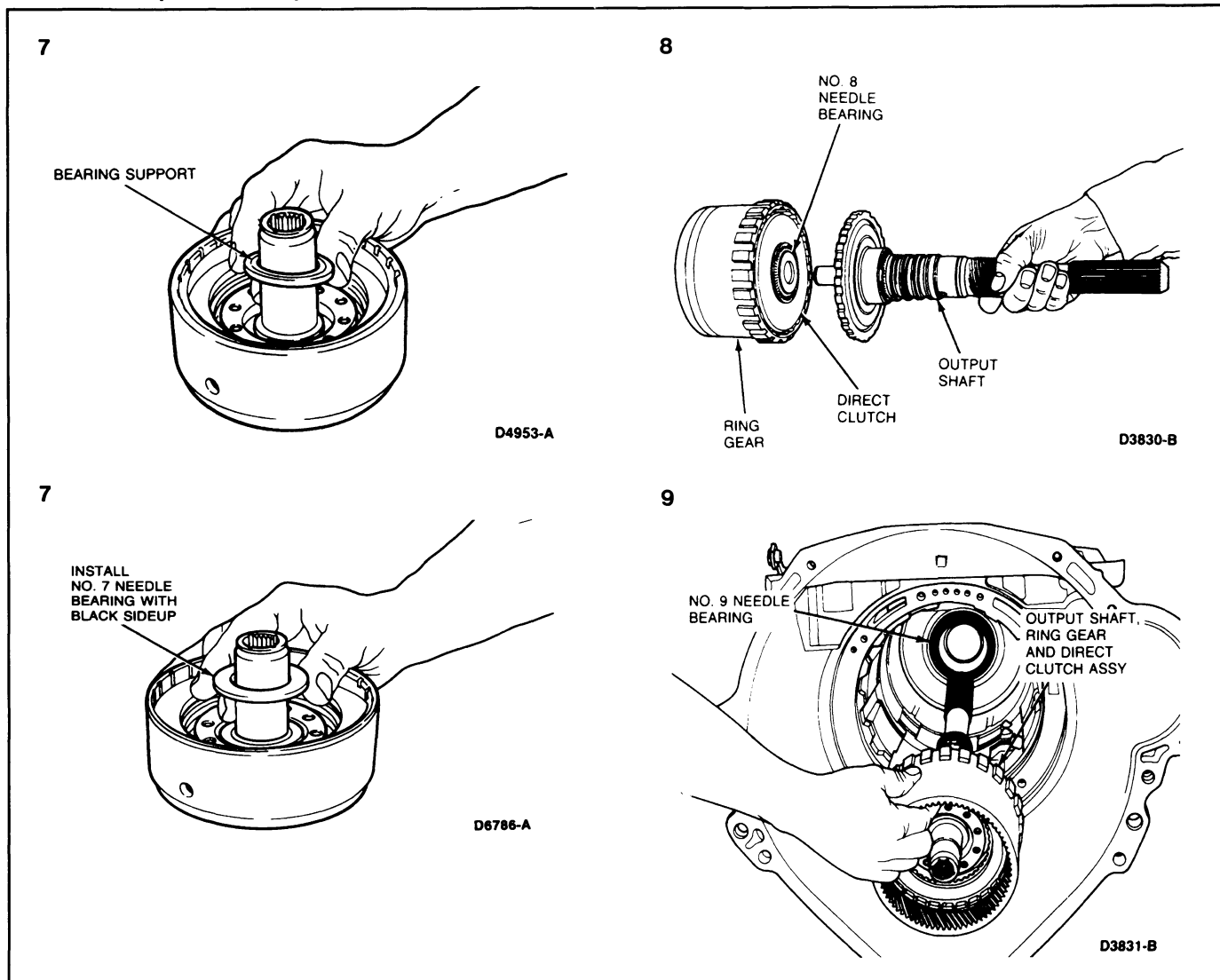


D4243-B

6



D3829-B

ASSEMBLY (Continued)**ADJUSTMENTS**
Throttle Valve (TV) Control Cable Adjustment
Service Adjustment Procedure

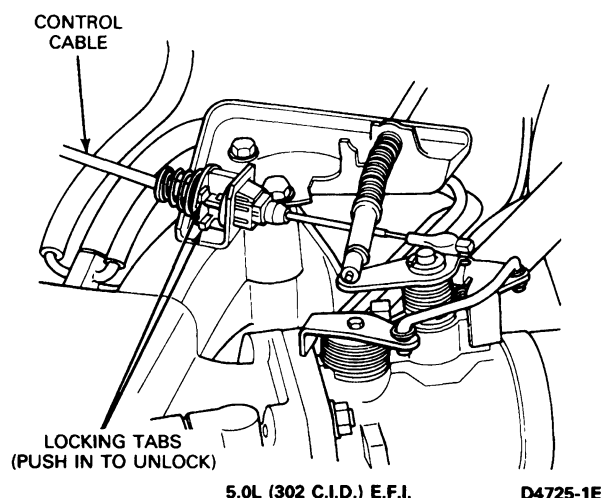
Two methods of TV system adjustment are available.

1. TV cable adjustment with engine off.
2. TV control pressure check and adjustment procedure with engine on.

The Throttle Valve (TV) Control Cable System consists of a cable attaching stud on the throttle body throttle lever, the TV Control Cable Assembly, the External TV Control Lever on the transmission, and the Cable Mounting Brackets at the throttle body and transmission. As the throttle body lever is moved from idle to wide open throttle (WOT), the TV control cable pulls the transmission TV control lever from idle to WOT. Return of the cable and transmission lever towards idle is accomplished by the return spring on the transmission end of the cable assembly. This spring and the end of the cable assembly is protected by a flexible rubber boot. The transmission external TV control lever actuates the internal TV control mechanism which regulates the TV control pressure. The travel of this lever is controlled by stops internal to the transmission.

ADJUSTMENTS (Continued)

The TV control cable is set and locked to its proper length during initial assembly by pushing in the locking tab at the throttle body end of the cable assembly. When the tab is unlocked the cable is released for adjustment. The take-up spring at this end of the cable automatically tensions the cable when released. With the slack taken up and the locking tab pushed in, the take-up spring plays no part in the operation of the system.



Under normal circumstances, it should not be necessary to alter or readjust the initial setting of the TV control cable. Situations requiring readjustment of the TV control cable include maintenance involving the removal and/or replacement of the throttle body, transmission, or TV cable assembly.

When the TV control cable is properly set, the transmission TV control lever will be at its internal idle stop (lever to rear as far as it will travel) when the throttle body throttle lever is at its idle stop.

TV Cable Adjustment with Engine Off

NOTE: At accelerator pedal WOT, the transmission TV control lever will not be at its WOT stop. The wide open throttle position must not be used as a reference point for adjusting the TV control cable.

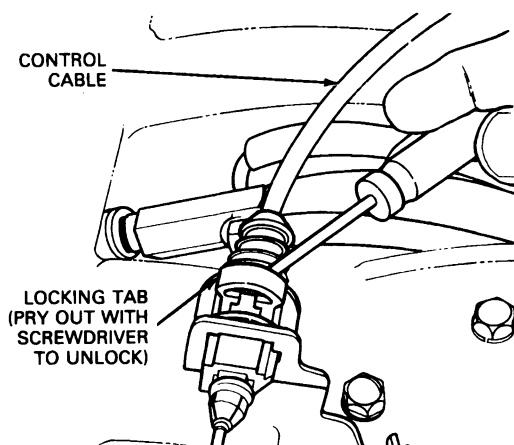
Idle Speed Affect on the TV Control Cable

The 5.0L (302 CID) EFI Engines use an air By-Pass ISC that does not affect throttle position. Therefore, idle automatic setting does not affect TV Cable adjustment.

TV Cable Adjustment Procedure, Retention Spring

1. Set parking brake and put selector in N (do not put selector in P).
2. Remove the protective cover over the cable linkage (F-150-250 and Bronco vehicles only).
3. Verify that the throttle lever is at the idle stop. If it isn't, check for binding or interference in the throttle system. **Do not attempt to adjust idle stop.**

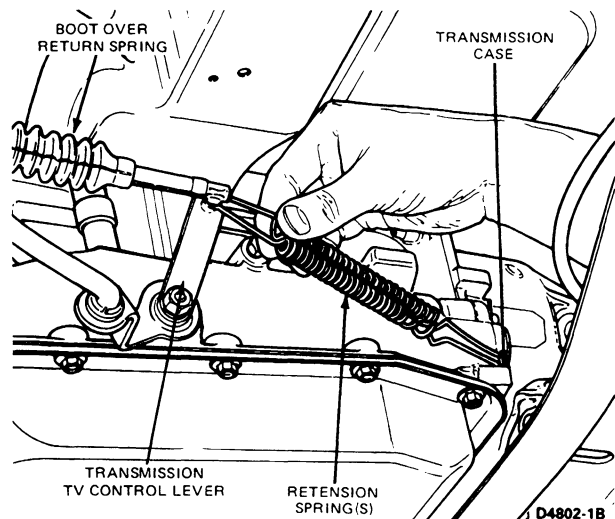
4. Verify that the cable routing is free of sharp bends or pressure points and that the cable operates freely. Lubricate the TV lever ball stud with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent if necessary. Check for damage to cable or rubber boot.
5. Unlock the locking tab at the throttle body end by prying up with a small screwdriver to free the cable.



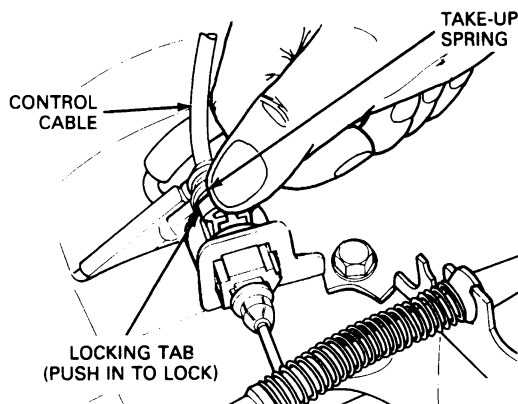
D4801-G

ADJUSTMENTS (Continued)

6. A retention spring must be installed on the TV control lever at the transmission, to hold it in the idle position (as far to rear as the lever will travel) with about ten pounds of force. If a suitable single spring is not available, two V8 TV return springs may be used. Attach retention spring(s) to the transmission TV lever and hook rear end of spring to the transmission case.



7. With the TV cable locking tab unlocked and the retention spring in place, rotate the transmission out TV lever 10-30 degrees and return slowly.
8. Push down on the locking tab until flush.



D4804-G

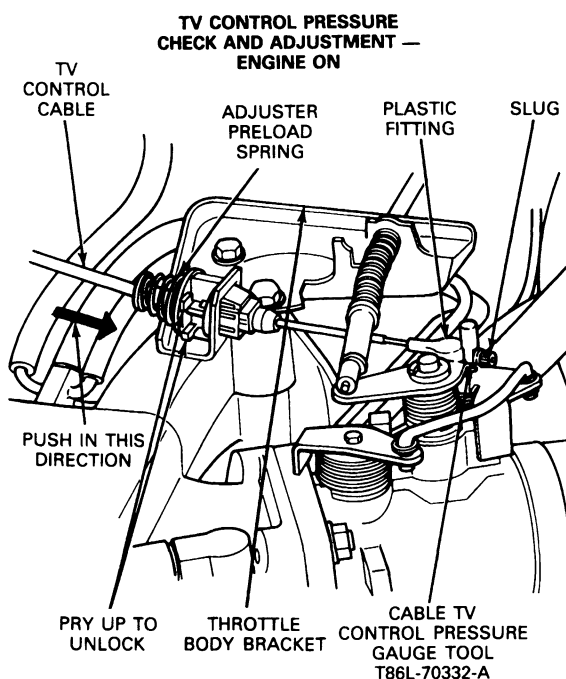
9. Remove the retention spring(s) from the transmission TV lever.

TV Cable Adjustment with Engine On

TV Control Pressure Check and Adjustment

NOTE: This procedure requires the use of TV Pressure Gauge with Hose T86L-70002-A. The results of the adjustment procedure depend on the accuracy of the pressure gauge. The pressure gauge should be checked (and recalibrated if necessary) approximately four times a year or when the following occurs:

- a. The needle will not return to 0 psi under no pressure.
 - b. The needle goes past 0 psi (negative side) under no pressure.
 - c. Bumping or dropping a pressure gauge.
1. Attach TV Pressure Gauge with Hose T86L-70002-A to the TV port on the transmission. On some applications it might be easier to use the TV Pressure Fitting Service Tool No. D80L-77001-A or equivalent.
 2. Remove the protective cover over the cable linkage.
 3. Insert the tapered end of the Cable TV Control Pressure Gauge Tool T86L-70332-A between the crimped slug on the end of the cable and the plastic cable fitting that attaches to the throttle lever. Push in gauge tool, forcing the crimped slug away from the plastic fitting. Make sure gauge tool is pushed in as far as it will go.



D4961-E

ADJUSTMENTS (Continued)

4. Operate the engine until normal operating temperature is reached (approximately 5-10 min. with transmission in park). The transmission fluid temperature should be approximately 100-150°F. Do not make pressure check if transmission fluid is cold or too hot to touch.
5. Set parking brake and place shift selector in N (neutral). With gauge block in place and engine idling in neutral, the TV pressure should be 33 ± 5 psi. For best transmission function, set the TV pressure as close as possible to the mean (average) pressure using the following procedure.
NOTE: Do not check or set TV pressure in P (park).
6. Unlock the TV Cable Locking Tab at the throttle body bracket. The adjuster preload spring should cause the adjusting slider to move away from the throttle body and the TV pressure should increase.
7. Push on the slider from behind the bracket until the TV pressure is 33 psi. While still holding the slider, push down on locking tab as far as it will go, locking slider in position.
NOTE: An increase of 1-2 psi is possible when transmission is shifted from NEUTRAL to a forward gear. This is considered normal and no compensation should be made.
8. Remove gauge tool, allowing cable to return to its normal idle position. With the engine still idling in neutral, TV pressure must be at or near zero (less than 5 psi). If not, reinstall gauge tool. Repeat Steps 6 and 7 but set the TV pressure to a pressure lower than previously set but not less than 26 psi. Remove gauge tool and recheck TV pressure to determine if it is at or near zero.

SPECIFICATIONS**FORWARD CLUTCH**

Steel	Friction	Clearance	Selective Snap Rings — Thickness
5	5	1.27-2.26mm (0.050-0.089 inch)	0.060-0.064 0.074-0.078 0.088-0.092 0.102-0.106

* Plus a waved plate (installed next to piston).

REVERSE CLUTCH

Steel	Friction	Clearance	Selective Snap Rings — Thickness
3	4	1.02-1.91mm (0.040-0.075 inch)	0.060-0.064 0.074-0.078 0.088-0.092 0.102-0.106

DIRECT CLUTCH

Steel	Friction	Clearance	Selective Snap Rings — Thickness
5	5	1.2-1.77mm (0.050-0.067 inch)	0.050-0.054 0.064-0.068 0.078-0.082 0.092-0.096

INTERMEDIATE CLUTCH

Steel	Friction	Clearance	Selective Snap Rings — Thickness
3	3	41.504-41.808mm (1.634-1.646 inch)	0.067-0.071 0.077-0.081 0.087-0.091 0.097-0.101

**Low/Reverse Servo Piston Travel —
2.743-6.121mm (0.108-0.241 inch)**

NOTE: Piston travel can be adjusted using one of the selective servo pistons available for service.

SPECIFICATIONS (Continued)

SELECTIVE SERVO PISTONS

Rod Length	I.D.
2.936	1 Groove
2.989	2 Groove
3.043	3 Groove

* Measured from the piston surface to the end of the rod.

Transmission End Play

NOTE: Transmission end play can be adjusted using one of the selective thrust washers available for service. After measuring depth, install the required thrust washer.

SELECTIVE THRUST WASHER — ALL MODELS

Depth	Thickness	Color Code
37.668-38.100mm (1.483-1.500 inch)	0.050-0.054	Green
38.125-38.532mm (1.501-1.517 inch)	0.068-0.072	Yellow
38.557-38.963mm (1.518-1.534 inch)	0.085-0.089	Natural
38.989-39.395mm (1.535-1.551 inch)	.0102-.106	Red
39.421-39.827mm (1.552-1.568 inch)	.119-.123	Blue

NOTE: The thrust washer is located on the stator support which is attached to the back of the pump housing.

CLUTCH AND BAND APPLICATION

	Interm. Friction Clutch	Interm. One-Way Roller Clutch	Overdrive Band	Reverse Clutch	Forward Clutch	Planetary One-Way Roller Clutch	Low/ Reverse Band	Direct Clutch
1st Gear Manual Low					Applied	Holding	Applied	
2nd Gear Manual Low	Applied	Holding	Applied		Applied			
1st Gear — Ⓢ (OVERDRIVE) or D(3)					Applied	Holding		
2nd Gear — Ⓢ (OVERDRIVE) or D(3)	Applied	Holding			Applied			
3rd Gear — Ⓢ (OVERDRIVE) or D(3)	Applied				Applied			Applied
4th Gear — Ⓢ (OVERDRIVE)	Applied		Applied					Applied
Reverse (R)				Applied			Applied	

TD3032F

CONVERTER END PLAY

Transmission	New or Rebuilt	Used
All	0.58mm (.023 inch)	1.27mm (.050 inch)

TD4446D

FLUID CAPACITY

Liters	Imperial Quarts	Quarts
11.6	10.2	12.3

TD4554B

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
Stator Support to Pump Body	16-22	12-16
Front Pump to Case	22-27	16-20

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Reinforcing Plate to Valve Body	9-14	80-120 (In-Lb)
Separator Plate to Valve Body	9-14	80-120 (In-Lb)
Valve Body to Case	9-11	80-100 (In-Lb)
Filter to Valve Body	9-14	80-120 (In-Lb)
Oil Pan to Case	8-14	72-120 (In-Lb)
Extension to Case	22-27	16-20
Governor Body to Counterweight	6-7	50-60 (In-Lb)
Governor Body Cover to Governor Body	2.3-3.4	20-30 (In-Lb)

(Continued)

SPECIFICATIONS (Continued)**TORQUE SPECIFICATIONS (Cont'd)**

Description	N-m	Lb-Ft
Converter to Flywheel	27-46	20-34
Inner Manual Lever to Shaft	26-37	19-27
Converter Housing Access. Cover to Converter Housing	16-22	12-16
Detent Spring Attaching Bolt	9-14	80-120 (In-Lb)
Outer Throttle Lever to Shaft	16-22	12-16
Cooler Connector Line to Case	24-31	18-23
Converter Plug to Converter	11-38	8-28
Neutral Start Switch to Case	11-15	96-132 (In-Lb)

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Pressure Plate to Case	8-16	72-144 (In-Lb)
Transmission to Engine	55-68	40-50
Crossmember to Extension Housing	87-110	64-81


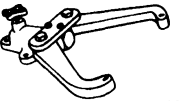


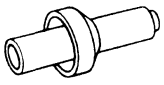
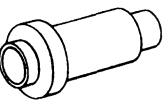
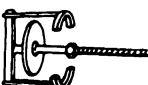
SERVICE REPLACEMENT COOLER LINE FITTING TORQUE SPECIFICATIONS

Radiator		Transmission	
N-m	Lb-Ft	N-m	Lb-Ft
24-31*	18-23	24-31*	18-23





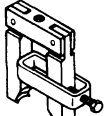

* 1/4" x 18 Straight or Elbow Fitting

TD4439E

SPECIAL SERVICE TOOLS/EQUIPMENT

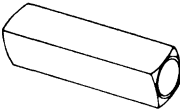
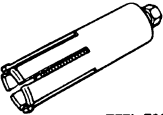

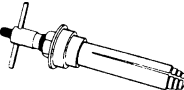
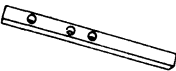

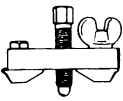
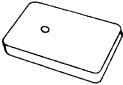
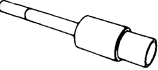
Tool Number/ Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T57L-500-B Bench Mounted Holding Fixture	 T57L-500-B
T58L-101-B Puller	 T58L-101-B
T59L-100-B Impact Slide Hammer	 T59L-100-B
T61L-7657-A Extension Housing Seal Replacer	 T61L-7657-A
T63L-77837-A Front Pump Seal Replacer	 T63L-77837-A
T65L-77515-A Clutch Spring Compressor	 T65L-77515-A

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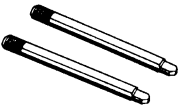
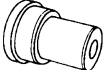

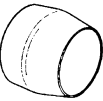

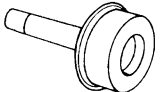
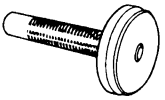
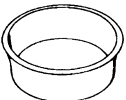
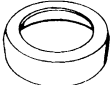
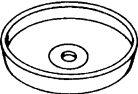
Tool Number/ Description	Illustration
T68P-7D158-A Forward Clutch Lip Seal Protector	 T68P-7D158-A
T71P-19703-C O-Ring Tool	 T71P-19703-C
T73L-6600-A Engine Oil Pressure Gauge	 T73L-6600-A
T74P-77247-A Neutral Start Switch Socket	 T74P-77247-A
T74P-77248-A Extension Housing Seal Remover	 T74P-77248-A
T74P-77498-A Shift Shaft Seal Replacer	 T74P-77498-A

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SPECIAL SERVICE TOOLS/EQUIPMENT **(Continued)**


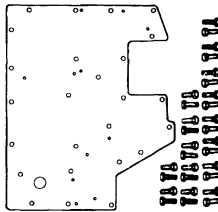


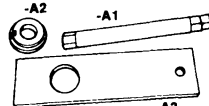
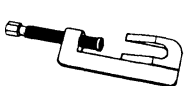
Tool Number / Description	Illustration
T76L-7902-C Converter Clutch Torquing Tool	 T76L-7902-C
T77L-7697-A Extension Housing Bushing Remover	 T77L-7697-A
T77L-7902-R Converter Clutch Holding Tool	 T77L-7902-R
T80L-7902-A End Play Checking Tool	 T80L-7902-A
T80L-77003-A Gauge Bar	 T80L-77003-A
T80L-77005-A Lip Seal Protector (Intermediate Clutch)	 T80L-77005-A
T80L-77030-A Servo Piston Selection Tool	 T80L-77030-A
T80L-77030-B Servo Piston Remover	 T80L-77030-B
T80L-77034-A Extension Housing Bushing Replacer	 T80L-77034-A

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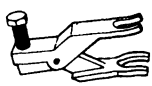
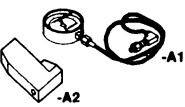


Tool Number / Description	Illustration
T80L-77100-A Valve Body Guide Pins	 T80L-77100-A
T80L-77110-A Rear Case Bushing Replacer	 T80L-77110-A
T80L-77140-A Forward Clutch Lip Seal Protector	 T80L-77140-A
T80L-77234-A Direct Clutch Lip Seal Protector (Inner)	 T80L-77234-A
T80L-77254-A Direct Clutch (Outer) Lip Seal Protector	 T80L-77254-A
T80L-77268-A Oil Pump Bushing Replacer	 T80L-77268-A
T80L-77268-B Oil Pump Bushing Remover	 T80L-77268-B
T80L-77403-A Reverse Clutch Seal Protector (Outer)	 T80L-77403-A
T80L-77403-B Reverse Clutch Seal Protector (Inner)	 T80L-77403-B
T80L-77405-A Reverse Clutch Spring Compressor	 T80L-77405-A

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT **(Continued)**

Tool Number/ Description	Illustration
T80L-77515-A Clutch Spring Compressor Extension	 T80L-77515-A
T82L-7006-A AOD Transmission Test Plate with Screws	 T82L-7006-A
T82L-9500-AH Disconnect Tool	 T82L-9500-AH
T82P-7006-C Test Plate Mounting Screws	 T82P-7006-C
T83L-7902-A Tool Set— Consists of: Torque Converter Checking Tool T83L-7902-A1 Rod Torque Adapter T83L-7902-A2 Pilot Guide T83L-7902-A3 Holding Fixture	 T83L-7902-A
T84P-7341-A Grommet Remover	 T84P-7341-A

(Continued)

Tool Number/ Description	Illustration
T84P-7341-B Grommet Replacer	 T84P-7341-B
T86L-70002-A TV Pressure Gauge Set T86L-70002-A1 TV Pressure Gauge Hose T86L-70002-A2 Rod TV Control Pressure Gauge Block	 T86L-70002-A
T86L-70332-A Cable TV Control Pressure Gauge	 T86L-70332-A
T89T-70010-A Pump Puller Adapters	 T89T-70010-A

TD8097A

Tool Number	Description
D80L-77001-A	Throttle Valve Control Pressure Fitting
D80P-4201-A	Depth Micrometer (Also Commercially Available)
TOOL-1175-AC	Seal Remover
TOOL-4201-C	Dial Indicator with Bracketry
TOOL-7000-DD	Rubber Tip for Air Nozzle
TOOL-7000-DE	Air Nozzle Assembly

ROTUNDA EQUIPMENT

Model	Description
014-00028	Torque Converter Cleaner
014-00737	Automatic Transmission Tester
021-00014	Vacuum Tester
021-00054	Torque Converter Leak Detector

SECTION 07-01D Transmission, Automatic — 4R70W (AODE-W)

SUBJECT	PAGE	SUBJECT	PAGE
CLEANING AND INSPECTION	07-01D-136	DISASSEMBLY AND ASSEMBLY (Cont'd.)	
DESCRIPTION		Center Support and Planetary Low One-Way	
Electronics.....	07-01D-8	Clutch.....	07-01D-113
Main Control Body	07-01D-8	Direct Clutch.....	07-01D-118
Oil Pump.....	07-01D-7	Forward Clutch	07-01D-108
Selector and Shift Patterns.....	07-01D-9	Intermediate One-Way Clutch	07-01D-102
Torque Converter.....	07-01D-7	Output Shaft and Direct Clutch	07-01D-115
DIAGNOSIS AND TESTING		Pump and Intermediate Clutch Piston	07-01D-97
After Self-Test.....	07-01D-48	Pump Bushing	07-01D-101
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Converter End Play.....	07-01D-78	Valve Body	07-01D-93
Diagnostic Hydraulic / Mechanical Routine		Sun Gear and Drive Shell	07-01D-114
Chart Instructions	07-01D-24	Transmission.....	07-01D-124
Drive Cycle Test	07-01D-48	Transmission.....	07-01D-80
Engine Idle Speed Check.....	07-01D-76	INSTALLATION	
On-Board Diagnostic Quick Tests	07-01D-46	Transmission.....	07-01D-135
Pinpoint Tests	07-01D-49	OPERATION	
Rotunda Transmission Tester	07-01D-52	4R70W (AODE-W) Transmission Electronic	
Shift Linkage Check	07-01D-76	Control System	07-01D-14
Stall Speed Test	07-01D-75	Electronics.....	07-01D-11
Stator to Impeller Interference Check.....	07-01D-77	Engine and Driver Demands.....	07-01D-13
Stator to Turbine Interference Check.....	07-01D-77	Geartrain.....	07-01D-10
Torque Converter One-Way Clutch		Main Geartrain Components	07-01D-10
Check	07-01D-76	Torque Converter	07-01D-9
Transmission Fluid Condition Check.....	07-01D-71	REMOVAL	
Transmission Fluid Cooler Flow Check	07-01D-74	Fluid Cooler Lines	07-01D-79
Transmission Fluid Leakage Checks.....	07-01D-71	Transmission Assembly	07-01D-79
Transmission Fluid Level Check.....	07-01D-70	SPECIAL SERVICE TOOLS	07-01D-139
DISASSEMBLY AND ASSEMBLY		SPECIFICATIONS	07-01D-138
1-2 Accumulator.....	07-01D-85	VEHICLE APPLICATION	07-01D-1

VEHICLE APPLICATION

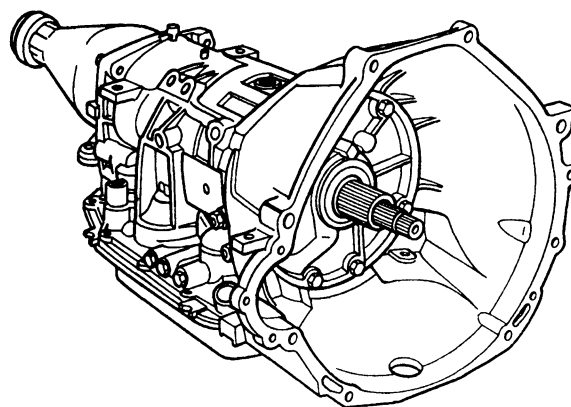
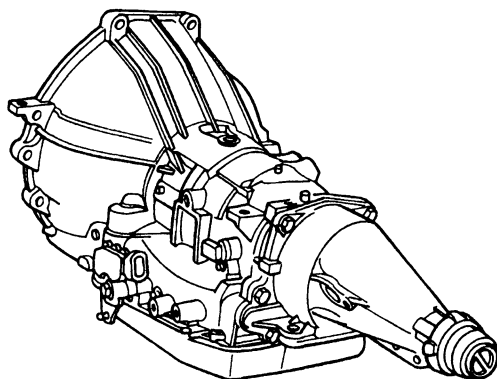
E-150 Vehicles Equipped with 4R70W (AODE-W)
Automatic Transmissions

DESCRIPTION

The 4R70W (AODE-W) transmission is a four-speed, rear-wheel drive automatic with an electronic shift, torque converter clutch control and line pressure controls.

DESCRIPTION (Continued)

The 4R70W (AODE-W) uses a Ravigneaux-style double-pinion compound gearset to produce four forward speeds and reverse. Two bands, two one-way roller clutches and four friction clutches are used to hold or drive various planetary gearset members.



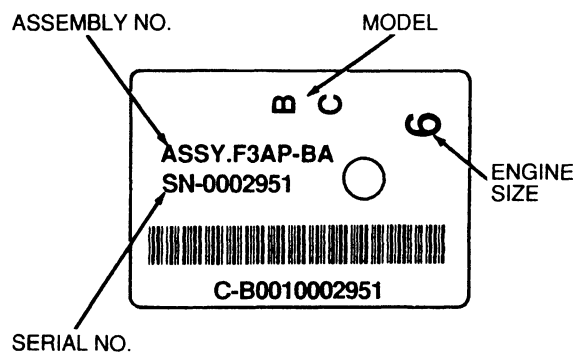
D10217-A

Transmission Identification

All vehicles are equipped with a Vehicle Certification Label, affixed to the LH (driver's) side door lock post.

Refer to the code in the space marked TR on the Vehicle Certification Label for proper transmission identification.

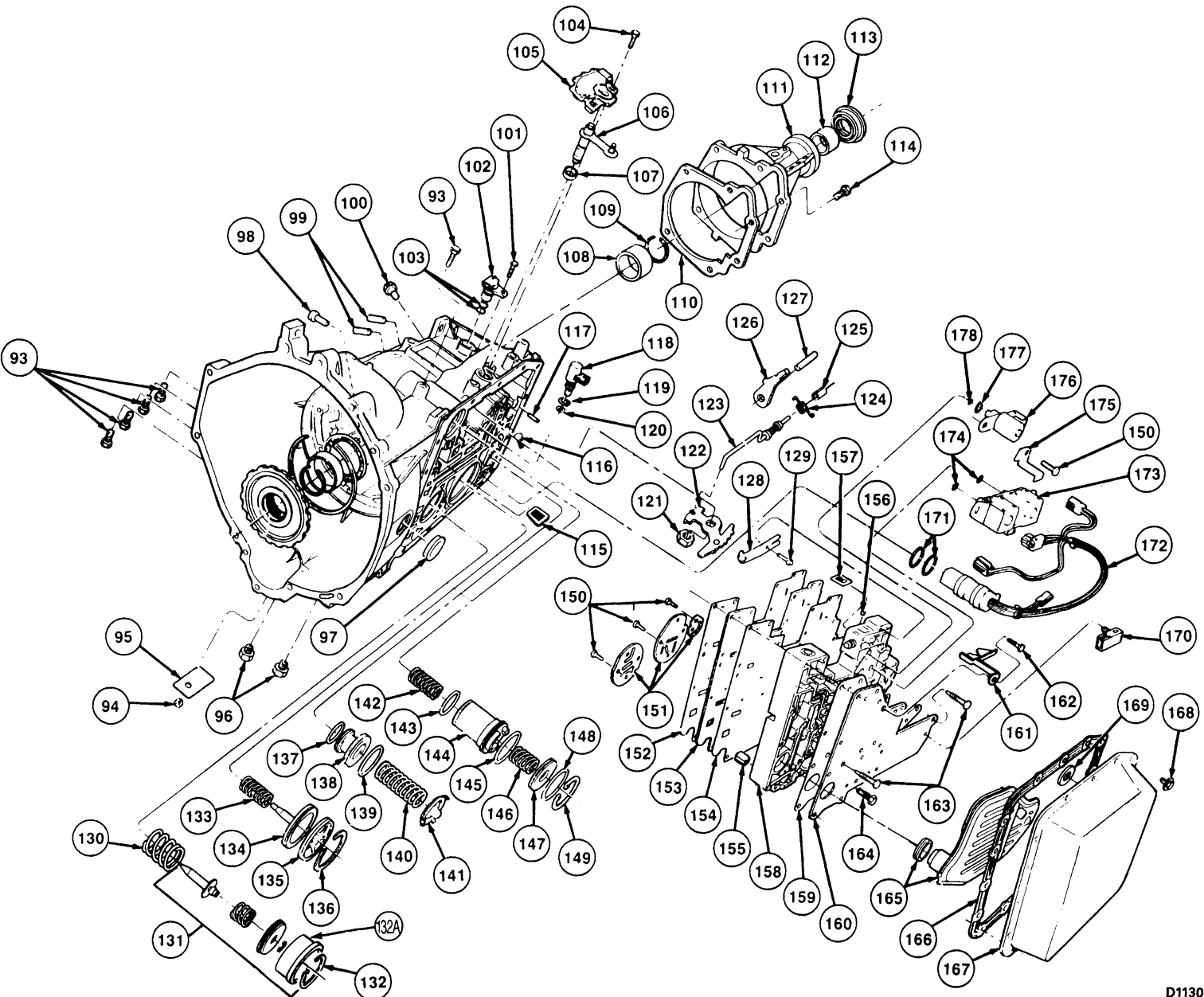
For additional information such as: model, service ID level or build date, refer to the transmission service ID tag which is attached to the transmission case.

ATTACHED TO PASSENGER SIDE OF CASE

D10215-B

DESCRIPTION (Continued)

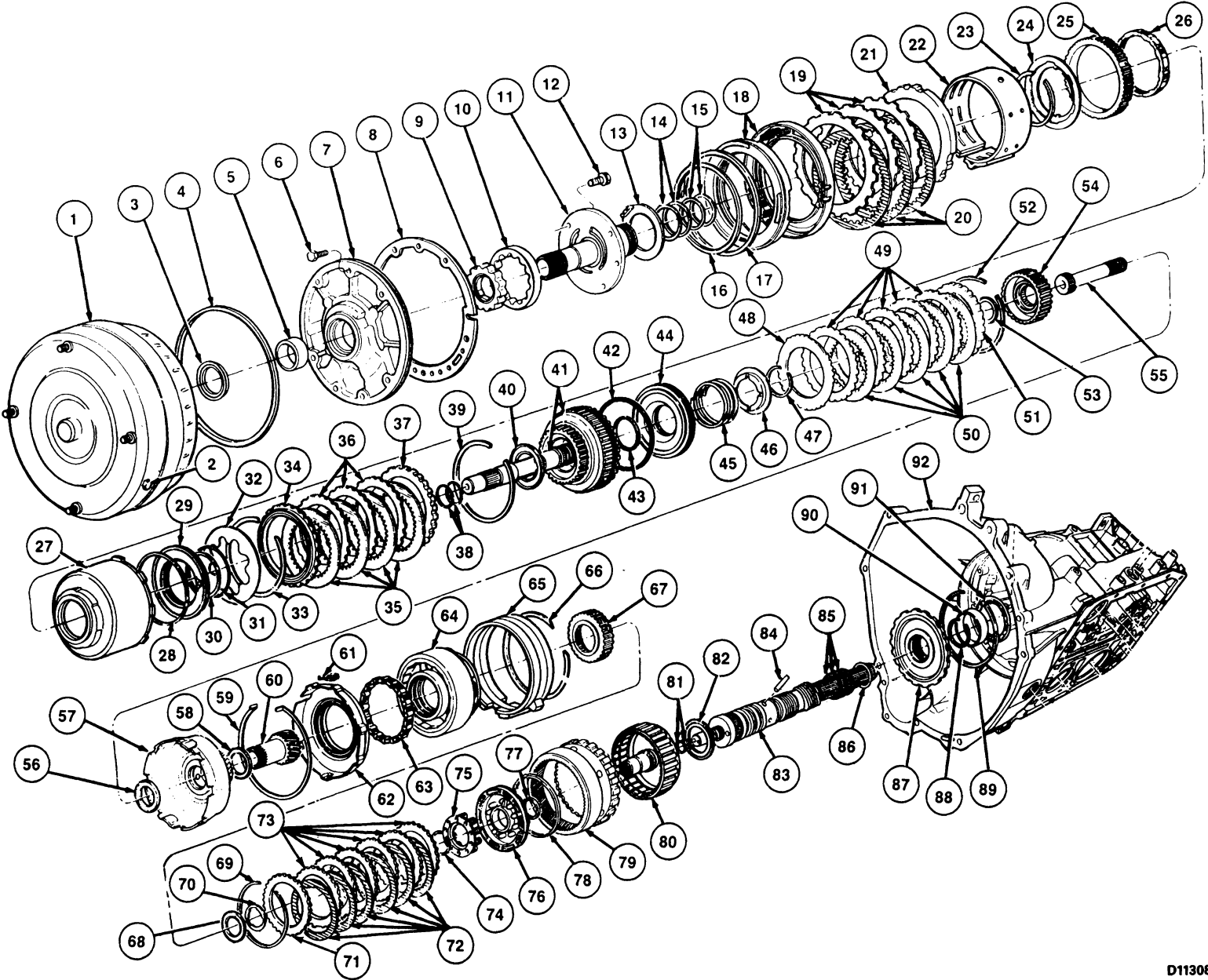
Transmission, Automatic, 4R70W (AODE-W)



D11307-A

DESCRIPTION (Continued)

Transmission, Automatic, 4R70W (AODE-W)



D11308-A

DESCRIPTION (Continued)

Item	Part Number	Description
1	7902	Converter Assembly
2	87650-S2	Converter Drain 1/8-27 Dryseal Plug
3	7A248	Front Oil Pump Seal Assy
4	7A248	Front Oil Pump O-Ring
5	7B258	Front Oil Pump Bushing
6	N605789-S100	M8 1.25 x 35 Hex Hd Bolt
7	7A106	Front Oil Pump Body Assy
8	7A136	Front Oil Pump Gasket
9	7H169	Oil Pump Inner Gerotor Gear
10	7H169	Oil Pump Outer Gerotor Gear
11	7A108	Front Pump Support Assy
12	N605787-S52	M8 x 1.25 x .25 Hex Flg Hd Bolt
13	7D014	Front Pump Support Thrust Washer
14	7D020	Reverse Clutch Cylinder Seal (2 Req'd)
15	7D019	Forward Clutch Cylinder Seal (2 Req'd)
16	7F225	Intermediate Clutch Piston Inner Seal
17	7F224	Intermediate Clutch Piston Outer Seal
18	7E005	Intermediate Clutch Piston Kit
19	7B442	Intermediate Clutch External Spline (Steel) Sel. Fit Plate
20	7B164	Intermediate Clutch Internal Spline (Friction) Plate Assy
21	7B066	Intermediate Clutch Pressure Plate
22	7F196	Overdrive Band Assembly
23	389790-S	3-21/64 Retaining Type Su Ext. Ring
24	7D191	Intermediate One-Way Clutch Retainer
25	7F221	Intermediate Clutch Race
26	7A089	Intermediate One-Way Clutch Assy
27	7D044	Reverse Clutch Drum Assy
28	7D403	Reverse Clutch Piston Outer Seal
29	7D402	Reverse Clutch Piston Assy
30	7D404	Reverse Clutch Piston Inner Seal
31	7D256	Reverse Clutch Piston Pressure Ring
32	7B070	Reverse Clutch Piston Return Spring
33	7A577	Reverse Clutch Piston Spring Retainer
34	7B066	Reverse Clutch Front Pressure Plate
35	7B164	Reverse Clutch Internal Spline Plate
36	7B442	Reverse Clutch External Spline (Steel) Plate
37	7B066	Reverse Clutch Rear Pressure Plate

(Continued)

Item	Part Number	Description
38	7B497	Input Shaft Seal (2 Req'd)
39	7D483	Reverse Clutch Pressure Plate Select Fit Retainer
40	7A166	Forward Clutch No. 2 Bearing and Race Assy
41	7F207	Forward Clutch Cylinder and Input Shaft Assy
42	7A548	Forward Clutch Piston Outer Seal
43	7C099	Forward Clutch Piston Inner Seal
44	7A262	Forward Clutch Piston
45	7A480	Forward Clutch Piston Return Spring
46	7A527	Forward Clutch Retainer Return Spring
47	388099-S	Retaining Snap Ring 1-59/64
48	7E085	Rear Clutch Pressure Plate Spring
49	7B422	Forward Clutch External Spline (Steel) Plate
50	7B164	Forward Clutch Internal Spline (Friction) Plate
51	7B066	Forward Clutch Pressure Plate
52	7D483	Retaining (Selective Fit) Snap Ring
53	7F231	Forward Clutch No. 3 Bearing and Race Assy
54	7B067	Forward Clutch Hub
55	7F351	Intermediate Stub (Short) Shaft
56	7C096	Forward Clutch Hub No. 4 Bearing and Race Assy
57	7A019	Reverse Sun Gear and Shell Assy
58	7C096	Forward Clutch Sun Gear No. 5 Bearing and Race Assy
59	388501-S	Center Support Retaining Ring 7-7/32
60	7A399	Forward Clutch Sun Gear Assy
61	7F277	Case to Planet Support Spring
62	7A130	Planetary Gear Support Assy
63	7A089	Planetary OWC Cage Spring and Roller Assy
64	7A398	Forward Planetary Assy
65	7D095	Reverse Band Assy
66	377437-S	.058 Thick Retaining Ring
67	7F236	Direct Clutch Hub
68	7F243	Direct Clutch Inner No. 7 Bearing and Race Assy
69	7D483	Direct Clutch Press Plate Select Fit Retaining Ring
70	7F237	Direct Clutch Inner Bearing Support Washer
71	7B066	Direct Clutch Pressure Plate

(Continued)

DESCRIPTION (Continued)

Item	Part Number	Description
72	7B164	Direct Clutch Internal Spline (Friction) Plate
73	7B442	Direct Clutch External Spline (Steel) Plate
74	388104-S	1-19/32 Retaining Ring
75	7F235	Direct Clutch Retainer and Spring Assy
76	7A262	Direct Clutch Piston Assy
77	7C099	Direct Clutch Piston Inner Seal
78	7A548	Direct Clutch Piston Outer Seal
79	7A153	Output Shaft Ring Gear
80	7F283	Direct Clutch Cylinder Assy
81	7F274	Output Shaft Small Direct Clutch Seal (2 Req'd)
82	7F240	Direct Clutch Outer No. 8 Bearing and Race Assy
83	7060	Output Shaft Assy
84	391231-S	.185 x 1.80 STGT Chamfer Pin
85	7F273	Output To Case Shaft Large Seal (3 Req'd)
86	87054-S96	O-Ring (Piloted Output Shaft Only) Seal
87	7D164	Output Shaft Hub
88	97713-S	1-13/16 Retaining Snap Ring
89	7C122	Retaining Snap Ring
90	7025	Rear Case Bushing
91	7F242	Case Rear No. 9 Bearing and Race Assy
92	7005	Case Assy
93	87650S	1/8-27 Dryseal Tapered Pipe Plug (5 Req'd)
94	373907-S2	1/4 Spring Nut
95	7B148	Identification Tag
96	7D273	Oil Tube Connector Assy (2 Req'd)
97	7N171	Converter Housing Access Plug
98	7F295	Overdrive Band Anchor Pin
99	388142-S	Reverse Band Anchor Pin
100	7034	Case Vent Assy
101	N605773-S2	M6-1.0 x 20 Hex Flg Hd Bolt
102	7H103	Transmission Speed Sensor Assy
103	N805867-S100	14.0 x 1.78 O-Ring Seal (2 Req'd)
104	N806933-S100	M6-1.0 x 25mm Bolt and Washer Assy (2 Req'd)
105	7F293	Manual Lever Position Sensor Assy
106	7A256	Manual Control Lever Assy
107	7B498	Manual Control Lever Oil Seal Assy
108	7B176	Output Shaft Sleeve
109	388104-S	1-19/32 Retaining Type Su External Ring

(Continued)

Item	Part Number	Description
110	7086	Extension Gasket
111	7A039	Extension Assy
112	7A034	Extension Housing Bushing
113	7052	Extension Housing Oil (Booted) Seal Assy
114	N803747-S100	M8-1.25 x 30 Bolt (6 Req'd)
115	7E387	Main Control Pump Screen
116	7E242	Oil Screen Assy
117	7B210	Manual Lever Shaft Retainer Pin
118	7G383	Electronic Pressure Control Solenoid
119	N805862-S	14.0 x 1.78 O-Ring Seal
120	391131	0.426 x 0.070 O-Ring Seal
121	N800287-S51	M14 x 1.5 Hex Intermediate Detent Lever Nut
122	7A115	Manual Valve Detent Lever Assy
123	7A232	Park Pawl Actuating Rod Assy
124	7D070	Parking Pawl Return Spring
125	7D419	Park Rod Guide Cup
126	7A441	Parking Brake Pawl
127	7D071	Parking Pawl Shaft
128	7E332	Manual Valve Detent Spring Assy
129	N606022-S1000	M6-1.0 x 40 Hex Flange Head Bolt
130	7F201	Overdrive Servo Piston Spring
131	7H188	Overdrive Servo Piston Assy
132	7384	2.85 Retaining Type TVP "H" Internal Ring
132A	—	Overdrive Servo Sleeve Assembly
133	7D031	Reverse Band Servo Piston Spring
134	7D189	Reverse Band Servo Piston Assy
135	7D036	Reverse Band Servo Piston Cover Assy
136	388215-S100	Internal 3 13/16 Retaining Ring
137	7F250	2-3 Accumulator Piston Upper Seal
138	7F251	2-3 Shift Accumulator Piston
139	7F249	2-3 Accumulator Piston Lower Seal
140	7F285	2-3 Shift Accumulator Piston Spring
141	7B264	2-3 Shift Accumulator Spring Retainer
142	7F284	1-2 Shift Accumulator Spring
143	7F248	1-2 Shift Accumulator Seal
144	7F251	1-2 Shift Accumulator Piston
145	7F249	1-2 Accumulator Piston Lower Seal
146	7G267	1-2 Shift Accumulator Spring
147	7F247	1-2 Accumulator Cover

(Continued)

DESCRIPTION (Continued)

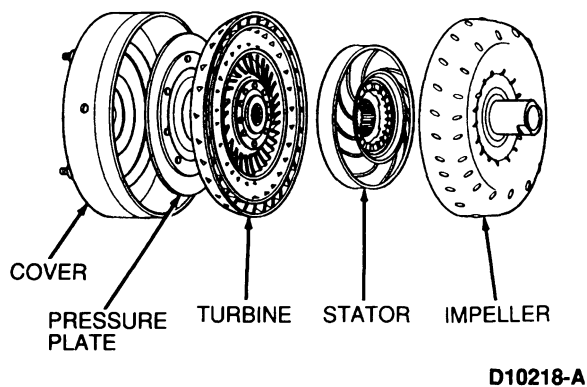
Item	Part Number	Description
148	7F294	1-2 Shift Accumulator Retainer Seal
149	7384	2-1/16 Retaining Type Hu Internal Ring
150	N605517-S1000	M6-1.0 x 16 Hex Head Bolt
151	7F282	Valve Body Reinforcing Plate
152	7C155	Valve Body Separator Upper Gasket
153	7A008	Plate Control Valve Body Separator
154	7D100	Valve Body Separating Lower Gasket
155	7H174	Converter Drainback Valve
156	7E195	1/4 Diameter Coast Booster Valve Shuttle Ball (8 Req'd)
157	7H187	Solenoid Pressure Supply Screen
158	7A100	Main Control Assy
159	7H173	Valve Body Cover Plate Gasket
160	7C034	Valve Body Cover Plate
161	7H111	Solenoid Retainer
162	N807179-S1000	M6-1.0 x 52 Hex Flange Head Bolt

(Continued)

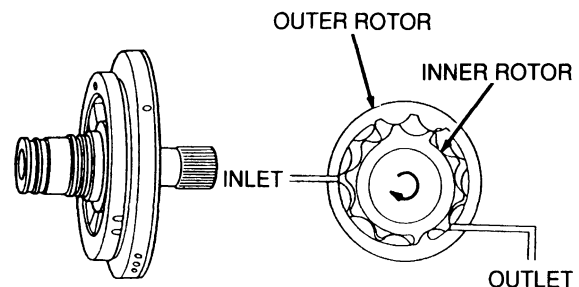
Item	Part Number	Description
163	N806381-S1300	M8-1.25 x 46 Hex Shoulder Pilot Bolt
164	N807178-S1000	M6-1.0 x 18 Hex Head Bolt
165	7A098	Oil Filter and Seal Assy
166	7A191	Oil Pan Gasket
167	7A194	Oil Pan
168	N605785-S1036	M8-1.25 x 18 Hex Flange Head Bolt
169	7L027	Ceramic Case Magnet
170	7H141	Transmission Oil Temperature Sensor
171	391139-S	0.864 x 0.070 O-Ring Seal (2 Req'd)
172	7G276	Wiring Connector Bulkhead Assy
173	7G484	Shift Control Solenoid Assy
174	N805860-S	6.07 x 1.70 O-Ring Seal (2 Req'd)
175	7H186	Shift Control Solenoid Hold Down Bracket
176	7G136	Torque Converter Clutch Solenoid Assy
177	391130-S	0.489 x 0.070 O-Ring Seal
178	391129-S	0.176 x 0.070 O-Ring Seal

Torque Converter

The 4R70W (AODE-W) uses a pressure plate-style torque converter clutch.

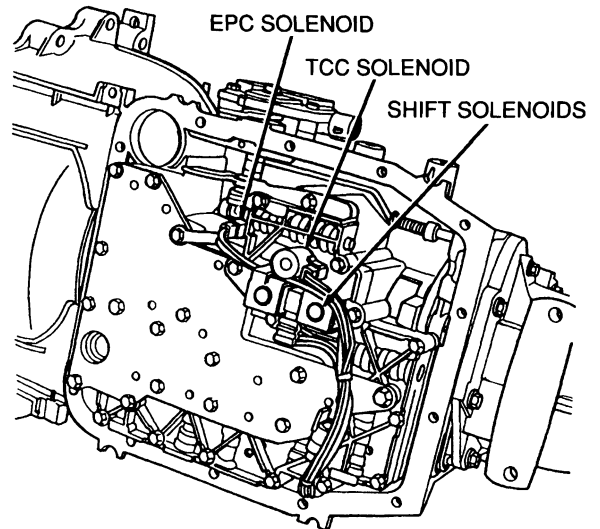
**Oil Pump**

The 4R70W (AODE-W) uses a gerotor design oil pump. The pump is more efficient at lower engine speeds. It is also made of aluminum.

**D10219-A**

DESCRIPTION (Continued)**Main Control Body**

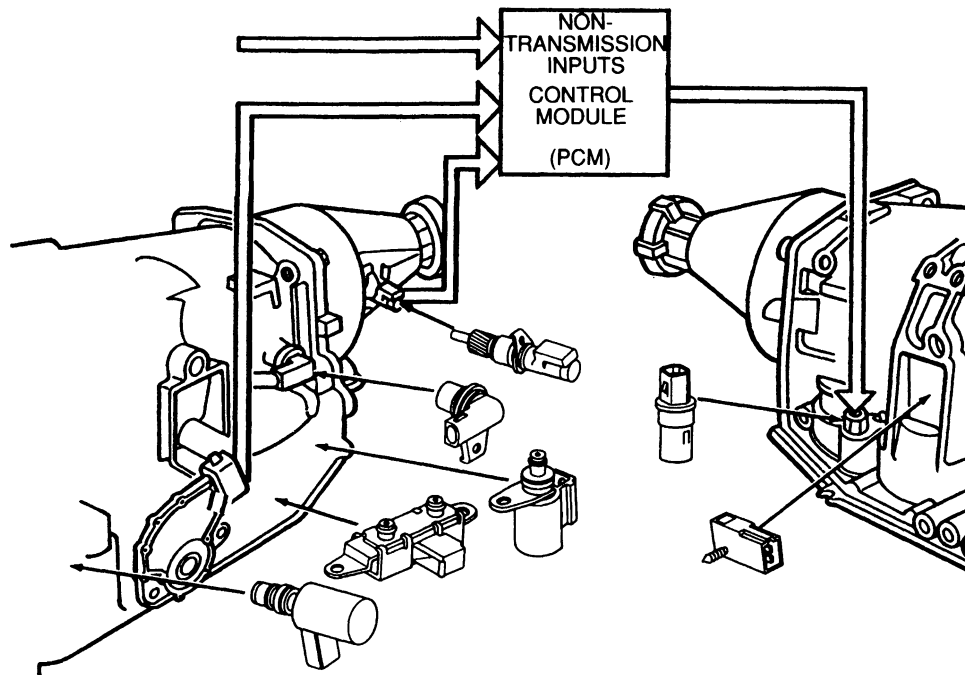
Four electronic solenoids (two shift solenoids, a torque converter clutch solenoid and an electronic pressure control solenoid) are installed on the valve body.



D10220-B

Electronics

The tie-in between the transmission, engine and other vehicle systems is electronic. This provides more accurate information (on temperature and altitude, for example) for smoother, more accurate shifting.



D10221-B

DESCRIPTION (Continued)**Selector and Shift Patterns**

The 4R70W (AODE-W) shift selector has six positions, ordered as follows: P,R,N,Ⓢ,2 and 1.

(P) Park

There is no powerflow through the transmission in PARK range. The parking pawl locks the output shaft to the case to prevent the vehicle from rolling. However, for safety reasons, the vehicle parking brake should also be used when the vehicle is parked and not in use. The engine can be started in the PARK range. In addition, PARK must be selected before the ignition key can be removed.

(R) Reverse

Reverse gear enables the vehicle to be operated in a rearward direction, at a reduced ratio. There is engine braking in REVERSE.

(N) Neutral

There is no powerflow through the transmission in NEUTRAL. However, the vehicle's wheels are free to move because the output shaft is not held by the parking pawl. The engine may be started in NEUTRAL, but the ignition key cannot be removed while the vehicle is in this range.

(Ⓢ) Overdrive

Overdrive is the normal selector position for most forward driving conditions. This position provides all automatic shifts (first through fourth), application and release of the torque converter clutch and maximum fuel economy during normal operation. Overdrive may be cancelled by depressing the Transmission Control Switch (TCS) on the end of the gear selector lever. With overdrive cancelled the transmission will allow automatic shifts from first through third gears only. Overdrive shifting through all four gears may be activated again by depressing the TCS. This should be done at closed throttle for best shift response.

(2) Second Gear

Selection of the (2) second gear position provides second gear start and hold. Application of the torque converter clutch may also occur in this range, depending on transmission and vehicle conditions. This position can be selected when starting on slippery roads for improved traction, or engine braking.

(1) Manual Low

Selection of Manual 2 or MANUAL LOW position at idle will allow first gear operation only (no upshifts). If this position is selected at normal road speeds, the transmission will initially downshift into second gear, then downshift into first gear when vehicle speed falls below approximately 45 km/h (28 mph).

The MANUAL LOW position will provide engine braking, making it especially useful for descending steep grades.



TRANSMISSION
SELECTOR
INDICATOR

D10222-A

OPERATION**Torque Converter**

The torque converter for the 4R70W (AODE-W) is a four-element converter. It contains the standard three elements (impeller, turbine and stator) for transmission and multiplication of torque, plus a torque converter clutch for increased fuel economy in third and fourth gears.

The operation of the main torque converter components is as follows:

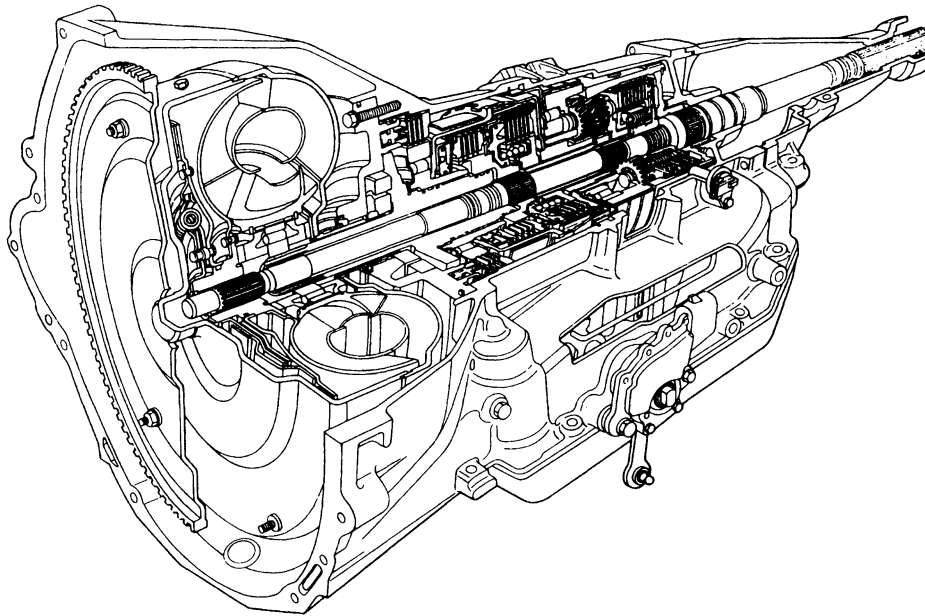
- Rotation of the converter housing and impeller set the fluid in motion.
- The turbine reacts to the fluid motion from the impeller, transferring rotation to the geartrain.
- The stator redirects fluid going back into the impeller, allowing for torque multiplication.

The addition of a torque converter clutch to the converter provides a mechanical link between the converter housing and the engine, allowing for direct transfer of power from the engine to the geartrain.

The converter clutch pressure plate is applied and released by fluid pressure, which is controlled by the powertrain control module (PCM) (12A650) through an electronic solenoid in the valve body.

OPERATION (Continued)

Cutaway View, 4R70W (AODE-W) Transmission



Geartrain

Power is transmitted from the torque converter to the Ravigneaux geartrain components through the input shaft and stub shaft. The geartrain contains a compound planetary set connected by dual pinion gears. By holding or driving certain members of the gearset, four forward ratios and one reverse ratio are obtained and transmitted to the output shaft. The ratios are as follows:

Gear Ratios	
1st gear	2.84 to 1
2nd gear	1.55 to 1
3rd gear	1.00 to 1
4th gear	0.20 to 1
Reverse	2.32 to 1

Members of the gearset are held or driven by a series of bands or clutches. The 4R70W (AODE-W) uses two bands, two one-way roller clutches and four friction clutches.

Main Geartrain Components

Input Shaft

The input shaft transfers speed and torque from the converter turbine to the geartrain. This shaft is splined to the turbine on one end and to the forward sun gear and stub shaft on the other end.

Stub Shaft

The stub shaft transfers power from the turbine shaft to the direct clutch cylinder during third and fourth gear operation.

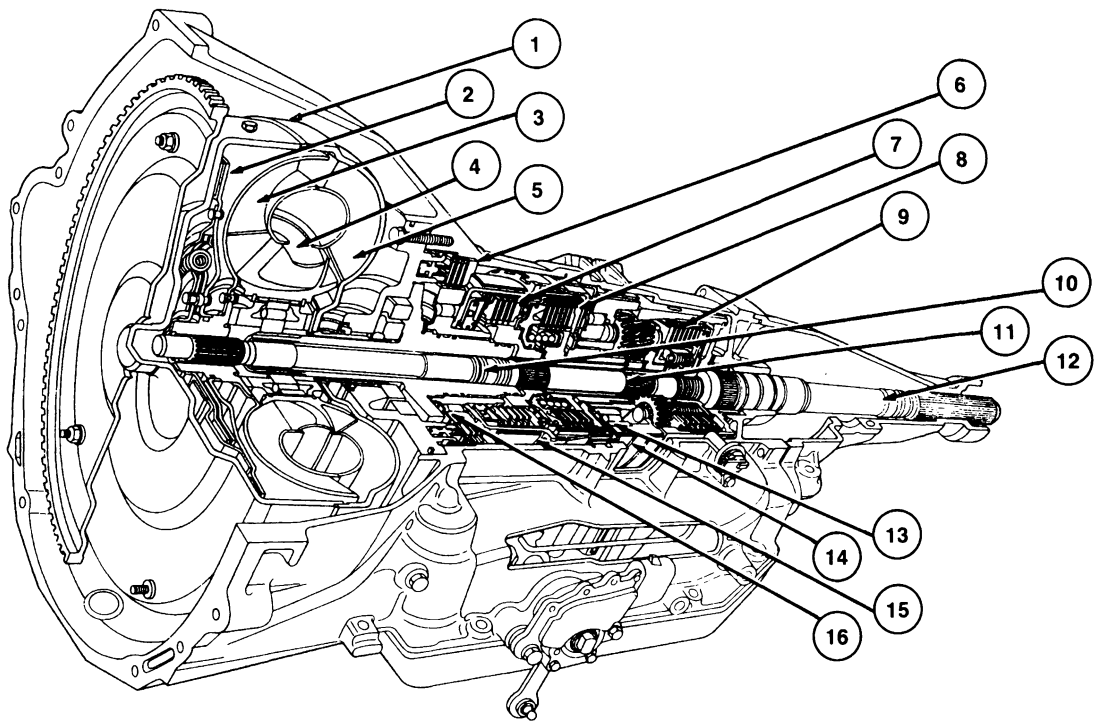
Compound Planetary Gearset

The planetary gearset in the 4R70W (AODE-W) is a Ravigneaux-type set consisting of forward and reverse sun gears, a pinion carrier, long and short pinions and a ring gear. Members are driven or held to produce four forward gear ratios plus one reverse ratio.

Output Shaft

The output shaft provides torque to the propeller shaft and rear axle assembly. It is driven by the ring gear of the planetary gearset.

OPERATION (Continued)



D10224-A

Item	Part Number	Description
1	—	Torque Converter Cover
2	—	Torque Converter Clutch
3	—	Turbine
4	—	Stator
5	—	Impeller
6	7B 164A	Intermediate Clutch
7	7B 164E	Reverse Clutch
8	7B 164D	Forward Clutch

(Continued)

Item	Part Number	Description
9	7B 164B	Direct Clutch
10	7F207	Input Shaft
11	7F351	Stub Shaft
12	7060	Output Shaft
13	7A089	Planetary One-Way Clutch
14	7D095	Reverse Band
15	7F 196	Overdrive Band
16	7A089	Intermediate One-Way Clutch

Electronics

Shift timing , shift feel (line pressure) and torque converter clutch control in the 4R70W (AODE-W) are controlled electronically by the powertrain control module (PCM) (12A650) and its input / output network. The transmission control is separate from the engine control strategy in the PCM, although some of the input signals are shared.

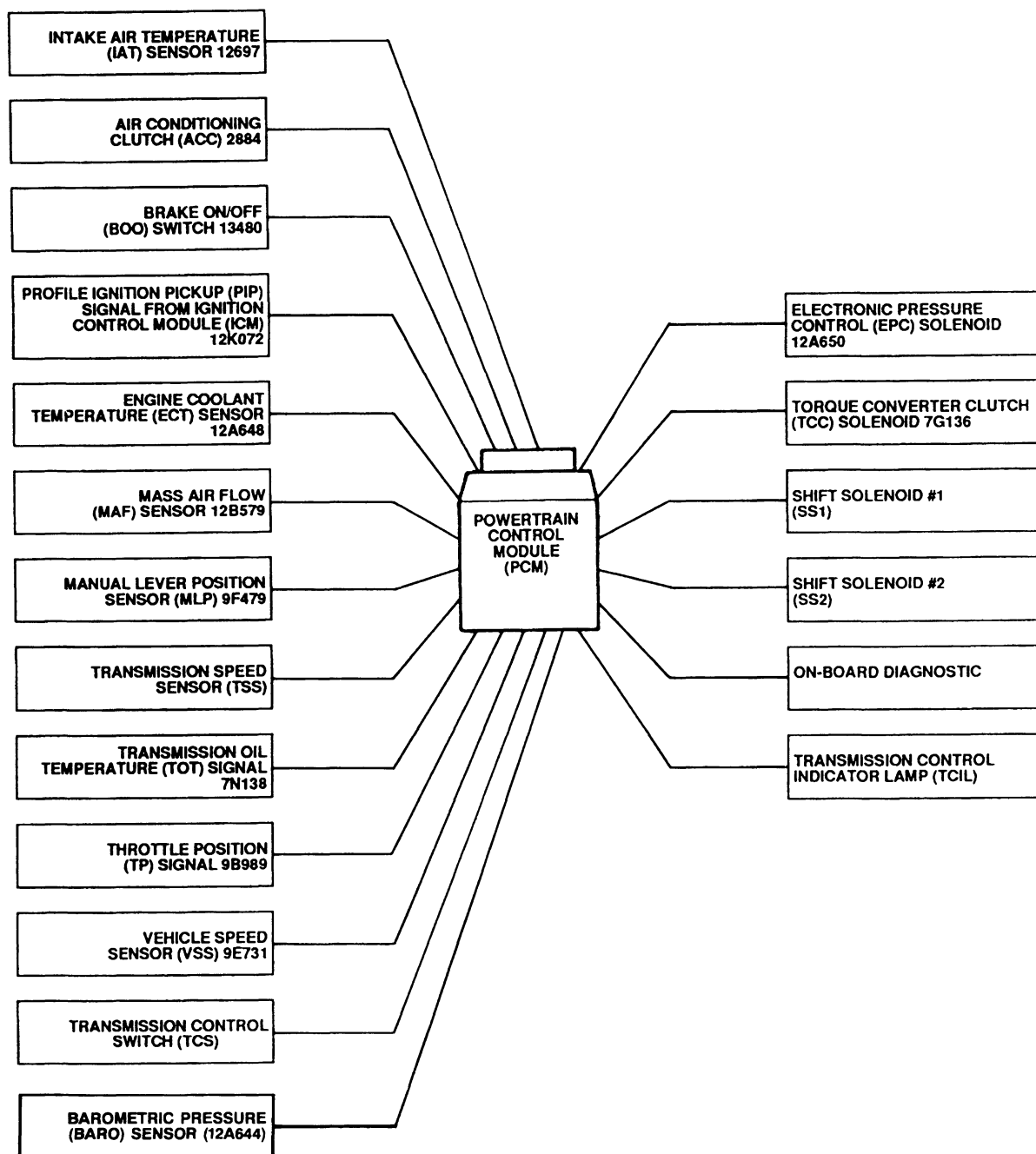
Some input signals come from engine-related sensors (mass air-flow sensor (MAF) (12B579), engine coolant temperature sensor (ECT) (12A648), barometric pressure sensor (BARO) (12A644), etc.) to give the PCM an idea of the load and climate the engine is operating under. Some other inputs are based on driver inputs, such as accelerator pedal position which is related to the PCM by the throttle position (TP) (9B989) sensor. Still other inputs are provided by the transmission itself, from sensors such as the output speed sensor, the manual lever position sensor (controlled by driver placement of the shift lever) and the transmission oil temperature sensor.

OPERATION (Continued)

Using all of these input signals, the PCM can determine when the time and conditions are right for a shift or converter clutch application. The PCM can also determine the line pressure needed to optimize shift feel. To accomplish these functions, the PCM controls four electronic solenoids—two On / Off solenoids for shifting, one pulse-width modulated (PWM) solenoid for torque converter clutch control or “controlled slip” of the torque converter clutch and an electronic pressure control (EPC) solenoid for line pressure control.

OPERATION (Continued)

Sensor Inputs and Outputs



INPUTS

PROCESSOR

OUTPUTS

D11309-A

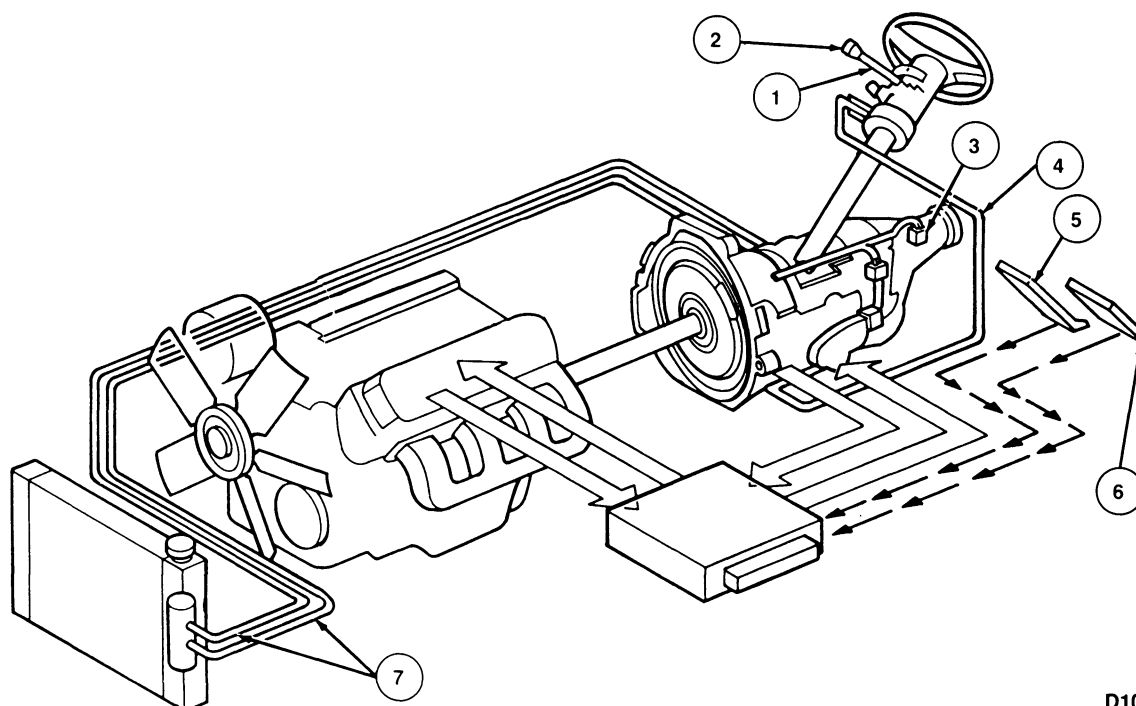
Engine and Driver Demands

The PCM receives and sends electrical signals that are used to make the 4R70W (AODE-W) transmission more responsive to driver and vehicle needs.

The driver demands are transmitted to the PCM through four components:

OPERATION (Continued)

- Shift selector lever—The driver's demand for a particular gear range is translated into an electrical signal for the PCM by the manual lever position (MLP) sensor.
- Accelerator pedal—The driver's demand for torque and acceleration are sent mechanically to the throttle body on the engine. A throttle position (TP) (9B989) sensor then translates this mechanical motion into an electrical signal and sends it to the PCM.
- Brake pedal—A Brake On / Off 13480 (BOO) switch tells the PCM when the brake is applied, indicating the driver demand to disengage the converter.
- Transmission Control Switch—A momentary contact switch that allows the driver to manually select three or four speed operations.

Component Feed to Powertrain Control Module

D10226-B

Item	Part Number	Description
1	7115	Transmission Range Selector
2	—	Transmission Control Switch (TCS)

(Continued)

Item	Part Number	Description
3	—	PSOM Module
4	7E395	Shift Cable
5	9735	Accelerator Pedal
6	2454	Brake Pedal
7	7A030	Cooler Lines

4R70W (AODE-W) Transmission Electronic Control System

The following is a list of the actuators and sensors used in controlling the transmission.

- Powertrain Control Module (PCM) (12A650)

INPUTS

- Engine Coolant Temperature (ECT) Sensor (12A648)
- Intake Air Temperature (IAT) Sensor (12697)

- Transmission Oil Temperature (TOT) Sensor (7H141)
- Manual Lever Position (MLP) Sensor (9F499)
- Brake ON/OFF (BOO) Switch (13480)
- Transmission Control Switch (TCS)
- Electronic Ignition (EI) System (12A297)
- Air Conditioning Clutch (ACC) (2884)
- Mass Air Flow (MAF) Sensor (12B579)
- Throttle Position (TP) Sensor (7M101)

OPERATION (Continued)

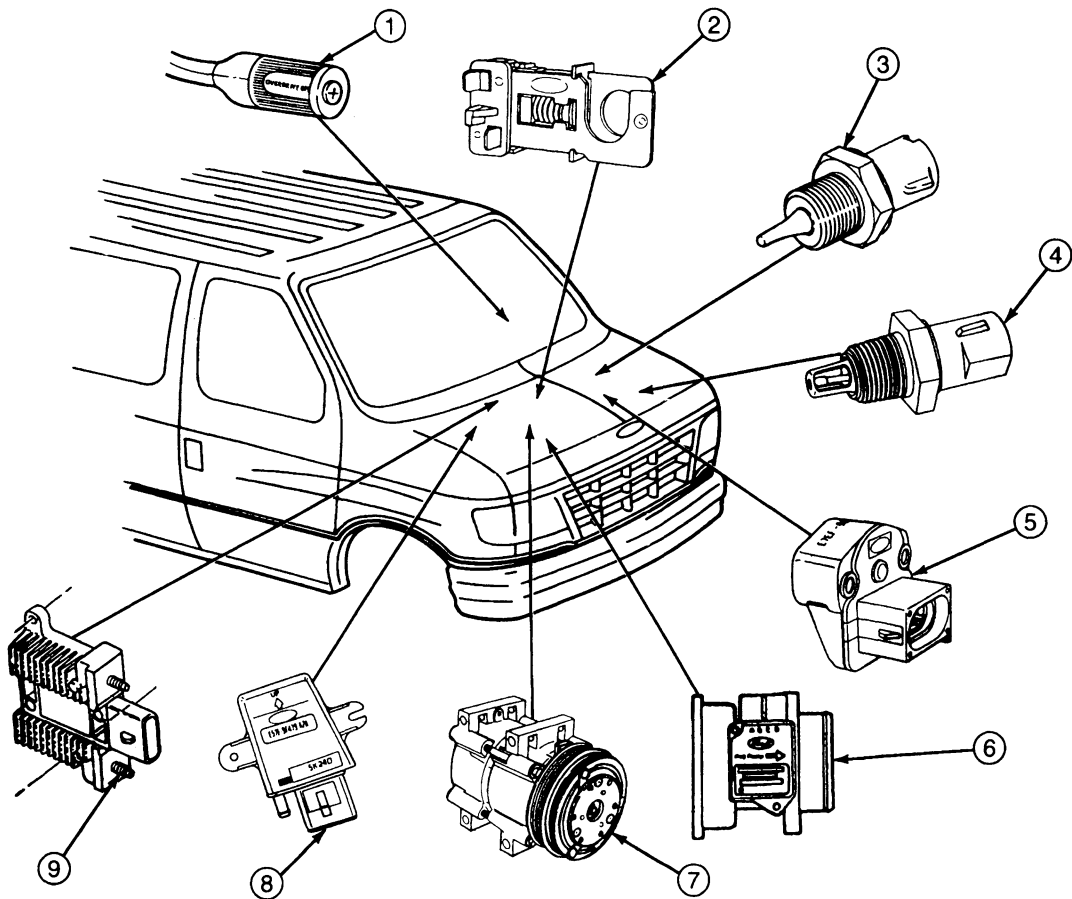
- Transmission Speed Sensor (TSS)
 - Programmable Speedometer / Odometer Module (PSOM)
 - Barometric Pressure (BARO) Sensor (12A644)

OUTPUTS

Transmission Control Indicator Lamp (TCIL)

 - Shift Solenoid Assembly
 - Shift Solenoid 1 (SS-1) (7G484)
 - Shift Solenoid 2 (SS-2) (7G484)
- Electronic Pressure Control (EPC) Solenoid (7G383)
 - Torque Converter Clutch Control (TCC) (7G136)
 - Transmission Control Indicator Light (TCIL)

4R70W (AODE-W) Transmission Electronic Control System, Actuators and Sensors



D11312-A

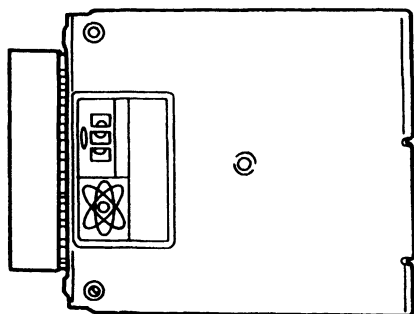
Item	Part Number	Description
1	—	Transmission Control Switch / Transmission Control Indicator Lamp (TCS/TCIL)
2	13480	Brake On / Off (BOO) Switch
3	12A648	Engine Coolant Temperature (ECT) Sensor

(Continued)

Item	Part Number	Description
4	12A697	Intake Air Temperature (IAT) Sensor
5	9B989	Throttle Position (TP) Sensor
6	12B579	Mass Air Flow (MAF) Sensor
7	2884	Air Conditioning Clutch (ACC)
8	9F479	Manifold Absolute Pressure (MAP) Sensor
9	12A199	Ignition Control Module (ICM)

OPERATION (Continued)

Powertrain Control Module

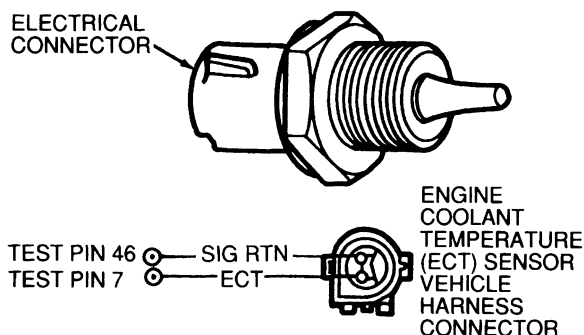


D10130-A

The operation of the 4R70W (AODE-W) automatic transmission is controlled by the powertrain control module (PCM). Many input sensors provide information to the PCM. The PCM then controls actuators which determine transmission operation.

Diagnostic Trouble Codes (DTCs): 511, 512 and 513

Engine Coolant Temperature (ECT) Sensor



D10147-A

The engine coolant temperature (ECT) sensor detects temperature of engine coolant and supplies information to the PCM.

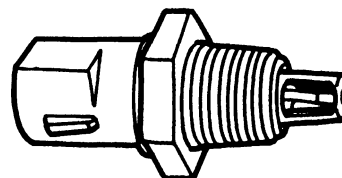
The ECT sensor is installed into the heater outlet fitting or cooling passage on the engine. For engine control applications, the ECT signal is used to modify ignition timing, EGR flow and air-to-fuel ratio as a function of engine coolant temperature. On electronic instrument clusters, the ECT output is used to control the coolant temperature indicator.

Transmission Function: The ECT sensor is used to control torque converter clutch operation.

Symptoms: Torque converter clutch will always be off, resulting in reduced fuel economy.

DTC's: 116, 117 and 118

Intake Air Temperature (IAT) Sensor



D10155-B

The sensor provides the multiport fuel injection (MPI) system with mixture (fuel and air) temperature information. The IAT is used both as a density corrector for airflow calculation and to proportion cold enrichment fuel flow.

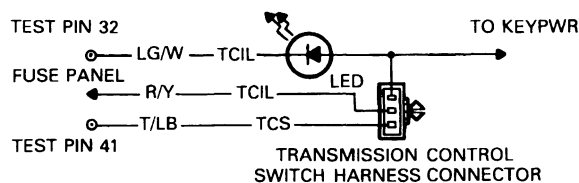
The sensor is installed into a cylinder runner of the intake manifold or mounted in the air cleaner assembly and provides the fuel system with mixture temperature information. The sensor input is used as a density corrector for airflow calculations and to proportion cold enrichment fuel flow.

Transmission Function: IAT is used in determining EPC pressure.

Symptoms: Incorrect EPC pressure either high or low will result in either harsh or soft shifts.

DTC's: 114, 112 and 113

Transmission Control Switch (TCS)



*TEST PINS LOCATED ON BREAKOUT BOX. ALL HARNESS CONNECTORS VIEWED INTO MATING SURFACE.

D11836-A

Description

The transmission control switch is a momentary contact switch. When the switch is pressed, a signal is sent to the PCM to allow automatic shifts from first through fourth gears or first through third gears only. The PCM then energizes the transmission control indicator lamp (TCIL).

NOTE: TCIL will also flash if the EPC circuit is shorted.

Sensor: Transmission Control Switch (TCS)

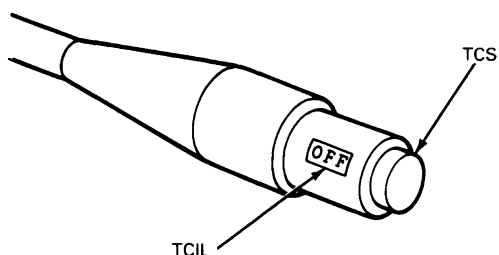
Transmission Function: Disable fourth gear operation.

OPERATION (Continued)

Symptoms: No overdrive cancel when switch is cycled.

DTC: 632 tested during Key On Engine Off (KOEO) Self-Test.

Transmission Control Indicator Lamp (TCIL)



D11837-A

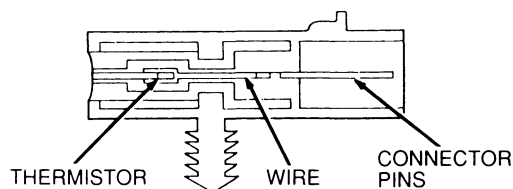
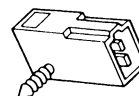
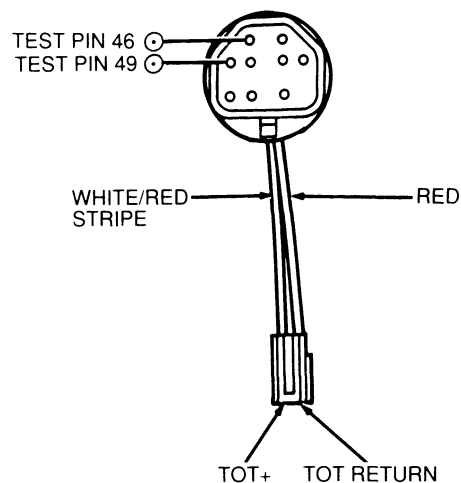
Transmission Function: Indicates overdrive cancel mode activated (lamp ON) and EPC circuit shorted (lamp flashing).

Symptoms: FAILED ON - Overdrive cancel mode always indicated, no flashing for EPC circuit shorted.

FAILED OFF - Overdrive cancel mode never indicated, no flashing for EPC circuit shorted.

DTC: 631

Transmission Oil Temperature (TOT) Sensor



D10158-B

The transmission oil temperature (TOT) sensor is located on the transmission main control in the transmission sump. It is a temperature sensitive device called a thermistor. It sends a voltage signal to the PCM. The voltage signal varies with transmission fluid temperature.

Transmission Function:

The PCM assembly uses this voltage signal to determine whether a cold start shift schedule is necessary. The shift schedule is compensated when the transmission fluid temperature is cold. The PCM also inhibits torque converter clutch operation at low transmission fluid temperatures and corrects EPC pressures for temperature.

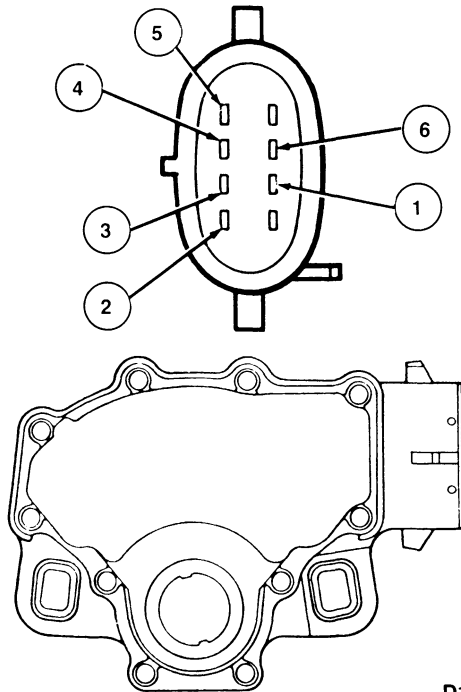
Symptoms:

Converter clutch engagement and stabilized shift schedules happen too soon after a cold start.

DTC's: 636, 637 and 638

OPERATION (Continued)

Manual Lever Position (MLP) Sensor



D10186-B

Item	Circuit / Color	Description
1	359 GY / R	PCM Signal Return
2	33 W / PK	Start
3	140 BK / PK	Back-Up Lamps
4	298 P / O	Accessory Feed
5	32 R / LB	Start
6	199 LB / Y	Resistance Signal to PCM

The manual lever position (MLP) sensor sends a signal to the PCM assembly, which indicates position of the shift lever (P,R,N,⊙,2,1). The MLP sensor is located on the outside of the transmission on the manual lever shaft.

NOTE: The sensor also contains the park / neutral position and backup lamp circuits.

Transmission Function:

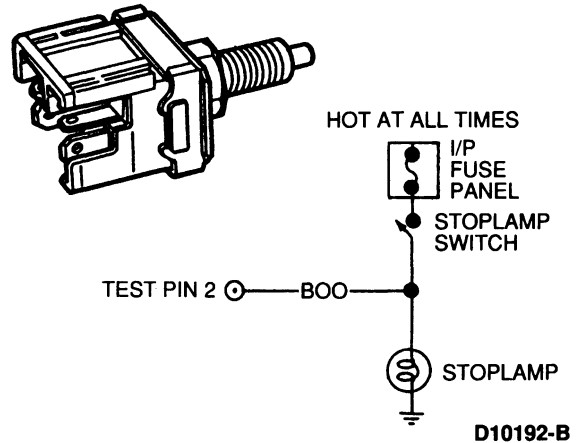
Determines desired gear and EPC pressure.

Symptoms:

Engagement concerns, wrong gear, no shifts.

DTC's: 634 and 522

Brake ON/OFF (BOO) Switch



D10192-B

The Brake ON/OFF (BOO) switch tells the PCM when the brakes are applied. The switch closes when brakes are applied and opens when they are released.

Transmission Function:

Disengage torque converter clutch when brake is applied.

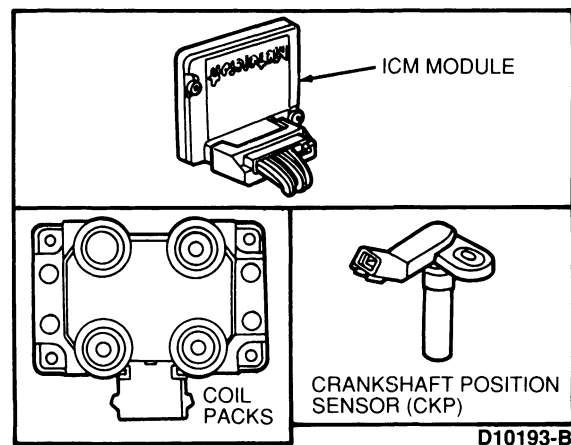
Symptoms:

Failed "ON"—torque converter clutch will not engage at less than one-third throttle.

Failed "OFF" or not connected—torque converter clutch will not disengage when brake is applied.

DTC: 536

Electronic Ignition (EI)



D10193-B

The electronic ignition consists of a crankshaft position (CKP) sensor (12A 127), ICM, two four tower coil packs and the PCM. The ICM operates by sending crankshaft position information from the CKP sensor to the ICM. The module generates a PIP signal (engine rpm) and sends it to the PCM.

OPERATION (Continued)

Transmission Function:

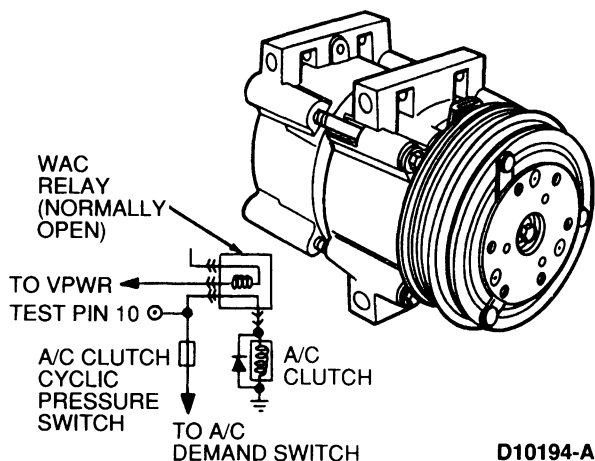
Uses rpm signal in the transmission strategy. Wide-open throttle (WOT) shift control, torque converter clutch control and EPC pressure.

Symptoms:

Harsh engagements and shifts, late WOT shift, no torque converter clutch engagement.

DTC's: 211, 212, 214 through 217, 232, 238 and 241

Air Conditioning Clutch (ACC)



An electro-magnetic clutch is energized when the clutch cycling pressure switch closes. The switch is located on the suction accumulator / drier. The closing of the switch completes the circuit to the clutch and draws it into engagement with the compressor drive shaft.

Transmission Function:

Adjust EPC pressure when A/C compressor clutch is engaged to compensate for additional load on the engine.

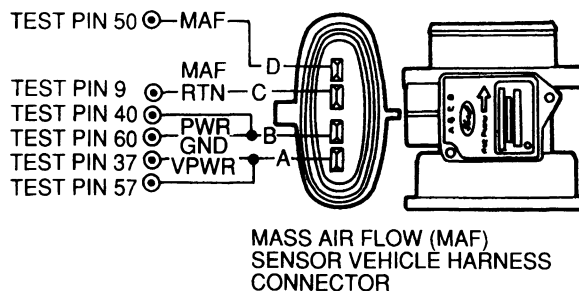
Symptoms:

Failed "ON"—EPC pressure slightly low with A/C OFF.

Failed "OFF"—EPC pressure slightly high with A/C ON.

DTC: 539

Mass Air Flow (MAF) Sensor



The mass air flow (MAF) sensor directly measures the mass of air flowing into the engine. The sensor output is a DC (analog) signal ranging from 0.5 volt to 5 volts used by the PCM to calculate injector pulse width. For transmission strategies this sensor is used for EPC pressure control, shift and torque converter clutch scheduling.

Transmission Function:

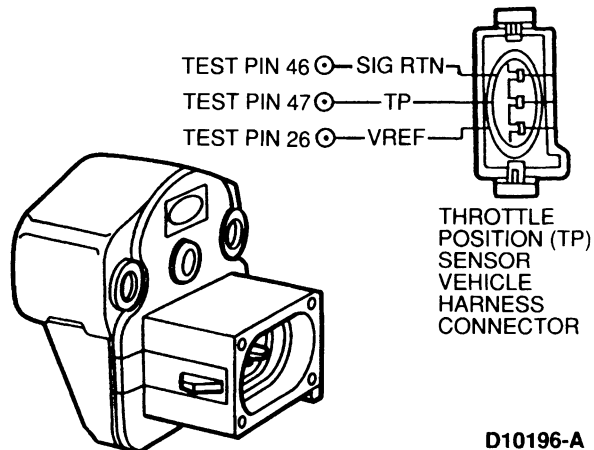
EPC pressure control, shift and torque converter clutch scheduling.

Symptoms:

High/low EPC pressure, incorrect shift schedule, incorrect converter engagement scheduling and symptoms similar to a throttle position (TP) sensor malfunction.

DTC's: 157, 158, 159, 184 and 185

Throttle Position (TP) Sensor



The throttle position (TP) sensor is a potentiometer mounted on the throttle body. The TP sensor detects the position of the throttle plate and sends this information to the PCM as a varying voltage signal.

Transmission Function:

Shift scheduling, EPC pressure control, torque converter clutch control.

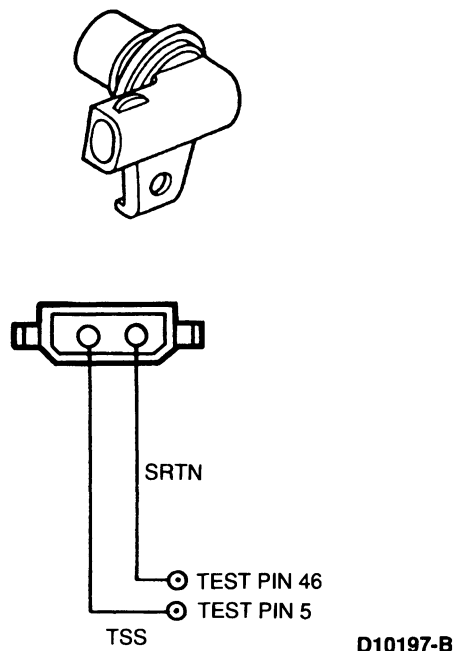
OPERATION (Continued)

Symptoms:

Harsh engagements, firm shift feel, abnormal shift schedule, torque converter clutch does not engage, torque converter clutch cycling.

DTC's: 121, 122, 123, 124, 125 and 167

Transmission Speed Sensor (TSS)

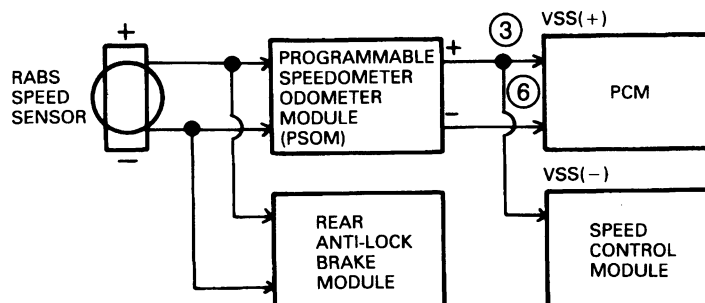


A transmission speed sensor (TSS) is a magnetic pickup, located at the output shaft ring gear that sends a signal to the PCM to indicate transmission output shaft speed.

Transmission Function:

Torque converter clutch control, shift scheduling, used in determining EPC pressure.

Programmable Speedometer/Odometer Module (PSOM)

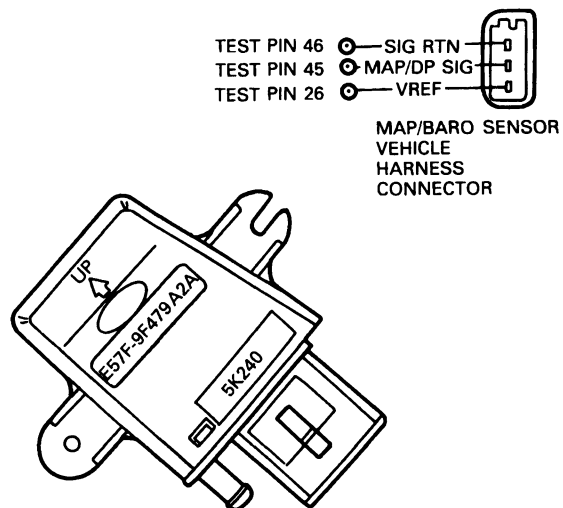


Symptoms:

No converter engagements, harsh shifts, abnormal shift schedules.

DTC: 639

Barometric Pressure (BARO) Sensor



The Barometric Pressure (BARO) Sensor measures barometric pressure to produce an electrical signal. The PCM uses this information to determine the altitude at which the vehicle is operating. The PCM then adjusts the transmission shift schedule for the altitude.

Transmission Function:

Used as an input to determine shift schedule and EPC pressure for altitude operation.

Symptoms:

Firm shift feel, late shifts at altitude.

DTCs: 126, 129

OPERATION (Continued)

The Programmable Speedometer / Odometer Module (PSOM) receives input from the Rear Anti-Lock Brake System (RABS) Speed Sensor, which is mounted on the rear axle differential housing. The PSOM processes this input signal information and relays it to the speed control module and the powertrain control module (PCM). This signal tells the PCM the vehicle speed in MPH.

Transmission Function:

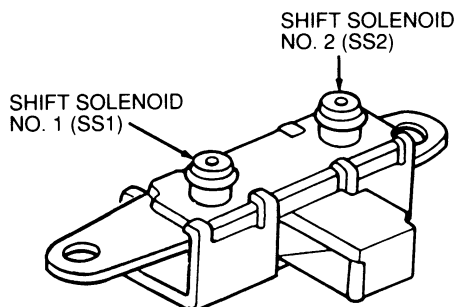
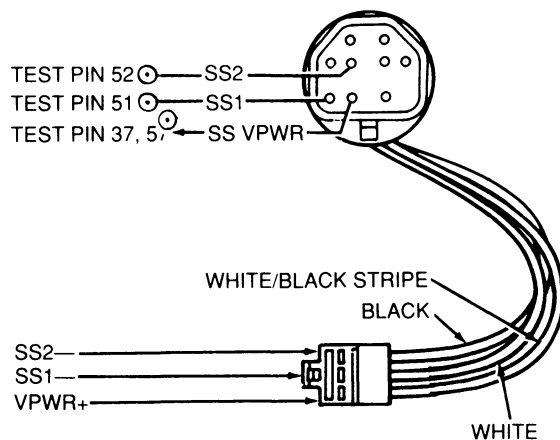
Module upshift schedules.

Symptoms:

Shift hunting on grades.

DTC: 452

Shift Solenoid Assembly (SS-1 and SS-2)



D10199-B

Two ON/OFF solenoids are used for electronic shift scheduling. One unit containing the two solenoids is located in the main control assembly. The solenoids are two-way, normally open style.

Transmission Function:

Solenoids SS-1 and SS-2 provide gear selection of first through fourth gears by controlling the pressure to the three shift valves.

SS-1 Symptoms:

Improper gear selection depending on failure mode and manual lever position.

Failed "ON"—first and fourth gear only.

Failed "OFF"—second and third gear only.

DTC's: 617, 618**, 619** and 621***

SS-2 Symptoms:

Improper gear selection depending on failure mode and manual lever position.

Failed "ON"—third and fourth gear only.

Failed "OFF"—first and second gear only.

DTC's: 618, 619** and 622***

SS-1 and SS-2 Symptoms:

Both failed "ON"—fourth gear only.

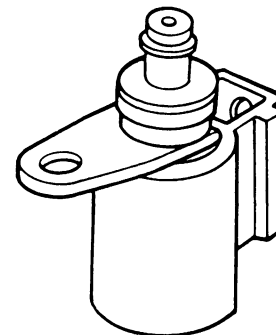
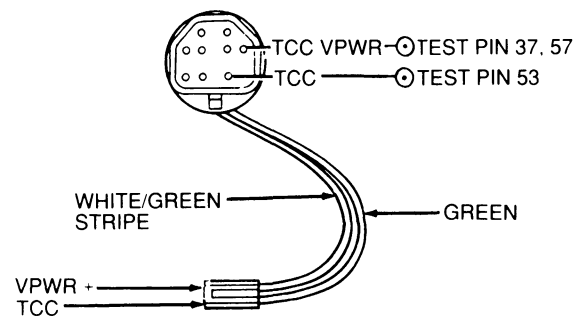
Both failed "OFF"—second gear only.

DTC's: 621* and 622*

* Output circuit check, generated only by electrical conditions.

** May also be generated by some non-electrical transmission component condition.

Torque Converter Clutch (TCC) Solenoid



D10200-B

The torque converter clutch (TCC) solenoid is used to control the apply and release of the torque converter clutch.

Transmission Function:

Used to engage the torque converter clutch.

Symptoms:

Failed "ON"—engine stalls in second gear (⊙, 2 range) at low idle speeds with the brake applied.

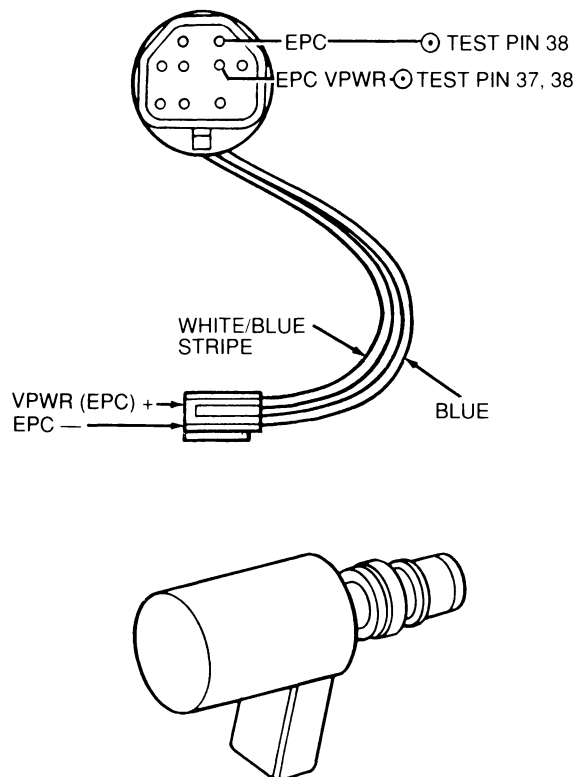
Failed "OFF"—converter never engages.

DTC's: 628, 652* and 656****

OPERATION (Continued)

* Output circuit check, generated only by electrical conditions.

** May also be generated by some non-electrical transmission component condition.

Electronic Pressure Control (EPC) Solenoid

D10201-B

The electronic pressure control (EPC) solenoid regulates transmission EPC (TV) pressure. EPC valve pressure is used to control line pressure and the 2-3 backout valve function.

Actuator:

Electronic pressure control (EPC)

Transmission Function:

Regulates EPC pressure, 2-3 backout valve control, line pressure.

Symptoms:

Failed "ON" — Minimum EPC pressure (minimum capacity), limit engine torque (alternate firing).

Failed "OFF" — Maximum EPC pressure, harsh engagements, harsh shifts.

DTC's: 624 and 625

Shift Solenoid Failure Modes**Shift solenoid failure "always ON":**

Failed "ON" due to PCM and/or vehicle wiring concerns, solenoid electrically or hydraulically stuck "ON" (TCS off).

SS-1 ALWAYS ON:	Transmission Selector Lever Position		
	OD	2	1
PCM Gear Commanded	Actual Gear Obtained		
1	1	1	1
2	1	1	1
3	4	2*	2*
4	4	2*	2*

* No Engine Braking

SS-2 ALWAYS ON:	Transmission Selector Lever Position		
	OD	2	1
PCM Gear Commanded	Actual Gear Obtained		
1	4	2*	2*
2	3	2*	2*
3	3	2*	2*
4	4	2*	2*

* No Engine Braking

Shift solenoid failure "always OFF":

Failed "OFF" due to PCM assembly and/or vehicle wiring concerns, solenoid electrically or hydraulically stuck "OFF" (TCS off).

SS-1 ALWAYS OFF:	Transmission Selector Lever Position		
	OD	2	1
PCM Gear Commanded	Actual Gear Obtained		
1	2	2	2
2	2	2	2
3	3	2*	2*
4	3	2*	2*

*No Engine Braking

SS-2 ALWAYS OFF:	Transmission Selector Lever Position		
	OD	2	1
PCM Gear Commanded	Actual Gear Obtained		
1	1	1	1
2	2	2	2
3	2	2	2
4	1	1	1

OPERATION (Continued)

4R70W (AODE-W) Solenoid Operations

Gear Selection Position	PCM Commanded Gear	4R70W (AODE-W) Solenoids		
		SS-1	SS-2	TCC
P / R / N	1	ON	OFF	HD
OD	1	ON	OFF	EC
OD	2	OFF	ON	EC
OD	3	OFF	ON	EC
OD	4	ON	ON	EC
D w/OD OFF				
1	1	ON	OFF	HD
2	2	OFF	OFF	EC

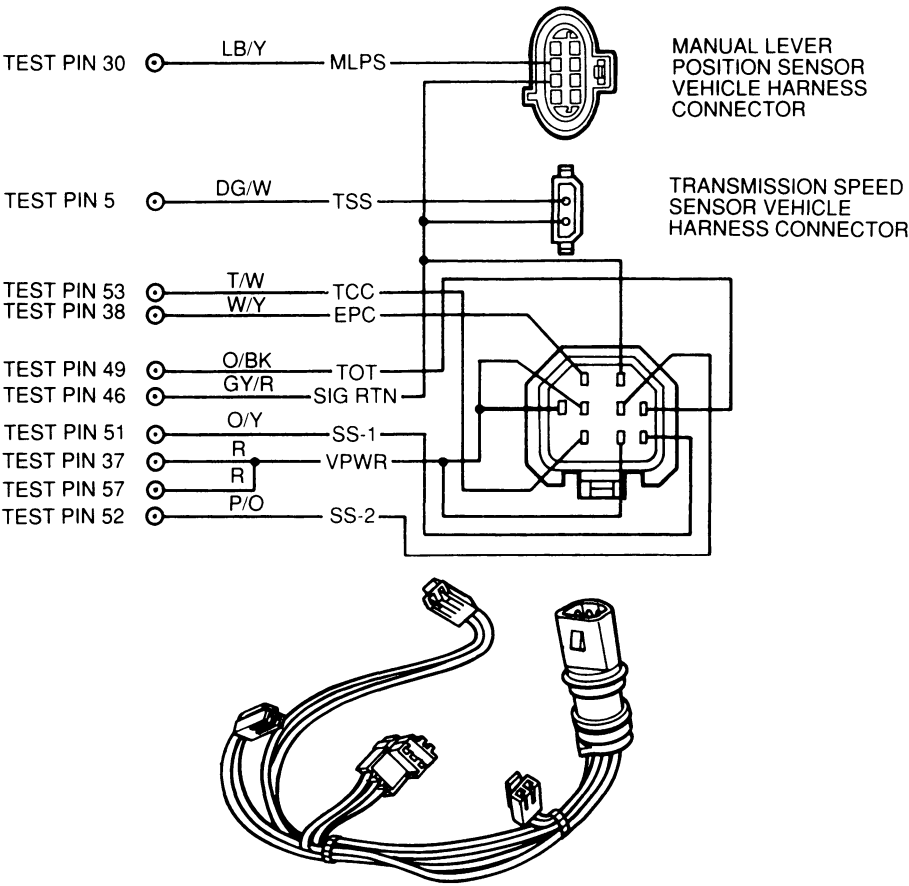
(Continued)

Gear Selection Position	PCM Commanded Gear	4R70W (AODE-W) Solenoids		
		SS-1	SS-2	TCC
3	3	OFF	ON	EC
Manual 2	2	OFF	OFF	EC
Manual 1	1	ON	OFF	HD
** 1	2	OFF	OFF	EC

** When a manual pull-in occurs above a calibrated speed the transmission will downshift from the higher gear until the vehicle speed drops below this calibrated speed.

EC = Electronically Controlled
HD = Hydraulically Disabled

Transmission — 4R70W (AODE-W)



D10204-B

DIAGNOSIS AND TESTING

The following diagnosis sequence is a proven method for troubleshooting the 4R70W (AODE-W) transmission. DO NOT attempt short cuts or assume the critical checks and adjustments have already been performed.

This diagnosis covers electronic and hydraulic / mechanical concerns from the transmission connector to internal transaxle components. Refer to the Powertrain Control / Emissions Diagnosis Manual¹ for electronic concerns from the transmission connector through the vehicle electronic system.

Required Equipment:

- Powertrain Control / Emissions Diagnosis Manual¹
- Rotunda SUPER STAR II Tester 007-004 1A or equivalent
- Rotunda Transmission Tester 007-00085 or equivalent
- Rotunda Digital Volt-Ohmmeter 014-00407 or equivalent
- MLP Tester D89T-70010-A or equivalent
- Gear Position Sensor Adjuster T492P-70010-AH or equivalent

4R70W (AODE-W) Diagnostic Sequence

1. Determine customer concern relative to vehicle usage.
 - Hot or cold vehicle operating temperature
 - Hot or cold ambient temperatures
 - Type of terrain
 - Vehicle loaded / unloaded
 - City or highway driving
2. Fluid level and condition check. Check for contamination or burnt smell. Check for leaks.
3. Road test vehicle to confirm customer concern.
4. Inspect vehicle for non-Ford approved add-on devices such as: cellular phones, speed controls, CB radio, linear boosters, back up alarm signals, computers etc., that if not installed properly will affect EEC-IV system or transmission function. Pay particular attention to add-on wiring splices.
5. Check shift linkage for proper adjustment.
6. After road test with vehicle at normal operating temperature perform a EEC-IV On-Board Diagnostics Quick Test using SUPER STAR II Tester 007-004 1A or equivalent as outlined in Section 5A of the Powertrain Control / Emissions Diagnosis Manual¹.

7. Service all diagnostic trouble codes (DTC's) as outlined in the Powertrain Control / Emissions Diagnosis Manual¹. Service all non-transmission codes first before servicing any transmission codes. If any transmission diagnostic trouble codes are still present or if referred to this Section after performing the pinpoint tests outlined in the Powertrain Control / Emissions Diagnosis Manual,¹ refer to the Pinpoint Test Index in this Section to determine the appropriate pinpoint test required to diagnose the diagnostic trouble code.
8. If transmission continuous codes are set during Quick Test, perform the Drive Cycle Test as outlined in this Section.
9. If no transmission codes are set during Quick Test, use Rotunda Transmission Tester 007-00085 or equivalent as outlined under Transmission Tester Instructions to isolate the condition to the transmission or to the vehicle harness and powertrain control module (PCM).

Diagnostic Hydraulic / Mechanical Routine Chart Instructions

The 4R70W (AODE-W) Hydraulic / Mechanical Routine charts are used to separate electrical from mechanical causes or concerns.

Refer to the following guidelines:

1. Define major concern.
2. Eliminate possible causes in the electrical cause / concern column 200 numbers.
3. Eliminate possible causes in the hydraulic / mechanical cause / concern column 300 numbers.

NOTE: The items listed under the main headings are arranged in order of disassembly.

Preliminary Diagnostics

- Check Fluid / Level Condition
- Vehicle at Normal Operating Temperature
- Visual Inspection of Harness Connections / Wiring
- Were On-Board Diagnostics run?
- Check for leaks
- Check for Electronic Add-On Items
- Check for Vehicle Modifications
- Check Shift Linkage for Proper Adjustment

¹ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

- Validate Customer Concern
 - Upshift
 - Downshift
 - Coasting
 - Engagement
 - Noise / Vibration
 - *RPM Dependant
 - *Vehicle Speed Dependant
 - *Shift Dependant
 - *Gear Dependant

DIAGNOSTIC ROUTINES INDEX

TITLE	ROUTINES	
	ELECTRICAL (1)	MECHANICAL HYDRAULIC
Engagement Concerns		
No Forward	201	301
No Reverse	202	302
Harsh Reverse	203	303
Harsh Forward	204	304
Delayed / Soft Reverse	205	305
Delayed / Soft Forward	206	306
Shift Concerns		
Some / All Shifts Missing	210	310
Timing Concerns		
—Early / Late	211	311
—Erratic	212	312
Feel		
—Soft / Slipping	213	313
—Harsh	214	314
No First Gear, Engages in Higher Gear	215	315
No Manual First Gear	216	316
No Manual Second Gear	217	317
Converter Operation Concerns		
No Apply	240	340
Always Applied / Stalls Vehicle	241	341
Cycling / Shudder / Chatter	242	342
Other Concerns		
No Engine Braking in 2nd Gear, Manual 2nd or Manual 1st Position	250	350
Shift Lever Efforts High	251	351
External Leaks	252	352
Poor Vehicle Acceleration	253	353
Noise / Vibration - Forward or Reverse	254	354
Engine will not Crank	255	355
No PARK Range	256	356
Overheating	257	357
Reference		
Hydraulic Pressure Chart		401

(1) Perform electrical routine first.

TD 10375B

No Forward Engagements

Possible Component	Reference / Action
201 — ELECTRICAL ROUTINE	
No Electrical Concerns	

(Continued)

DIAGNOSIS AND TESTING (Continued)**No Forward Engagements (Cont'd)**

Possible Component	Reference / Action
301 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid —Improper level —Condition	—Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.
Shift Linkage —Damaged, misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures —Low forward clutch pressure, Low line pressure	—Check pressure at line and forward clutch tap. Refer to Pressure Chart for specification. If pressures are low, check the following possible components: oil filter and seal assembly, main controls, pump assembly, forward clutch assembly.
Oil Filter and Seal Assembly —Plugged, damaged —Filter seal damaged	—Replace filter and seal assembly.
Main Controls —3-4 shift valve, main regulator valve, orifice control valve, manual valve —stuck, damaged —Bolts not tightened to specification —Gaskets damaged —2-3 accumulator and seals damaged	—Inspect for damage. Service as required. —Retighten bolts to specification. —Inspect gasket for damage and replace. —Inspect piston, seals and bore for damage. Service as required.
Pump Assembly —Bolts not tightened to specification —Porosity / cross leaks and ball missing or leaking, plugged hole —No. 3 and No. 4 seal rings damaged —Gaskets damaged	—Retighten bolts to specification. —Inspect for porosity and leaks. Service as required. —Inspect seals for damage. Service as required. —Inspect for damage and replace.
Forward Clutch Assembly —Seals, piston damaged —Check balls damaged, missing, mislocated, not seating properly —Friction Elements damaged or worn	—Inspect seals for damage. Service as required. —Inspect for mislocation, poor seating, damage. Replace cylinder as required. —Check for abnormal wear, damage. Service as required.
Low One-Way Clutch Assembly (Planetary) —Worn, damaged or assembled wrong	—Inspect for damage. Service as required.
Output Shaft —Sleeve / pin damaged	—Inspect for damage. Service as required.

TD10377B

No Reverse Engagement

Possible Component	Reference / Action
202 — ELECTRICAL ROUTINE	
No Electrical Concerns	
302 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid —Improper level —Condition	—Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.
Shift Linkage —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures	

(Continued)

DIAGNOSIS AND TESTING (Continued)**No Reverse Engagement (Cont'd)**

Possible Component	Reference / Action
—Low reverse clutch pressure, Low reverse band pressure, Low line pressure	—Check pressure at line pressure tap. Refer to Hydraulic Pressure Chart for specifications. If pressures are low, check the following possible components: oil filter and seal assembly, main controls, reverse servo, pump assembly, reverse clutch assembly.
Oil Filter and Seal Assembly —Plugged, damaged	—Replace filter and seal assembly.
Main Controls —No. 6 shuttle ball, manual valve, main regulator valve, 1-2 accumulator seals stuck or damaged —Bolts not tightened to specification. —Gasket damaged	—Inspect for damage. Service as required. —Retighten bolts to specification. —Inspect for damage and replace.
Low Reverse Servo —Seals (piston and cover) damaged —Servo cover retaining ring assembled wrong —Anchor pins (case) damaged	—Inspect for damage. Service as required.
Pump Assembly —Bolts not tightened to specification. —Porosity / cross leaks / ball missing or leaking, plugged hole —Gasket damaged —No. 1 and 2 seal rings damaged	—Retighten bolts to specification. —Inspect pump assembly. Replace as required. —Inspect for damage and replace. —Inspect for damage. Service as required.
Reverse Clutch Assembly —Seals, piston damaged —Check ball missing or damaged —Friction elements damaged or worn	—Inspect for damage. Service as required.
Low Reverse Band —Band, servo, anchor pins damaged or worn	—Inspect for damage. Service as required.

TD10379B

Harsh Reverse Engagement

Possible Component	Reference / Action
203 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, TOT sensor, EPC solenoid	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ² for diagnosis. Perform engagement test, EPC test and Pinpoint Tests B and E using transmission tester (007-00085) as outlined. Service as required. Clear codes, road test and rerun Self-Test.
303 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid —Improper level —Condition	—Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.
Shift Linkage —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures —High line pressure High EPC pressure	—Check pressure at line and EPC pressure taps. Refer to Hydraulic Pressure Chart for specifications. If high, check the following possible components: main controls, oil filter and seal assembly.
Oil Filter and Seal Assembly —Plugged or damaged —Filter seal damaged	—Replace filter and seal assembly.
Main Controls	

(Continued)

² Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Harsh Reverse Engagement (Cont'd)**

Possible Component	Reference / Action
<ul style="list-style-type: none"> —No. 6 Shuttle ball, No. 5 check ball, manual valve, main regulator valve stuck, damaged or missing —Bolts not tightened to specification —Gasket damaged —EPC solenoid stuck or damaged 	<ul style="list-style-type: none"> —Inspect for damage. Service as required. —Retighten bolts to specification. —Inspect for damage and replace. —Inspect for damage, contamination. Perform EPC test in Routine No. 203. Service as required.
Low Reverse Servo <ul style="list-style-type: none"> —Seals (piston and cover) damaged —Servo cover retaining ring assembled wrong —Anchor pins (case) damaged 	<ul style="list-style-type: none"> —Inspect for damage. Service as required.
Pump Assembly <ul style="list-style-type: none"> —Bolts not tightened to specification —Porosity / cross leaks —Gasket damaged —No. 1 and No. 2 seal rings damaged 	<ul style="list-style-type: none"> —Retighten bolts to specification. —Inspect pump assembly. Replace as required. —Inspect for damage and replace. —Inspect for damage. Service as required.
Reverse Clutch Assembly <ul style="list-style-type: none"> —Seals, piston damaged —Check ball missing or damaged —Friction elements damaged, worn —Return spring piston damaged, worn 	<ul style="list-style-type: none"> —Inspect for damage. Service as required.
Low Reverse Band <ul style="list-style-type: none"> —Band, servo, anchor pin damaged or worn 	<ul style="list-style-type: none"> —Inspect for damage. Service as required.

TD10381B

Harsh Forward Engagement

Possible Component	Reference / Action
204 — ELECTRICAL ROUTINE	
Powertrain Control System <ul style="list-style-type: none"> —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, TOT sensor, EPC solenoid 	<ul style="list-style-type: none"> —Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual³ for diagnosis. Perform engagement test, EPC test and Pinpoint Tests B and E using transmission tester (007-00085) as outlined. Service as required. Clear codes, road test and rerun Self-Test.
304 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid <ul style="list-style-type: none"> —Improper level —Condition 	<ul style="list-style-type: none"> —Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.
Improper Pressures <ul style="list-style-type: none"> —High forward clutch pressure, High line pressure, High EPC pressure 	<ul style="list-style-type: none"> —Check pressure at line, EPC and forward pressure taps. Refer to Hydraulic Pressure Chart for specifications. If pressures are high, check the following possible components: main controls, pump assembly.
Main Controls <ul style="list-style-type: none"> —Main regulator valve, 2-3 Backout valve 2-3 Accumulator seal / retainer stuck, damaged —Bolts not tightened to specification —Gaskets damaged —EPC solenoid stuck or damaged 	<ul style="list-style-type: none"> —Inspect and service as required. —Retighten bolts to specification. —Inspect for damage and replace. —Inspect for damage or contamination. Perform EPC test in Routine No. 204. Service as required.
Pump Assembly <ul style="list-style-type: none"> —Bolts not tightened to specification —Porosity / cross leaks —Gaskets damaged 	<ul style="list-style-type: none"> —Retighten bolts to specification. —Inspect for porosity / leaks. Replace pump as required. —Inspect for damage and replace.

(Continued)

³ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Harsh Forward Engagement (Cont'd)**

Possible Component	Reference / Action
Forward Clutch Assembly —Check balls missing or damaged —Friction element damaged or worn —Forward clutch wave spring damaged —Forward clutch return spring damaged	—Inspect for mislocation, poor seating, damage. Replace forward clutch cylinder. —Inspect for damage. Service as required. —Inspect for damage. Service as required. —Inspect for damage. Service as required.

TD10383B

Delayed / Soft Reverse Engagement

Possible Component	Reference / Action
205 — ELECTRICAL ROUTINE	
No Electrical Concerns	
305 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid —Improper level —Condition	—Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.
Shift Linkage —Damaged, misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures —Low reverse clutch pressure —Low reverse band pressure —Low line pressure	—Check pressure at line tap. Refer to Hydraulic Pressure Chart for specifications. If pressures are low, check the following possible components: main controls, pump assembly, reverse clutch assembly, reverse servo.
Oil Filter and Seal Assembly —Plugged, damaged —Filter seal damaged	—Replace filter and seal assembly.
Main Controls —No. 6 shuttle ball, 1-2 accumulator seals, manual valve, main regulator valve stuck or damaged —Bolts not tightened to specification. —Gaskets damaged	—Inspect for damage. Service as required. —Retighten bolts to specification. —Inspect for damage and replace.
Low Reverse Servo —Seals (piston and cover) damaged —Servo cover retaining ring assembled wrong.	—Inspect for damage. Service as required.
Pump Assembly —Bolts not tightened to specification. —Porosity / cross leaks / ball missing or leaking —Gaskets damaged —No. 1 and No. 2 seal rings damaged	—Retighten bolts to specification. —Inspect pump assembly. Replace as required. —Inspect for damage and replace. —Inspect for damage. Service as required.
Reverse Clutch Assembly —Seals, piston damaged —Check ball missing or damaged —Friction elements damaged, worn —Return spring and piston damaged, worn	—Inspect for damage. Service as required.
Low Reverse Band —Damaged, worn	—Inspect for damage. Service as required.

TD10385B

DIAGNOSIS AND TESTING (Continued)**Delayed / Soft Forward Engagement**

Possible Component	Reference / Action
206 — ELECTRICAL ROUTINE	
No Electrical Concerns	
306 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid —Improper level —Condition	—Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.
Shift Linkage —Damaged, misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures —Low forward clutch pressure Low line pressure Low EPC pressure	—Check pressure at line, forward clutch and EPC taps. Refer to Hydraulic Pressure Chart for specifications. If pressures are low, check the following possible components: oil filter and seal assembly, main controls and pump assembly.
Oil Filter and Seal Assembly —Plugged, damaged —Filter seal damaged	—Replace filter and seal assembly.
Main Controls —3-4 shift valve, main regulator valve, orifice control valve stuck or damaged —Bolts not tightened to specification —Gaskets damaged —2-3 or 1-2 accumulator, seals, bore damaged or stuck	—Inspect and service as required. —Retighten bolts to specification. —Inspect for damage and replace. —Inspect for damage. Service as required.
Pump Assembly —Bolts not tightened to specification. —Porosity / cross leaks —Gaskets damaged —No. 3, No. 4 seal rings damaged	—Retighten bolts to specification. —Inspect pump assembly. Replace as required. —Inspect for damage and replace. —Inspect for damage. Service as required.
Forward Clutch Assembly —Seals, piston damaged —Check balls missing, damaged —Friction elements damaged, worn	—Inspect for damage. Service as required. —Inspect for mislocation, poor seating, damage. Replace cylinder as required. —Check for damage. Service as required.

TD10411B

Shift Concerns: Some or All Shifts Missing

Possible Component	Reference / Action
210 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids, Transmission Speed Sensor (TSS), MLP sensor	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ⁴ for diagnosis. Perform Pinpoint Tests A, D and F using Rotunda Transmission Tester (007-00085) and MLP tester (D89T-70010-A) as outlined. Service as required. Clear codes, road test and rerun Self-Test.
310 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid —Improper level —Condition	—Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.
Shift Linkage, MLP Sensor	

(Continued)

4 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Shift Concerns: Some or All Shifts Missing (Cont'd)**

Possible Component	Reference / Action														
—Damaged, misadjusted	<p>—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.</p> <p>—For further diagnosis, refer to the appropriate shift routine(s) in the following chart:</p> <table border="1"> <thead> <tr> <th>Shift</th><th>Routine</th></tr> </thead> <tbody> <tr><td>1-2</td><td>220/320</td></tr> <tr><td>2-3</td><td>221/321</td></tr> <tr><td>3-4</td><td>222/322</td></tr> <tr><td>4-3</td><td>223/323</td></tr> <tr><td>3-2</td><td>224/324</td></tr> <tr><td>2-1</td><td>225/325</td></tr> </tbody> </table> <p>CD8088-A</p>	Shift	Routine	1-2	220/320	2-3	221/321	3-4	222/322	4-3	223/323	3-2	224/324	2-1	225/325
Shift	Routine														
1-2	220/320														
2-3	221/321														
3-4	222/322														
4-3	223/323														
3-2	224/324														
2-1	225/325														

TD 10387B

Shift Concerns: Shift Timing — Early / Late

Possible Component	Reference / Action														
211 — ELECTRICAL ROUTINE															
Powertrain Control System Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids, EPC solenoid, TOT sensor, TSS	<p>—Run Self-Test. Refer to Powertrain Control/Emissions Diagnosis Manual⁵ for diagnosis. Perform Pinpoint Tests A, B, E and F using Rotunda Transmission Tester (007-00085) as outlined. Service as required. Clear codes, road test and rerun Self-Test.</p>														
311 — HYDRAULIC/MECHANICAL ROUTINE															
Other —Tire size change —Axle ratio change	<p>—Verify vehicle has original equipment. Refer to Certification Label and Safety Standard Certification Label. Changes in tire size, axle ratio will affect shift timing.</p>														
Fluid —Improper level —Condition	<p>—Adjust fluid to proper level.</p> <p>—Inspect as outlined under Fluid Condition Check.</p>														
Improper Pressures —Line pressure EPC pressure	<p>—Check pressure at line and EPC taps. Refer to Hydraulic Pressure Chart for specifications. If not OK, check the main controls. If OK refer to the appropriate shift routine(s) in the following chart.</p> <table border="1"> <thead> <tr> <th>Shift</th><th>Routine</th></tr> </thead> <tbody> <tr><td>1-2</td><td>320</td></tr> <tr><td>2-3</td><td>321</td></tr> <tr><td>3-4</td><td>322</td></tr> <tr><td>4-3</td><td>323</td></tr> <tr><td>3-2</td><td>324</td></tr> <tr><td>2-1</td><td>325</td></tr> </tbody> </table> <p>CD8089-A</p>	Shift	Routine	1-2	320	2-3	321	3-4	322	4-3	323	3-2	324	2-1	325
Shift	Routine														
1-2	320														
2-3	321														
3-4	322														
4-3	323														
3-2	324														
2-1	325														
Main Controls —EPC solenoid, stuck or damaged hydraulically or mechanically —Valves, accumulators, seals stuck or damaged or assembled wrong —Gaskets damaged —Solenoid screen (in valve body) blocked or damaged	<p>—Inspect for damage, contamination. Perform EPC tests in Routine No. 211. Service as required.</p> <p>—Inspect for damage. Service as required.</p> <p>—Inspect for damage and replace.</p> <p>—Clean or replace screen.</p>														

TD 10389B

5 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Shift Concerns: Timing - Erratic

Possible Component	Reference / Action														
212 — ELECTRICAL ROUTINE															
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids, TCC solenoid, MLP sensor, TSS	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ⁶ for diagnosis. Perform Pinpoint Tests A, C, D and F using Rotunda Transmission Tester (007-00085) or equivalent and MLP Tester (D89T-70010-A) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.														
312 — HYDRAULIC / MECHANICAL ROUTINE															
Fluid —Improper level —Condition	—Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.														
Main Controls —Valves, accumulators, seals, assembled wrong, stuck or damaged —Gaskets damaged —Solenoid screen (in valve body) blocked or damaged	—Inspect for damage. Service as required. —Inspect for damage and replace. —Clean or replace screen.														
Torque Converter Clutch	—Refer to Hydraulic / Mechanical Routine 342, Converter Cycling.														
For Diagnosis related to a specific shift	—Refer to the appropriate shift routine(s) in the following chart: <table border="1"> <thead> <tr> <th>Shift</th><th>Routine</th></tr> </thead> <tbody> <tr> <td>1-2</td><td>320</td></tr> <tr> <td>2-3</td><td>321</td></tr> <tr> <td>3-4</td><td>322</td></tr> <tr> <td>4-3</td><td>323</td></tr> <tr> <td>3-2</td><td>324</td></tr> <tr> <td>2-1</td><td>325</td></tr> </tbody> </table>	Shift	Routine	1-2	320	2-3	321	3-4	322	4-3	323	3-2	324	2-1	325
Shift	Routine														
1-2	320														
2-3	321														
3-4	322														
4-3	323														
3-2	324														
2-1	325														
	CD8089-A														

TD 10391B

Shift Concerns: Feel — Soft / Slipping

Possible Component	Reference / Action
213 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, EPC solenoid, TSS	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ⁶ for diagnosis. Perform Pinpoint Tests E and F using Rotunda Transmission Tester (007-00085) as outlined. Service as required. Clear codes, road test and rerun Self-Test.
313 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid —Improper level —Condition	—Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.
Improper Pressures —Low line pressure Low EPC pressure	—Check pressures at line and EPC taps. Refer to Hydraulic Pressure Chart for specifications. If pressures are low or all shifts are soft / slipping, go to Main Controls. If pressures are OK and a specific shift is soft / slipping, refer to the appropriate routine(s) in the following chart:

(Continued)

6 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Shift Concerns: Feel — Soft/Slipping (Cont'd)**

Possible Component	Reference / Action														
	<table> <tr> <th>Shift</th><th>Routine</th></tr> <tr> <td>1-2</td><td>320</td></tr> <tr> <td>2-3</td><td>321</td></tr> <tr> <td>3-4</td><td>322</td></tr> <tr> <td>4-3</td><td>323</td></tr> <tr> <td>3-2</td><td>324</td></tr> <tr> <td>2-1</td><td>325</td></tr> </table> <p>CD8089-A</p>	Shift	Routine	1-2	320	2-3	321	3-4	322	4-3	323	3-2	324	2-1	325
Shift	Routine														
1-2	320														
2-3	321														
3-4	322														
4-3	323														
3-2	324														
2-1	325														
Main Controls — 1-2 Accumulator, 2-3 backout valve, main regulator valve, orifice control valve, overdrive servo regulator valve stuck, damaged or assembled wrong — EPC solenoid stuck or damaged	— Inspect for damage. Service as required. — Inspect for damage and contamination. Perform EPC tests in Routine No. 213. Service as required.														

TD10393B

Shift Concerns: Feel — Harsh

Possible Component	Reference / Action														
214 — ELECTRICAL ROUTINE															
Powertrain Control System — Electrical inputs / outputs, Vehicle wiring harnesses, PCM, EPC solenoid, TSS	— Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ⁷ for diagnosis. Perform Pinpoint Tests E and F using Rotunda Transmission Tester (007-00085) as outlined. Service as required. Clear codes, road test and rerun Self-Test.														
314 — HYDRAULIC / MECHANICAL ROUTINE															
Fluid — Improper level — Condition	— Adjust fluid to proper level. — Inspect as outlined under Fluid Condition Check.														
Improper Pressures — High line pressure, high EPC pressure	— Check pressures at line and EPC taps. Refer to Hydraulic Pressure Chart for specifications. If pressures are high or all shifts are harsh, go to Main Controls. If pressures are OK and a specific shift is harsh, refer to the appropriate shift routine in the following chart: <table> <tr> <th>Shift</th><th>Routine</th></tr> <tr> <td>1-2</td><td>320</td></tr> <tr> <td>2-3</td><td>321</td></tr> <tr> <td>3-4</td><td>322</td></tr> <tr> <td>4-3</td><td>323</td></tr> <tr> <td>3-2</td><td>324</td></tr> <tr> <td>2-1</td><td>325</td></tr> </table> <p>CD8089-A</p>	Shift	Routine	1-2	320	2-3	321	3-4	322	4-3	323	3-2	324	2-1	325
Shift	Routine														
1-2	320														
2-3	321														
3-4	322														
4-3	323														
3-2	324														
2-1	325														
Main Controls — 1-2 Accumulator, 2-3 backout valve, main regulator valve, orifice control valve, Overdrive servo regulator valve stuck, damaged or assembled wrong — EPC solenoid stuck or damaged	— Inspect for damage. Service as required. — Inspect for damage, contamination. Perform EPC tests in Routine No. 214. Service as required.														

TD10395B

7 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Shift Concerns: No 1st Gear, Engages in Higher Gear

Possible Component	Reference / Action																								
215 — ELECTRICAL ROUTINE																									
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids, MLP sensor	—Run Self-Test. —Refer to Powertrain Control / Emissions Diagnosis Manual ⁸ for diagnosis. Perform Pinpoint Tests A and D using Rotunda Transmission Tester (007-00085) or equivalent and the MLP Tester (D89T-700 10-A) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.																								
315 — HYDRAULIC / MECHANICAL ROUTINE																									
Shift Linkage, MLP Sensor —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.																								
Improper Pressures —Low reverse clutch pressure, low reverse band pressure, low line pressure	—Check for which pressures are on and refer to Pressures Applied Chart and corresponding routines. <table border="1"><thead><tr><th>Forward</th><th>Intermediate</th><th>Direct</th></tr></thead><tbody><tr><td>Off</td><td>Off</td><td>X</td></tr><tr><td>Off</td><td>X</td><td>Off</td></tr><tr><td>Off</td><td>X</td><td>X</td></tr><tr><td>X</td><td>Off</td><td>X</td></tr><tr><td>X</td><td>X</td><td>Off</td></tr><tr><td>X</td><td>X</td><td>X</td></tr><tr><td>X</td><td>Off</td><td>Off</td></tr></tbody></table> <div>X = Pressures Applied</div> <div>CD8093-A</div>	Forward	Intermediate	Direct	Off	Off	X	Off	X	Off	Off	X	X	X	Off	X	X	X	Off	X	X	X	X	Off	Off
Forward	Intermediate	Direct																							
Off	Off	X																							
Off	X	Off																							
Off	X	X																							
X	Off	X																							
X	X	Off																							
X	X	X																							
X	Off	Off																							
Mechanical —Bands, clutches or seals damaged or worn	—Refer to Transmission, Disassembly and Assembly.																								

TD10397B

Shift Concerns: No Manual 1st Gear

Possible Component	Reference / Action
216 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids, MLP sensor	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ⁸ for diagnosis. Perform Pinpoint Tests A and D using Rotunda Transmission Tester (007-00085) or equivalent and the MLP Tester (D89T-700 10-A) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
316 — HYDRAULIC / MECHANICAL ROUTINE	
Shift Linkage, Cable, MLP Sensor —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures —Low reverse clutch pressure Low reverse band pressure Low line pressure Low EPC pressure	—Check pressure at line and EPC pressure taps. Refer to Hydraulic Pressure Chart for specifications. If pressures are low, check the following possible components: oil filter and seal assembly, main controls, reverse clutch assembly and reverse servo assembly.
Oil Filter and Seal Assembly —Plugged or damaged	—Replace filter and seal assembly.
Main Controls	

(Continued)

8 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Shift Concerns: No Manual 1st Gear (Cont'd)**

Possible Component	Reference / Action
—No. 6 shuttle ball, manual valve, main regulator valve, low servo modulator valve stuck, damaged or assembled wrong	—Inspect for damage. Service as required.
—Bolts not tightened to specification	—Retighten bolts to specification.
—Gaskets damaged	—Inspect for damage and replace.
Low Reverse Servo	
—Seals (piston and cover) damaged	—Inspect for damage. Service as required.
—Servo cover retaining ring assembled wrong	
—Anchor pins (case) damaged	

TD 10399B

Shift Concerns: No Manual 2nd Gear

Possible Component	Reference / Action
217 — ELECTRICAL ROUTINE	
Powertrain Control System	
—Electrical inputs / outputs, Vehicle wiring harnesses, Powertrain Control Module (PCM), Shift solenoids, MLP sensor	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ⁹ for diagnosis. Perform Pinpoint Tests A and D using Rotunda Transmission Tester (007-00085) or equivalent and the MLP Tester (D89T-70010-A) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
317 — HYDRAULIC / MECHANICAL ROUTINE	
Shift Linkage, Cable, MLP Sensor	
—Damaged, misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Assembly procedures.
Main Controls	
—Orifice Control Valve, 3-4 Shift Valve, 1-2 and 2-3 Shift Valve, 3-4 Capacity Modulator Valve stuck, damaged or assembled wrong.	—Inspect for damage. Service as required.
—Bolts not tightened to specification	—Retighten bolts to specification.
—Gaskets damaged	—Inspect for damage and replace as required.

TD8098A

Shift Concerns: 1-2 Shift

Possible Component	Reference / Action
220 — ELECTRICAL ROUTINE	
Powertrain Control System	
—Electrical inputs / outputs, Vehicle Wiring Harnesses, PCM, Shift solenoids, TSS	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ⁹ for diagnosis. Perform Pinpoint Tests A and F using Rotunda Transmission Tester (007-00085) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
320 — HYDRAULIC / MECHANICAL ROUTINE	
Shift Linkage, MLP Sensor	
—Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures	
—Intermediate clutch pressure Line pressure	—Check pressure at line and intermediate clutch taps. Refer to Hydraulic Pressure Chart for specifications. If not OK, check the Main Controls.
Main Controls	
—1-2 Shift valve, 1-2 accumulator valve stuck or damaged	—Inspect for damage. Service as required.
—Bolts not tightened to specification	—Retighten bolts to specification.
—SS-1 malfunction	—Activate solenoid using transmission tester. If solenoid operation cannot be felt when placing hand on solenoid, replace solenoid. Inspect O-rings for damage. Service as required.

(Continued)

9 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Shift Concerns: 1-2 Shift (Cont'd)**

Possible Component	Reference/Action
—Gasket damaged —No. 8 ball not seating	—Inspect for damage and replace. —Inspect for damage and service as required.
Pump —Porosity / cross leaks, balls missing, damaged or leaking —Gasket damaged	—Inspect for porosity / leaks, balls missing. Replace pump as required. —Inspect for damage and replace.
Intermediate Clutch Assembly —Seals damaged —Piston damaged —Friction elements damaged or worn	—Inspect for damage. Service as required. —Inspect for damage. Service as required. —Inspect for damage. Service as required.
Intermediate One-Way Clutch Assembly —Not holding or damaged	—Inspect for damage. Service as required.
Low One-Way Clutch Assembly —Not overrunning or damaged	—Inspect for damage. Service as required.

TD10401B

Shift Concerns: 2-3 Shift

Possible Component	Reference/Action
221 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids, TSS	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ¹⁰ for diagnosis. Perform Pinpoint Tests A and F using Rotunda Transmission Tester (007-00085) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
321 — HYDRAULIC / MECHANICAL ROUTINE	
Shift Linkage —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures —Direct clutch pressure	—Check pressure at direct clutch tap. Refer to Hydraulic Pressure Chart for specifications. If not OK, check the main controls.
Main Controls —2-3 Shift valve, check ball No. 1 or No. 3, solenoid pressure regulator valve, 2-3 backout valve, 2-3 modulator valve, orifice control valve stuck, damaged or assembled wrong —Bolts not tightened to specification. —SS-2 Malfunction —Gaskets damaged —Output shaft seals damaged or cup plug leaking or missing —2-3 Accumulator damaged or stuck —Solenoid screen (in main control) blocked or damaged	—Inspect for damage. Service as required. —Retighten bolts to specification. —Activate solenoid using transmission tester. If solenoid operation cannot be felt when placing hand on solenoid replace solenoid. Inspect O-rings for damage. Service as required. —Inspect for damage and replace. —Inspect for damage and service as required. —Inspect piston seal and bore for damage. Service as required. —Clean or replace screen.
Intermediate One-Way Clutch Assembly —Not overrunning or damaged	—Inspect for damage. Service as required.
Output Shaft —Seal rings damaged —Cup plug damaged or missing	—Inspect for damage. Service as required.
Direct Clutch Assembly —Seals or piston damaged —Friction elements worn or damaged —Check ball not seating	—Inspect for damage. Service as required. —Inspect for damage. Service as required. —Inspect for damage. Service as required.

(Continued)

10 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Shift Concerns: 2-3 Shift (Cont'd)

Possible Component	Reference / Action
—Return spring assembly damaged	—Inspect for damage. Service as required.
Case —Output shaft rear seals leaking or damaged	—Inspect for damage. Service as required. Inspect case for damaged seal area. If damaged, replace case.

TD10403B

Shift Concerns: 3-4 Shift

Possible Component	Reference / Action
222 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids, TSS, Transmission Control Switch (TCS)	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ¹¹ for diagnosis. Perform Pinpoint Tests A and F using Rotunda Transmission Tester (007-00085) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
322 — HYDRAULIC / MECHANICAL ROUTINE	
Shift Linkage, MLP Sensor —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures —Forward clutch pressure Direct clutch pressure Line pressure	—Check line, direct and forward clutch pressures at appropriate taps. Refer to Hydraulic Pressure Chart for specifications. If pressures are out of specification, check Main Controls.
Main Controls —3-4 Shift Valve, solenoid pressure regulator valve, OD servo regulator, 3-4 capacity modulator valve, 2-3 backout valve, orifice control valve, 1-2 and 2-3 shift valves stuck, damaged or assembled wrong —Bolts not tightened to specification. —SS-1 or SS-2 malfunction —Gaskets damaged —OD servo cover, rod and piston cushion spring or seals damaged —No's 1, 2, 4 and 7 check balls damaged or missing —Solenoid screen (in main control) blocked or damaged	—Inspect for damaged and service as required. —Retighten bolts to specification. —Activate solenoid using transmission tester. If solenoid operation cannot be felt when placing hand on solenoid, replace solenoid. Inspect O-rings for damage. Service as required. —Inspect for damage and replace. —Inspect for damage. Service as required. —Inspect for damage. Service as required. —Clean or replace screen.
Pump —Porosity / cross leaks, balls missing, damaged or leaking —Gaskets damaged	—Inspect for porosity / leaks, balls missing. Replace pump as required. —Inspect for damage. Replace as required.
OD Band —OD band and reverse clutch drum assembly damaged, worn or assembled wrong —Intermediate one-way clutch assembly damaged	—Inspect for damage and service as required. —Inspect for damage. Service as required.
Forward Clutch Assembly —Seals or piston damaged elements —Friction worn or damaged —Check ball stuck, damaged or not seating properly	—Inspect for damage. Service as required. —Inspect for damage. Service as required. —Inspect for damage. Service as required.
Input Shaft —Seals damaged	—Inspect for damage. Service as required.

TD10405B

11 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Shift Concerns: 4-3 Shift (Automatic)

Possible Component	Reference / Action
223 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids, Transmission Control Switch (TCS)	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ¹² for diagnosis. Perform Pinpoint Test A using Rotunda Transmission Tester (007-00085) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
323 — HYDRAULIC / MECHANICAL ROUTINE	
Improper Pressures —Forward clutch pressure Line pressure	—Check line and forward clutch at pressure taps. —Refer to Hydraulic Pressure Chart for specification. If out of specification, check main controls.
Main Control —3-4 shift valve, solenoid pressure regulator valve, OD servo regulator, 3-4 capacity modulator, orifice control valve, 2-3 backout valve, 1-2, 2-3 shift valves stuck, damaged or assembled wrong —Check balls No. 1, No. 2, No. 7 damaged, missing or not seating properly —Bolts not tightened to specification —SS-1 malfunction —Gaskets damaged —OD servo, seal, rod damaged —Solenoid screen (in main control) blocked or damaged	—Inspect for damage. Service as required —Inspect for damage. Service as required. —Retighten bolts to specification. —Activate solenoid using transmission tester. If solenoid operation cannot be felt when placing hand on solenoid, replace solenoid. Inspect O-rings for damage. Service as required. —Inspect for damage and replace. —Inspect for damage. Service as required. —Clean or replace screen.
Pump —Porosity / cross leaks, balls missing, damaged or leaking —Seal rings damaged. —Gaskets damaged	—Inspect for porosity / leaks, balls missing. Replace pump as required. —Inspect for damage. Service as required. —Inspect for damage and replace.
Overdrive Band —OD band and reverse clutch assembly damaged, worn or assembled wrong —Intermediate one-way clutch assembly damaged	—Inspect for damage. Service as required. —Inspect for damage. Service as required.
Forward Clutch Assembly —Seals or piston damaged —Friction elements damaged, worn —Check ball stuck, damaged or not seating properly —Forward clutch piston and return spring damaged	—Inspect for damage. Service as required. —Inspect for damage. Service as required. —Inspect for damage. Service as required. —Inspect for damage. Service as required.
Input Shaft —Seals damaged	—Inspect for damage. Service as required.

TD10407B

Shift Concerns: 3-2 Shift (Automatic)

Possible Component	Reference / Action
224 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ¹² for diagnosis. Perform Pinpoint Test A using Rotunda Transmission Tester (007-00085) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
324 — HYDRAULIC / MECHANICAL ROUTINE	
Improper Pressures	

(Continued)

12 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Shift Concerns: 3-2 Shift (Automatic) (Cont'd)

Possible Component	Reference / Action
—Direct clutch	—Check pressure at direct clutch tap. Refer to Hydraulic Pressure Chart for specification. If not within specification, check main controls.
Main Controls —2-3 shift valve stuck or damaged —Check balls damaged or missing —Bolts not tightened to specification —SS-2 malfunction —Gaskets damaged	—Inspect for damage. Service as required —Inspect for damage. Service as required. —Retighten bolts to specification. —Activate solenoid using transmission tester. If solenoid operation cannot be felt when placing hand on solenoid, replace solenoid. Inspect O-rings for damage. Service as required. —Inspect for damage and replace.
Intermediate One-Way Clutch —Not holding or damaged	—Inspect for damage. Service as required.
Direct Clutch Assembly —Seals or piston damaged —Friction element damaged, worn —Check ball stuck, damaged or not seating properly	—Inspect for damage. Service as required. —Inspect for damage. Service as required. —Inspect for damage. Service as required.

TD10409B

Shift Concerns: 2-1 Shift (Automatic)

Possible Component	Reference / Action
225 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Shift solenoids	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ¹³ for diagnosis. Perform Pinpoint Test A using Rotunda Transmission Tester (007-00085) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
325 — HYDRAULIC/MECHANICAL ROUTINE	
Improper Pressures —Intermediate clutch	—Check pressure at intermediate clutch tap. Refer to Hydraulic Pressure Chart for specifications. If not within specifications, check Main Controls and Pump.
Main Controls —1-2 shift valve, 1-2 accumulator solenoid pressure regulator valve stuck, damaged or assembled wrong —Bolts not tightened to specification —SS-1 malfunction —Gaskets damaged	—Inspect for damage. Service as required. —Retighten bolts to specification. —Activate solenoid using transmission tester. If solenoid operation cannot be felt when placing hand on solenoid, replace solenoid. Inspect O-rings for damage; service as required. —Inspect for damage and replace.
Pump —Gaskets damaged —Porosity / cross leaks	—Inspect for damage and replace. —Inspect for leak / porosity. Replace pump as required.
Intermediate Clutch Assembly —Piston damaged —Friction elements damaged, worn —End clearance improper	—Inspect for damage. Service as required. —Inspect for damage. Service as required. —Inspect and correct as outlined under Transmission, Assembly
Intermediate One-Way Clutch —Damaged	—Inspect for damage. Service as required.
Low One-Way Clutch —Not holding or damaged	—Inspect for damage. Service as required.

TD10413B

¹³ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Converter: No Apply

Possible Component	Reference / Action
240 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Torque Converter Clutch (TCC) solenoid, TOT sensor, TSS sensor	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ¹⁴ for diagnosis. Perform Pinpoint Tests B, C, and F using Rotunda Transmission Tester (007-00085) or equivalent as outlined. Service as required. , Clear codes, road test and rerun Self-Test.
340 — HYDRAULIC / MECHANICAL ROUTINE	
Shift Linkage —Damaged, misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Improper Pressures —Low line pressure, low EPC pressure	—Check pressure at line and EPC taps. Refer to Hydraulic Pressure Chart for specifications. —If pressure is low, check EPC and main regulator valve. If within specification, check main controls.
Main Controls —Solenoid pressure regulator valve, manual valve, bypass clutch control valve and plunger, converter pressure limit valve, drain back valve stuck, damaged or assembled wrong —Bolts not tightened to specification —Solenoid screen (in valve body) blocked or damaged —TCC solenoid malfunction —Gaskets damaged	—Inspect for damage and service as required. —Retighten bolts to specification. —Clean or replace screen. —Activate solenoid using transmission tester. If solenoid operation cannot be felt when placing hand on solenoid, replace solenoid. Inspect O-rings for damage. Service as required. —Inspect for damage and replace.
Pump Assembly —Bolts not tightened to specification —Porosity / cross leaks, balls leaking —Gaskets damaged	—Retighten bolts to specification. —Inspect for porosity / leaks, ball missing. Replace pump as required. —Inspect for damage and replace.
Input Shaft —Seals damaged	—Inspect for damage. Service as necessary.
Torque Converter Assembly —Leakage, friction material damaged, internal seals damaged	—Inspect torque converter as outlined. Service or replace as required.

TD10415B

Converter: Always Applied / Stalls Vehicle

Possible Component	Reference / Action
241 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Torque Converter Clutch (TCC) solenoid, TOT sensor	—Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual ¹⁴ for diagnosis. Perform Pinpoint Tests B and C using Rotunda Transmission Tester (007-00085) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
341 — HYDRAULIC / MECHANICAL ROUTINE	
Main Controls —Drain back valve, bypass clutch and plunger stuck, damaged or assembled wrong —Bolts not tightened to specification	—Inspect for damage and service as required. —Retighten bolts to specification.

(Continued)

14 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Converter: Always Applied / Stalls Vehicle (Cont'd)

Possible Component	Reference / Action
<ul style="list-style-type: none"> —TCC solenoid malfunction —No. 7 ball improper seating —Gaskets damaged 	<ul style="list-style-type: none"> —Activate solenoid using transmission tester. If solenoid operation cannot be felt when placing hand on solenoid, replace solenoid. Inspect O-rings for damage. Service as required. —Inspect for damage. Service as required. —Inspect for damage and replace.
Pump Assembly <ul style="list-style-type: none"> —Bolts not tightened to specification —Ball missing, leaking, porosity / cross leaks —Gaskets damaged 	<ul style="list-style-type: none"> —Retighten bolts to specification. —Inspect for porosity / leaks, balls missing. Replace pump as required. —Inspect for damage and replace.
Input Shaft <ul style="list-style-type: none"> —Seals damaged 	<ul style="list-style-type: none"> —Inspect for damage. Service as required.
Torque Converter Assembly <ul style="list-style-type: none"> —No end clearance —Piston plate damaged or stuck to cover 	<ul style="list-style-type: none"> —Inspect converter as outlined and replace as required. —If cover is heat-stained, replace converter.

TD 10417B

Converter: Cycling / Shudder / Chatter

Possible Component	Reference / Action
242 — ELECTRICAL ROUTINE	
Powertrain Control System <ul style="list-style-type: none"> —Electrical inputs / outputs, Vehicle wiring harnesses, PCM, Torque Converter Clutch (TCC) solenoid, TSS 	<ul style="list-style-type: none"> —Run Self-Test. Refer to Powertrain Control / Emissions Diagnosis Manual¹⁵ for diagnosis. Perform Pinpoint Tests C and F using Rotunda Transmission Tester (007-00085) or equivalent as outlined. Service as required. Clear codes, road test and rerun Self-Test.
342 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid Condition	<ul style="list-style-type: none"> —Inspect fluid condition. If burnt, drain fluid and converter. Replace fluid and filter assembly. Bring vehicle to normal operating temperature. Perform Drive Cycle Test as outlined. Perform Self-Test. If condition still exists, continue diagnostics.
Main Controls <ul style="list-style-type: none"> —Solenoid pressure regulator valve, No. 7 check ball, bypass clutch control valve and plunger, converter pressure limit valve stuck, damaged or assembled wrong —Bolts not tightened to specification —Solenoid screen (in valve body) blocked or damaged —TCC solenoid malfunction —Gaskets damaged 	<ul style="list-style-type: none"> —Inspect for damage. Service as required. —Retighten bolts to specification. —Clean or replace screen. —Activate solenoid using transmission tester. If solenoid operation cannot be felt when placing hand on solenoid, replace solenoid. Inspect O-rings for damage. Service as required. —Inspect for damage and replace.
Pump Assembly <ul style="list-style-type: none"> —Bolts not tightened to specification —Porosity / cross leaks, balls missing or leaking —Gaskets damaged 	<ul style="list-style-type: none"> —Retighten bolts to specification. —Inspect for porosity / leaks or balls missing. Replace pump as required. —Inspect for damage and replace.
Input Shaft <ul style="list-style-type: none"> —Seals damaged 	<ul style="list-style-type: none"> —Inspect for damage. Service as required.
Converter <ul style="list-style-type: none"> —Excessive end clearance 	<ul style="list-style-type: none"> —Inspect converter as outlined. Replace as required.

TD 10419B

15 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Other: No Engine Braking in 2nd Gear, Manual 2nd or Manual 1st Position

Possible Component	Reference / Action
250 — ELECTRICAL ROUTINE	
No Electrical Concerns	
350 — HYDRAULIC / MECHANICAL ROUTINE	
Shift Linkage —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Main Controls —3-4 shift valve, 1-2 and 2-3 shift valve, gaskets, orifice control valve, 3-4 capacity modulator valve, stuck or damaged or assembled wrong —OD servo assembly damaged or stuck	—Inspect for damage. Service as required. —Inspect cover, piston and seal for damage. Service as required.
Overdrive —OD band, reverse clutch drum assembly worn or damaged —Intermediate one-way clutch assembly damaged	—Inspect for damage. Service as required. —Inspect for damage service as required.

TD 10421B

Other: Shift Efforts High

Possible Component	Reference / Action
251 — ELECTRICAL ROUTINE	
No Electrical Concerns	
351 — HYDRAULIC / MECHANICAL ROUTINE	
Shift Linkage, MLP Sensor —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.
Manual Lever —Retaining pin damaged, nut loose, detent spring bent or damaged or PARK mechanism damaged	—Inspect for damage. Service as required.
Main Controls —Manual valve stuck or damaged —Bolts not tightened to specification	—Inspect for damage. Service as required. —Retighten bolts to specification.
Brake Shift Interlock	—Refer to Section 07-05.

TD 10423B

Other: External Leaks

Possible Component	Reference / Action
252 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs / outputs sensor seals leaking (MLP, TSS, VSS or transmission connector)	—Inspect for leakage and service as required.
352 — HYDRAULIC / MECHANICAL ROUTINE	
Seals, Gaskets —Converter, pump, pan, extension housing - gasket / seal, manual lever, fluid level indicator tube	—Locate source of leak. Service as required.
Other —Cooler fitting, pressure taps, converter drain plug, band anchor pins, cooler lines, case porosity, case cracked —Vent blocked or damaged	—Locate source of leak. Service as required. —Check vent for damage or blockage. Service as required.

TD 10425B

DIAGNOSIS AND TESTING (Continued)**Other: Noise/Vibration - Forward/Reverse (Cont'd)**

Possible Component	Reference/Action																
—Reverse: gear set friction elements —Output Shaft Splines worn or damaged	<table border="1"> <thead> <tr> <th>Shift</th><th>Routine</th></tr> </thead> <tbody> <tr><td>1-2</td><td>320</td></tr> <tr><td>2-3</td><td>321</td></tr> <tr><td>3-4</td><td>322</td></tr> <tr><td>4-3</td><td>323</td></tr> <tr><td>3-2</td><td>324</td></tr> <tr><td>2-1</td><td>325</td></tr> <tr><td>Converter Cycling</td><td>242/342</td></tr> </tbody> </table> <p style="text-align: right;">CD8094-A</p>	Shift	Routine	1-2	320	2-3	321	3-4	322	4-3	323	3-2	324	2-1	325	Converter Cycling	242/342
Shift	Routine																
1-2	320																
2-3	321																
3-4	322																
4-3	323																
3-2	324																
2-1	325																
Converter Cycling	242/342																
Other Noises/Vibrations: —Main Controls valve resonance —Shift Cable vibration grounding —Cooler lines grounding	—Locate source of disturbance. Service as required.																

TD10429A

Other: Engine Will Not Crank

Possible Component	Reference/Action
255 — ELECTRICAL ROUTINE	
Powertrain Control System —Electrical inputs/outputs, Vehicle wiring harnesses, Engine starting system hardware, MLP sensor	—Run Self-Test. Refer to Powertrain Control/Emissions Diagnosis Manual ¹⁷ for diagnosis. Perform Pinpoint Test D using MLP tester (D89T-70010-A) or equivalent as outlined. Service and adjust as required.
355 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkage, MLP Sensor —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.

TD10431B

Other: No Park Range

Possible Component	Reference/Action
256 — ELECTRICAL ROUTINE	
No Electrical Concerns	
356 — HYDRAULIC/MECHANICAL ROUTINE	
Shift Linkage, MLP Sensor —Damaged or misadjusted	—Inspect and service as required. Adjust linkage as outlined. After servicing linkage, verify that the MLP sensor is properly adjusted. Refer to Transmission, Assembly.

(Continued)

17 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**Other: No Park Range (Cont'd)**

Possible Component	Reference / Action
Park Mechanism —Output shaft ring, park brake pawl, parking pawl return spring, park rod guide cup, parking pawl shaft, parking pawl actuating rod, manual lever, manual lever detent spring damaged or assembled wrong	—Inspect for damage or wrong assembly and service as required.

TD10433B

Other: Transmission Overheating

Possible Component	Reference / Action
257 — ELECTRICAL ROUTINE	
Refer to Routine 240 / 340, Converter: No Apply	
357 — HYDRAULIC / MECHANICAL ROUTINE	
Fluid —Improper level —Condition	—Adjust fluid to proper level. —Inspect as outlined under Fluid Condition Check.
Cooler Lines —Damaged, blocked or reversed	—Inspect for damage and proper installation. Service as required.
Auxiliary Cooler —Damaged, blocked or restricted or improperly installed	—Inspect for damage and proper installation. Service as required.
Vehicle Concerns Causing Engine Overheating	—Refer to Section 03-03
Main Controls —Drain back valve, bypass clutch control valve, converter limit valve stuck, damaged or assembled wrong	—Inspect for damage and service as required.
Converter —No Apply	—Refer to Routine 240 / 340.

TD10435B

CAUTION: Do not install Transmission Tester when verifying these pressures.

NOTE: Vehicle harness must be installed at transmission connector to verify these pressures.

NOTE: Pressures may vary with model.

401 — Diagnostic Pressure Chart

Pressures At Idle					
GEAR	EPC (TV) 88	LINE	FORWARD CLUTCH	INTERMEDIATE CLUTCH	DIRECT CLUTCH
1M 1D	0-62 kPa (0-9 psi)	345-517 kPa (50-75 psi)	310-517 kPa (45-75 psi)	0-34 kPa (0-5 psi)	0-34 kPa (0-5 psi)
2M 2D	0-62 kPa (0-9 psi)	345-517 kPa (50-75 psi)	310-517 kPa (45-75 psi)	310-517 kPa (45-75 psi)	0-34 kPa (0-5 psi)
3	0-62 kPa (0-9 psi)	345-517 kPa (50-75 psi)	310-517 kPa (45-75 psi)	310-517 kPa (45-75 psi)	310-517 kPa (45-75 psi)
4	0-62 kPa (0-9 psi)	345-517 kPa (50-75 psi)	0-34 kPa (0-5 psi)	310-517 kPa (45-75 psi)	310-517 kPa (45-75 psi)
R	0-62 kPa (0-9 psi)	552-827 kPa (80-120 psi)	0-34 kPa (0-5 psi)	0-34 kPa (0-5 psi)	0-34 kPa (0-5 psi)
P	0-62 kPa (0-9 psi)	345-517 kPa (50-75 psi)	0-34 kPa (0-5 psi)	0-34 kPa (0-5 psi)	0-34 kPa (0-5 psi)
N	0-62 kPa (0-9 psi)	345-517 kPa (50-75 psi)	0-34 kPa (0-5 psi)	0-34 kPa (0-5 psi)	0-34 kPa (0-5 psi)
Pressures at Wide Open Throttle (WOT) Stall					

(Continued)

DIAGNOSIS AND TESTING (Continued)**401 — Diagnostic Pressure Chart (Cont'd)**

Pressures At Idle					
GEAR	EPC (TV) 88	LINE	FORWARD CLUTCH	INTERMEDIATE CLUTCH	DIRECT CLUTCH
1M	573-642 kPa	1104-1447 kPa	1035-1447 kPa	0-34 kPa	0-34 kPa
1D	(83-93 psi)	(160-210 psi)	(150-210 psi)	(0-5 psi)	(0-5 psi)
R	573-642 kPa	1517-1930 kPa	0-34 kPa	0-34 kPa	0-34 kPa
	(83-93 psi)	(220-280 psi)	(0-5 psi)	(0-5 psi)	(0-5 psi)

On-Board Diagnostic Quick Tests

The Quick Tests are in the Powertrain Control/Emissions Diagnosis Manual¹⁸. These tests can be used to diagnose the PCM, sensors and actuators of the 4R70W (AODE-W) transmission.

The following is a guide for using the On-Board Diagnostic Quick Tests, with some special considerations to remember:

Quick Test 1.0

Perform the Visual Check and Vehicle Preparation procedures as outlined in the Powertrain Control/Emissions Diagnosis Manual¹⁸.

Inspect the following:

- Air cleaner and inlet ducting
- All engine vacuum hoses for damage: leaks, cracks, blockage, proper routing etc.
- PCM system wiring harnesses for proper connections, bent or broken pins, corrosion, loose wires, proper routing, etc.
- PCM, sensors and actuators for physical damage
- Engine coolant for proper level
- Transmission fluid for level, quality and for external leakage
- Any non-factory installed items wired into the transmission or PCM harnesses

NOTE: Perform all necessary servicing before continuing with Quick Tests.

Quick Test 2.0

Connect SUPER STAR II Tester 007-004 1-A or equivalent to Data Link connector.

NOTE: The SUPER STAR II Tester must be used on fast mode to properly display the DTCs.

NOTE: If SUPER STAR II Tester is unavailable, refer to the Powertrain Control/Emissions Diagnosis Manual¹⁸ for alternate methods to run the Self-Test.

The following are procedures to run the EEC-IV On-Board Diagnostics.

All Tests:

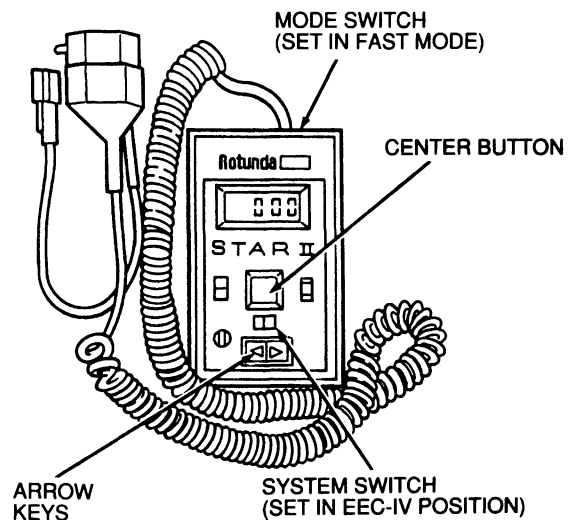
NOTE: The Self-Test can be entered only once each time the key is turned on. To re-enter the Self-Test, turn the key off and wait 10 seconds.

Vehicle and SUPER STAR II 007-004 1A Tester Preparation

Prepare the vehicle as follows:

- Shift lever in PARK
- Engine to operating temperature
- Apply parking brake
- Block wheels
- Turn OFF all electrical loads including A/C and defroster
- Connect SUPER STAR II Tester 007-004 1A or equivalent to the vehicle. Refer to Powertrain Control/Emissions Diagnosis Manual¹⁸ for specific vehicle test lead location.

Prepare the SUPER STAR II Tester as follows:



D10293-A

- Place system switch in the EEC-IV position.
- Tester in fast mode only (necessary to display three-digit codes).
- Keep tester leads away from any moving parts.

¹⁸ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

- Deactivate Self-Test by making sure the button in the middle is up. If not, press button once to unlatch.
- Speaker switch on, if desired.
- Turn tester to the ON position.

CAUTION: Do not replace parts based on a code, perform Pinpoint Tests first.

Quick Test 3.0 Key On, Engine Off (KOEO)

Some special considerations for Key On, Engine Off Quick Test include the following:

- The KOEO test provides both "hard" Diagnostic Trouble Codes (DTCs) (present at the time of testing) and continuous memory DTCs.
- Always service the "hard" DTCs first. These are displayed first on the tester.

Performing KOEO Self-Test

1. Activate Self-Test by pressing center button on SUPER STAR II tester (grounding Self-Test input STI).
2. Turn ignition switch to RUN position.
3. PCM will run Self-Test and then output "hard" DTCs (or Code 111-pass test). "Hard" DTCs are repeated to make it easier to verify sequence. After "hard" DTCs have been repeated (or Code 111 repeated) a single pulse occurs to signal that next set of DTCs will be from continuous test (or Code 111-pass).
4. To display DTCs, unlatch center button and use memory buttons to scroll through codes.

Quick Test 4.0 Continuous Memory Codes

Continuous memory codes are from concerns which were detected during normal vehicle operation. These codes are retained for 40 warm up cycles.

After servicing any KOEO or KOER "hard" DTCs and a pass code 111 is received on both, service the continuous memory codes.

Some special considerations for Continuous testing include the following:

- The cause of some Continuous Memory Codes may have been eliminated if KOEO and /or KOER DTCs were serviced. Always re-test and service any DTCs that still remain.
- If DTCs are present, go to the EEC-IV On-Board Diagnostic Trouble Code Description Chart in this Section for service information. Erase DTC, perform drive cycle and repeat the Quick Test after completing service on the DTCs.

- If the continuous test passes (111) and a concern is still present, refer to the Hydraulic / Mechanical charts, Oasis and TSBs for concern diagnostics.

CAUTION: DTCs in continuous memory can be erased by disconnecting the battery or by ungrounding the Self-Test Input (STI) while the codes are being displayed during the KOEO Self-Test. This STI is ungrounded by disconnecting the small Data-Link connector or unlatching the Star Tester button. Always write down the DTCs to avoid losing information that can be used to diagnose the customer's concern.

- Service any non-transmission DTCs first as they can directly affect the operation of the transmission. Repeat the Quick Test and Road Test to verify the correction.

Special Test Modes:

NOTE: The wiggle test may also be entered by "latching" STI; ON, OFF, ON.

1. Wiggle test mode:
 - After all DTCs have been received the wiggle test mode is entered.
 - The wiggle test allows the technician to attempt to re-create an intermittent malfunction. Tap, move and wiggle the suspected sensor and /or wire harness. When a malfunction is detected the Self-Test Output (STO) will be turned on as long as the concern is present. STO ON will cause the SUPER STAR II Tester to sound a continuous tone. The Malfunction Indicator Lamp (MIL) will also illuminate.
2. Output cycling test mode:
 - After all KOEO DTCs have been received, the output test mode is entered. Actuator outputs will turn ON and OFF each time the throttle is depressed to WOT and then returned to closed position.

Quick Test 5.0 Key On Engine Running (KOER)

The Engine Running Self-Test provides "hard" DTCs only.

Some special considerations for Engine Running Self-Test include the following:

- After the engine ID code (STO LO flashes), push and release the brake pedal, press and release the TCS.
- If a DTC appears after the KOER test, a malfunction is present. Refer to and look up the DTC on the EEC-IV On-Board Diagnostic Trouble Code Description Chart in this Section for service information.

KOER Self-Test:

NOTE: Engine must be warm or DTC 116—ECT out of Self-Test range will occur.

1. Connect SUPER STAR II Tester (if not already connected) with mode switch set to FAST mode.

DIAGNOSIS AND TESTING (Continued)

2. Start and run engine until engine reaches operating temperature.
3. Turn OFF engine and wait 10 seconds.
4. Activate Self-Test (press center button on SUPER STAR II Tester).
5. Start engine.

- Self-Test begins when the engine ID code is received. (This code consists of the number of cylinders divided by 2 plus an added zero.)

Number of Cylinders	Engine ID Code
8	40

- After the ID code is entered, the technician must cycle the TCS. Then press and release the brake service pedal to check BOO switch.
 - A signal output pulse (10) is sent to signal the technician to quickly press the throttle to wide open and immediately release. SUPER STAR II TESTER will display the word DYNAMIC.
 - Diagnostic Trouble Codes (DTCs) are then sent.
6. The Engine Running wiggle test may be entered automatically upon completion of the KOER Self-Test.

Special Test Mode:

NOTE: The wiggle test may also be entered by "latching" STI; ON, OFF, ON.

1. Wiggle test mode:
 - After all KOER codes have been received the wiggle test mode is entered by pressing the center button of the SUPER STAR II Tester twice. This will unlatch and latch STI.

The wiggle test allows the technician to attempt to re-create an intermittent malfunction. Tap, move and wiggle the suspected sensor and / or wire harness. When a malfunction is detected the STO will be turned on as long as the concern is present. STO ON will cause the STAR Tester to sound a continuous tone. The malfunction indicator lamp (MIL) will also illuminate.

Quick Test 6.0 (Computed Timing Check)

This Quick Test is used to diagnose engine idle concerns only. Any engine concerns or DTCs should be serviced **BEFORE** the transmission concerns are serviced.

Drive Cycle Test

After performing the Quick Test, use the following Drive Cycle Test for checking 4R70W (AODE-W) continuous codes:

NOTE: The Drive Cycle Test must be followed exactly.

1. Record and then erase Quick Test codes.
2. Warm engine to normal operating temperature.
3. Make sure transmission fluid level is correct.
4. With transmission in OVERDRIVE, moderately accelerate from stop to 80 Km/h (50 mph). This allows the transmission to shift into fourth gear. Hold speed and throttle opening steady for a minimum of 15 seconds.
5. With transmission in OVERDRIVE, press TCS (TCIL should illuminate) and moderately accelerate from stop to 64 Km/h (40 mph). This allows transmission to shift into third gear. Hold speed and throttle open steady for a minimum of 15 seconds (30 seconds above 4000 ft).
6. Press TCS (TCIL should turn off) and accelerate from 64 Km/h (40 mph) to 80 Km/h (50 mph). This allows transmission to shift into fourth gear. Hold speed and throttle position steady for a minimum of 15 seconds.
7. With transmission in fourth gear and maintaining steady speed and throttle opening, lightly apply and release brake (to operate stoplamps). Then hold speed and throttle steady for an additional five seconds minimum.
8. Brake to a stop and remain stopped for a minimum of 20 seconds.
9. Repeat Steps 4 through 8 at least five times.
10. Perform Quick Test and record continuous codes.

After Self-Test

After the Self-Test procedures are completed, service all DTCs.

DIAGNOSIS AND TESTING (Continued)

Begin with non-transmission related DTCs, then service any transmission related DTCs. Refer to the EEC-IV On-Board Diagnostics Trouble Code Description Chart for information on Condition and Symptoms. This chart will be helpful in referring to the proper manual(s) and to aid in diagnosing internal transmission concerns and external non-transmission inputs. The Pinpoint Tests are used in diagnosing electrical concerns of the 4R70W (AODE-W) transmission. Make sure that the vehicle wiring harness and the PCM are diagnosed as well. The Powertrain Control / Emissions Diagnosis Manual¹⁹ will aid in diagnosing non-transmission electronic components.

NOTE: The vehicle wiring harness, PCM and non-transmission sensors may affect transmission operations. Service these concerns first.

Pinpoint Tests

NOTE: Prior to entering Pinpoint Tests, check the EEC-IV system wiring harness for proper connections, bent or broken pins, corrosion, loose wires, proper routing, proper seals and their condition. Check the PCM, sensors and actuators for damage. Refer to the Powertrain Control / Emissions Diagnosis Manual.¹⁹

NOTE: If electrical diagnosis has been performed and a concern still exists, refer to the Hydraulic / Mechanical Diagnosis.

If DTCs are present while performing the On-Board Diagnostics, refer to the EEC-IV On-Board Diagnostics Trouble Code Description Chart for the appropriate service procedure. Prior to entering Pinpoint Tests, refer to any TSBs and Oasis messages for 4R70W (AODE-W) transmission concerns.

NOTE: Prior to entering pinpoint tests, the vehicle harness must be checked for continuity and shorts; the PCM must be checked for any concerns. Refer to the Powertrain Control / Emissions Diagnosis Manual¹⁹ for proper procedures.

NOTE: If any non-transaxle DTC's appear, service those codes first. They could affect the electrical operation of the transaxle. Record and erase codes from continuous memory after service has been performed. After servicing any DTC's in the Quick Test, the Quick Test should be repeated.

NOTE: Check PCM wiring harness for proper connections, bent or broken pins, corrosion, loose wires, proper routing, proper seals and their condition. Check the PCM, sensors and actuators for physical damage.

¹⁹ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)**EEC-IV SELF TEST DIAGNOSTIC TROUBLE CODE DESCRIPTION CHART**

DTC	COMPONENT	DESCRIPTION	CONDITION	SYMPTOMS/ACTIONS
THREE DIGIT				
111	SYSTEM	Pass	No fault detected.	Fault not detected by PCM. ①
452	VSS	Insufficient input from VSS	PCM detected a loss of vehicle speed signal during operation.	Converter clutch engages, shift engagement/disengagement (hunting) on grades. ①
636	TOT	TOT out of self test range	Transmission not at operating temperature during self test.	Warm vehicle to normal operating temperature.
637	TOT	-40°C (-40°F) indicated TOT sensor circuit open	Voltage drop across TOT sensor exceeds scale set for temperature -40°C (-40°F).	Firm shift feel. Refer to Pinpoint Test B.
638	TOT	157°C (315°F) indicated TOT sensor circuit grounded	Voltage drop across TOT sensor exceeds scale set for temperature of 157°C (315°F).	
522	MLP	MLP not in PARK	Self test not run in PARK.	Rerun self test in PARK.
634	MLP	MLP out of range	Indicated voltage drop across MLP exceeds limits established for each position. Misadjusted sensor.	Harsh engagements, firm shift feel, no crank in NEUTRAL, improper shifts. Refer to Pinpoint Test D.
536	BOO	Brake not actuated during self test	Brake not cycled during KOER.	Code set during self test. Rerun and depress BOO switch. ①
		BOO switch circuit failed	Brake On/Off circuit failure.	Failed ON — Converter clutch will not engage at less than 1/3 throttle. Failed OFF or not connected Converter clutch will not disengage when brake is applied. ①
112	IAT	IAT indicates 125°C (254°F)	Voltage drop across IAT exceeds scale set for temperature 125°C (254°F) (grounded).	Incorrect EPC pressure. Either high or low which will result in harsh or soft shifts. ①
113	IAT	IAT indicates -40°C (-40°F)	Voltage drop across IAT exceeds scale set for temperature -40°C (-40°F) (open circuit)	
114	IAT	IAT out of self test range	IAT temperature higher or lower than expected during KOEO, KOER.	Rerun self test with vehicle at normal operating temperature. ①
116	ECT	ECT out of self test range	ECT temperature higher or lower than expected during KOEO, KOER.	Rerun self test with vehicle at normal operating temperature. ①
117	ECT	ECT indicates 125°C (254°F)	Voltage drop across ECT exceeds scale set for temperature 125°C (254°F) (grounded).	Torque Converter clutch will always be off resulting in reduced fuel economy. ①
118	ECT	ECT indicates -40°C (-40°F)	Voltage drop across ECT exceeds scale set for temperature -40°C (-40°F) (open circuit).	
639	TSS	Insufficient input from transmission speed sensor TSS	PCM detected a loss of TSS signal during operation.	Harsh shifts, abnormal shift schedule, no converter clutch activation. Refer to Pinpoint Test F.
121	TP	TP voltage high/low for self test	TP was not in the correct position for self test.	Rerun at appropriate TP position.

① Refer to Powertrain Control/Emissions Diagnosis Manual. Can be purchased as a separate item.

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DIAGNOSIS AND TESTING (Continued)

EEC-IV SELF TEST DIAGNOSTIC TROUBLE CODE DESCRIPTION CHART (Continued)

DTC THREE DIGIT	COMPONENT	DESCRIPTION	CONDITION	SYMPTOMS/ACTIONS
122 123 124 125 167	TP	TP DTCs	PCM assembly has detected an error. This error may cause a transmission concern.	Harsh engagements, firm shift feel, abnormal shift schedule, converter clutch does not engage, converter clutch cycling.
212 211-219 221-224 232-239 241-243	ICM ICM ICM ICM	ICM DTCs	ICM system has a malfunction which may cause a transmission concern.	Harsh engagements and shifts, late WOT shifts, no converter clutch engagement.
539	ACC	A/C switch error	A/C or defrost ON condition may result from A/C clutch being ON during quick test. A/C clutch failed ON.	Code set during self test — rerun TOT-A/C off. Failed ON — EPC pressure slightly low with A/C OFF.
157 184 158 185 159	MAF MAF MAF	MAF concern	MAF system has a malfunction which may cause a transmission concern.	High/low EPC pressure, incorrect shift schedule. Incorrect converter clutch scheduling. Symptoms similar to a TP Sensor failure.
621 ²	SS-1	SS-1 solenoid circuit failure	SS-1 circuit failed to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during self test.	Improper gear selection depending on condition mode and manual lever position. Refer to Solenoid On/Off Chart. Refer to Pinpoint Test A.
617 ³	SS-1 or internal parts	1-2 shift error	Engine rpm drop not detected when 1-2 shift was commanded by PCM.	Improper gear selection depending on failure or mode and manual lever position. Refer to Solenoid On/Off Chart. Shift errors may also be due to other internal transmission concerns. (Stuck valves, damaged friction material.) Refer to Pinpoint Test A.
618 ³	SS-1, SS-2 or internal parts	2-3 shift error	Engine rpm drop not detected when 2-3 shift was commanded by PCM.	
619 ³	SS-1, SS-2 or internal parts	3-4 shift error	Engine rpm drop not detected when 3-4 shift was commanded by PCM.	
622 ²	SS-2	SS-2 solenoid circuit failure	SS-2 circuit failed to provide voltage drop across solenoid. Circuit open or shorted or PCM driver failure during self test.	Improper gear selection depending on failure or mode and manual lever position. Refer to Solenoid On/Off Chart. Refer to Pinpoint Test A.
652 ²	TCC	TCC solenoid circuit failure during self test	TCC solenoid circuit failed to provide drop across solenoid. Circuit open or shorted or PCM driver failure during self test.	Short circuit — engine stalls in second gear (OD, 2 range) at low idle speeds with brake applied. Open circuit — converter clutch never engaged. Refer to Pinpoint Test C.
631	TCIL	TCIL circuit failure	TCIL circuit open or shorted.	Failed ON — overdrive cancel mode on. NO flashing TCIL for EPC failure. Failed OFF — Overdrive cancel mode never indicated. NO flashing TCIL for EPC failure ² .
632	TCS	TCS not changing states	TCS not cycled during self test. TCS circuit open or shorted.	Rerun self-test and cycle switch NO D cancel when switch is cycled.

¹ Refer to Powertrain Control/Emissions Diagnosis Manual. Can be purchased as a separate item.² Output circuit check, generated only by electrical conditions.³ May also be generated by other non-electrical related transmission hardware condition.

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DIAGNOSIS AND TESTING (Continued)

EEC-IV SELF TEST DIAGNOSTIC TROUBLE CODE DESCRIPTION CHART (Continued)

DTC THREE DIGIT	COMPONENT	DESCRIPTION	CONDITION	SYMPTOMS/ACTIONS
628 ^③	MCCC	Torque converter clutch control engagement error	The PCM picked up an excessive amount of converter clutch slippage when converter was scheduled to be engaged during normal vehicle operation.	Erratic or no converter clutch operation. Refer to Pinpoint Test C.
656	TCC	Excessive torque converter clutch slip indicated.	Excessive variations in slip (Engine speed surge) across the torque converter clutch.	Engine RPM oscillation is present in third gear. Refer to Pinpoint Test C.
998 ^②		Failure mode effect management (FMEM) failure	Failure detected in one or more critical inputs.	PCM enables alternate functions. Check for other error codes.
624 ^②	EPC	EPC solenoid circuit failure, shorted circuit or output driver.	Voltage through EPC solenoid is checked. An error will be noted if tolerance is exceeded.	Short circuit causes minimum EPC pressure (minimum capacity) and limits engine torque (alternate firm).
625 ^②	EPC	Shorted ECA output driver.		Open circuit — causes maximum EPC pressure, harsh engagements and shifts. Refer to Pinpoint Test E.

^① Refer to Powertrain Control/Emissions Diagnosis Manual. Can be purchased as a separate item.

^② Output circuit check, generated only by electrical conditions.

^③ May also be generated by other non-electrical related transmission hardware condition.

CD8095-B

Rotunda Transmission Tester

Use Rotunda Transmission Tester 007-00085 or equivalent to diagnose electronically controlled transaxles. The following instructions outline the set-up and use of this tester in the pinpoint tests for the 4R70W (AODE-W).

Tester Jacks

- VPWR Pin Jacks (red):** VPWR test points for solenoid circuits.
- Solenoid (MCCC, EPC) Signal Line Pin Jacks (black):** Signal line test points for solenoid circuits.

NOTE: The tester overlay is labeled for the MCCC solenoid. This is used to test the torque converter clutch (TCC) solenoid.
- BAT+ (red) and BAT- (black) Pin Jacks:** Battery reference points when measuring circuits for shorts.
- TOT Pin Jacks:** Test points for TOT sensor.

- OSS Pin Jacks:** Test points for TSS sensor.

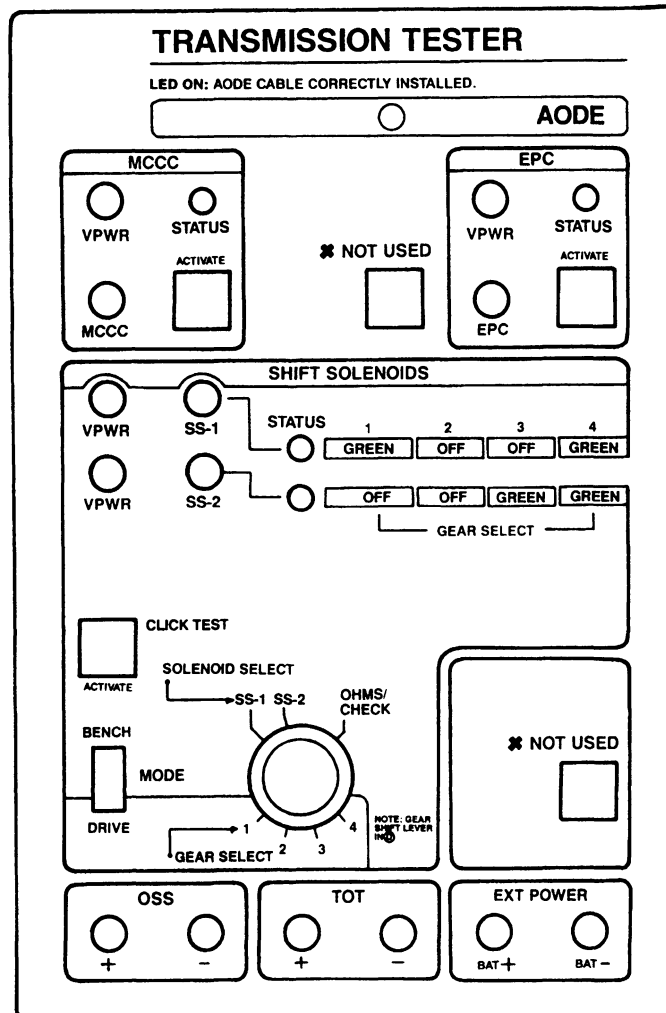
NOTE: The tester overlay is labeled for the OSS solenoid. This is used to test the transmission speed sensor (TSS).

Tester LEDs and Controls

- Overlay and Cable Correctly Installed LEDs:** Only LEDs with ☉ symbol and cable correctly match.
- Status LEDs:** LED "OFF" when not activated by tester (solenoid not activated, open circuit or signal line short to ground). LED "GREEN" when activated by tester and current draw is correct. LED "RED" when activated by tester and current draw is excessive (short to Battery Positive Voltage (B+)). All LEDs light orange during Self-Test.
- Solenoid Activate Buttons:** Energize respective solenoids during click testing and activate selected circuits during DRIVE mode testing.
- Bench/Drive Switch:** Selects operating mode, either BENCH or DRIVE.

DIAGNOSIS AND TESTING (Continued)

5. **Solenoid Select/Gear Select Switch:** Has three functions.
 In BENCH MODE: acts as shift solenoid selector for click testing. In DRIVE MODE: acts as forward gear selector in place of vehicle's PCM controlled shifting. Hydraulic safety mechanisms and overrides are built into the transaxle.
 In OHMS CHECK: allows you to measure ohms.

4R70W (AODE-W) Overlay

D10502-A

Transmission Tester Instructions

The Rotunda Transmission Tester 007-00085 allows a technician to operate the electrical portion of the transmission independent of the vehicle electronics which allows the technician to determine transmission concerns. The Transmission Tester usage is divided in five steps:

- I. Preliminary Testing and Diagnosis
- II. Installing the Transmission Tester
- III. Static Testing - Vehicle OFF

- IV. Dynamic Testing - Vehicle Running
- V. Removing Transmission Tester and Clearing Diagnostic Trouble Codes

I. Preliminary Testing and Diagnosis

Before any diagnostic testing is done on vehicle some preliminary checks must be performed, as outlined below. Be sure to write down findings, especially any DTCs found, for future reference.

DIAGNOSIS AND TESTING (Continued)

- a. Check transmission fluid level and condition.
- b. Check for add-on items (phones, computers, CB radio, etc.).
- c. Visually inspect wiring harness and connectors.
- d. Check for vehicle modifications.
- e. Check shift linkage for proper adjustment.
- f. Verify customer concern:
 - Upshift, Downshift, Coasting, Engagement, Noise/Vibration
- g. Vehicle must be at normal operating temperature.
- h. Perform vehicle Self-Test.
- i. Record all DTCs.
- j. Service all non-transmission codes.

II. Installing the Transmission Tester (Set-Up Procedures)

Installing the transmission tester at the transmission connector allows separation of the vehicle electronics from transmission electronics. Disconnecting normal vehicle electronics will set additional codes and cause firm shifts. (Disconnecting the transmission connector defaults transmission to maximum line pressure).

NOTE: During tester usage additional DTCs may be set. Therefore, it is important that all codes are erased after service has been made. To verify elimination of all codes rerun Self-Test.

NOTE: The following manuals should be available to assist in diagnosis of electronically controlled transmissions:

- Powertrain Control/Emissions Diagnosis Manual²⁰
- Transmission Tester Manual (provided with tester).

CAUTION: Do not attempt to pry off connectors with a screwdriver. This will damage the connector and could result in transmission concerns.

1. Disconnect vehicle wiring harness at transmission connector.
2. Turn tester solenoid select switch to the OHMS CHECK position.
3. Connect appropriate tester interface cable and overlay to transmission and tester.

CAUTION: Route all cables away from heat sources.

4. Install a line pressure gauge into line pressure tap on transmission.

CAUTION: Route gauge line away from heat sources.

5. Plug transmission tester power supply into lighter receptacle. At this time, all LEDs should illuminate for a short period and then turn off. This is the tester internal circuit check.
6. Position Bench/Drive switch to BENCH mode.

III. Static Testing - Vehicle Off

Static testing procedures allow for shop testing of the transmission in the vehicle or on the bench. Completion of these tests prove out transmission electronics.

CAUTION: For resistance checks, be sure the tester solenoid select switch is set to the OHMS/DIODE CHECK position or damage to the ohmmeter may result.

Resistance/Continuity Tests

- Refer to the appropriate Pinpoint Test to be performed based on the Self-Test DTCs displayed.
- Using a Rotunda Digital Volt-Ohmmeter or equivalent and the Transmission Tester perform the Pinpoint Tests as indicated based on the Self-Test DTCs which were displayed.
- Service as indicated by the pinpoint tests. Always retest and road test vehicle after service.

Transmission Solenoids and Sensors Resistance Tests**EPC Solenoid**

- Set ohmmeter to 100-200 ohm range.
- Connect negative lead of ohmmeter to the EPC jack.
- Connect positive lead of ohmmeter to the VPWR jack.
- Record resistance.
- Refer to the following charts for values.

If out of specification, refer to Pinpoint Test E in this Section.

Solenoids (SS-1, SS-2, TCC)

- Set ohmmeter to 100-200 ohm range.
- Connect positive lead of ohmmeter to the appropriate VPWR jack for the solenoid being tested.
- Connect negative lead of the ohmmeter to the appropriate solenoid (SS-1, SS-2, MCCC) jack and record resistance.

Refer to following charts for values.

If out of specification, refer to Pinpoint Test A (SS-1, SS-2); Pinpoint Test C (TCC);

TRANSMISSION APPLICATION

Solenoid	Ohms
SS-1	20-30
SS-2	20-30
TCC	1.0-3.0
EPC	2.48-5.66

Transmission Operating Temperature (TOT)

- Set ohmmeter to 1000 ohm scale.
- Connect ohmmeter positive lead to +TOT jack.
- Connect ohmmeter negative lead to -TOT jack.

²⁰ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

- Record resistance. Resistance will vary with temperature.
- Refer to the following chart.

If out of specification, refer to Pinpoint Test B in this Section.

Temperature		Resistance
°C	°F	Ohms (K)
0-20	32-68	100K-37K
21-40	69-104	37K-16K
41-70	105-158	16K-5K
71-90	159-194	5K-2.7K
91-110	195-230	2.7K-1.5K
110-130	230-266	1.5K-0.8K

Transmission Speed Sensor (TSS)

- Set ohmmeter to 1000 ohm (K) range.
- Connect the positive lead of the ohmmeter to the +TSS.
- Connect the negative lead of the ohmmeter to the -TSS.
- Record resistance.
- TSS should be 450-750 ohms.

If out of specification, refer to Pinpoint Test F in this Section.

Sensors Short To Ground and Solenoid Voltage Test

NOTE: LED will turn GREEN when solenoid activates and turn OFF when deactivated.

LED will turn RED if an **activated** solenoid / harness is shorted to B+.

LED will remain OFF if an **activated** solenoid / harness is shorted to ground or no continuity.

1. Set tester Bench / Drive switch to BENCH mode.
2. Set voltmeter to 20 volt DC range.
3. Connect voltmeter positive lead to the appropriate solenoid. Connect voltmeter negative lead to the appropriate solenoid.
4. Using a VOM, check for voltage across each solenoid by activating the solenoid switches. Depress the appropriate switch. The LED should illuminate, the voltage should change and an audible click may be heard. If LED does not illuminate, a short to ground condition exists.

NOTE: TCC solenoid click may or may not be audible.

5. Observe and record values.

IV. Dynamic Testing - Vehicle Running

Dynamic testing is the final step in the transmission tester usage. It allows the transmission to be proven out electronically and hydraulically.

Transmission Solenoid Cycling and Drive Test Procedures

Preliminary Set Up

1. Set Bench / Drive switch to DRIVE mode.
2. Set gear select switch to first gear position.
3. Place vehicle in PARK.
4. Start vehicle.

EPC Solenoid

CAUTION: Do not attempt to hold the EPC switch depressed (minimum line pressure) and stall the transmission (holding the vehicle with the brake while depressing the throttle with the transmission in gear), as transmission damage will result.

5. Observe line pressure. Record value. Line pressure should go to maximum. If not, refer to the Hydraulic / Mechanical charts for diagnostic tips or Pinpoint Test E concerning EPC solenoid.
6. Depress EPC switch. Line pressure should drop to a minimum value. Record value. If not, refer to the Hydraulic / Mechanical diagnostic charts or Pinpoint Test E for the EPC solenoid.

Engagements

7. Verify that Bench / Drive switch is in DRIVE mode and Gear Select switch is in first gear position.
8. Depress EPC switch. Line pressure should drop to idle pressure. While holding EPC switch down, shift vehicle from PARK to REVERSE.

Does vehicle shift into REVERSE?

Shift vehicle from REVERSE to DRIVE.

Does vehicle shift into DRIVE?

Release the EPC switch, pressure should return to maximum. Repeat engagements. With the EPC switch released, engagements should be **firm**.

Upshift / Downshift

NOTE: Upshifts and downshifts will be **firm** during this procedure.

NOTE: Pressure gauges may be removed.

NOTE: These tests should be performed on the road. If performed on the hoist, the technician may not feel at all shifts when engaged.

LEDs will turn **GREEN** when solenoids are activated and turn **OFF** when deactivated. Refer to the appropriate overlay for the proper status shift sequence of the shift solenoids during upshifts and downshifts.

10. Shift vehicle into OVERDRIVE and accelerate to 24 km / h (15 mph), select second gear by rotating gear select switch to second gear position.

Did vehicle upshift to second gear?

Did appropriate shift solenoids activate / deactivate?

DIAGNOSIS AND TESTING (Continued)

11. Accelerate to 40 km/h (25 mph) and select third gear position.

Did vehicle upshift to third gear?

Did appropriate shift solenoids activate/deactivate?

12. Accelerate to 56-72 km/h (35/45 mph) and select fourth gear position.

Did vehicle upshift to fourth gear?

Did appropriate shift solenoids activate/deactivate?

13. Reverse the order to downshift.

Does vehicle downshift from fourth to third, third to second, and second to first?

Did appropriate shift solenoids activate/deactivate?

Torque Converter Clutch (TCC) Engagement

NOTE: This test should be performed on the road. If performed on a hoist, feeling the torque converter clutch engage may not be possible.

CAUTION: Do not depress MCCC switch with transmission in gear and the vehicle at a stop. Damage to the torque converter clutch may result.

14. Accelerate and shift vehicle up into third gear. Hold speed steady and depress the MCCC switch.

Does the torque converter engage?

Does the engine rpm drop?

Did TCC solenoid activate?

Transmission Speed Sensor (TSS) Function Check

NOTE: This test may be performed on the hoist or on the road.

15. Set voltmeter to 20 volts AC.

Connect voltmeter positive lead to the (+) OSS jack.

Connect voltmeter negative lead to the (-) OSS jack.

Slowly accelerate vehicle and monitor voltmeter.

Does voltage increase with vehicle speed?

V. Removing Transmission Tester and Clearing DTCs

1. Disconnect transmission tester from transmission connector.

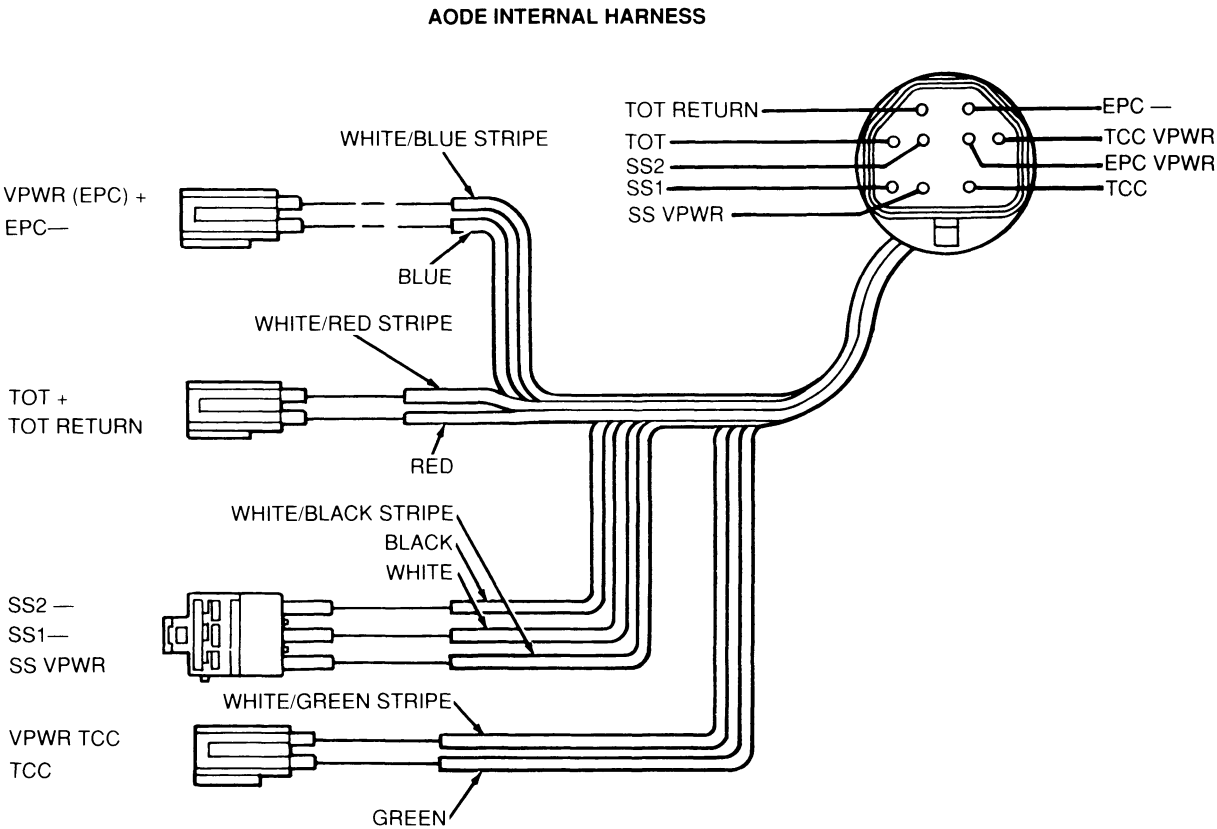
CAUTION: Do not attempt to pry off connectors with a screwdriver. This will damage the connector and could result in a transmission concern.

2. Re-install vehicle wiring harnesses. Verify connection by pulling up on the harness.
3. Re-install all heat shields that were previously removed.
4. Disconnect transmission tester power lead from vehicle.
5. Erase all diagnostic trouble codes using the procedures in the Powertrain Control/Emissions Diagnosis Manual²¹ (unlatch center button of SUPER STAR II Tester which DTCs are being displayed during KOEO).
6. Rerun EEC-IV On-Board Diagnostics to receive a pass code (111).

²¹ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

7. Verify customer concern has been eliminated.



D10500-B

Electrical Diagnosis

Use the following pinpoint tests to diagnose transmission electrical concerns.

PINPOINT TEST A: DTCs: 617, 618, 619, SOLENOID CIRCUIT FAILURE 621, 622

TEST STEP		RESULT	ACTION TO TAKE
A1	ELECTRONIC DIAGNOSTICS		
<ul style="list-style-type: none">The following items must be checked before proceeding:<ul style="list-style-type: none">Check the PCM for proper function (On-Board Diagnostics).Check vehicle wiring harness for continuity and shorts to ground.Make sure all connectors are engaged properly.Make sure all terminals in connectors are properly seated.Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals.Have items been checked?		Yes No	<ul style="list-style-type: none">GO to A2.PERFORM checks.

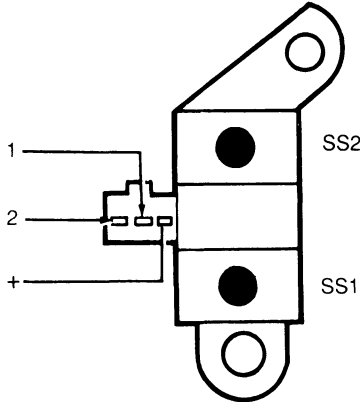
DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A: DTCs: 617, 618, 619, SOLENOID CIRCUIT FAILURE 621, 622 (Continued)

TEST STEP		RESULT	ACTION TO TAKE								
A6	CHECK SOLENOID /HARNESS FOR SHORT TO GROUND	Yes No	▶ GO to A7. ▶ GO to Hydraulic / Mechanical diagnosis.								
<ul style="list-style-type: none">Check for continuity between BAT- jack (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Solenoid</th><th>Tester Jack</th></tr><tr><td>SS-1</td><td>SS-1 / VPWR</td></tr><tr><td>SS-2</td><td>SS-2 / VPWR</td></tr></table> <ul style="list-style-type: none">Connection should show infinite resistance (no continuity).Is there continuity?				Solenoid	Tester Jack	SS-1	SS-1 / VPWR	SS-2	SS-2 / VPWR		
Solenoid	Tester Jack										
SS-1	SS-1 / VPWR										
SS-2	SS-2 / VPWR										
A7	INTERNAL ELECTRONIC DIAGNOSTICS										
<ul style="list-style-type: none">Drain transmission fluid.Remove transmission pan.Check that the internal harness connector is fully engaged on the shift solenoid assembly.Check that the internal harness connector terminals are fully seated in the connector.Inspect the connector for damage.Are above in good condition?		Yes No	▶ GO to A8. ▶ SERVICE as required.								
A8	CHECK INTERNAL HARNESS (Continuity)	Yes No	▶ GO to A9. ▶ REPLACE internal harness. GO to A10.								
<ul style="list-style-type: none">Disconnect internal harness from solenoid assembly (3-wire connector). <p>CAUTION: Do not probe into connector terminals.</p> <ul style="list-style-type: none">For SS-1, connect the positive lead from an ohmmeter to the tester jack SS-1 and the negative lead at the White wire of the 3-wire connector.Record resistance. Resistance should be less than 0.5 ohm.For SS-2, connect the positive lead from an ohmmeter to the tester jack SS-2 and the negative lead at the Black wire of the 3-wire connector.Record resistance. Resistance should be less than 0.5 ohm.For VPWR, connect positive lead to VPWR and the negative lead to the White / Black wire of the 3-wire connector.Record resistance. Resistance should be less than 0.5 ohm.Is resistance for each solenoid less than 0.5 ohm?											
A9	CHECK INTERNAL HARNESS (SHORTS TO GROUND)	Yes No	▶ REPLACE internal harness. GO to A10. ▶ GO to A10.								
<ul style="list-style-type: none">Check for continuity between BAT- jack (engine ground) and the appropriate wire with an ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Solenoid</th><th>Wire</th></tr><tr><td>SS-1</td><td>White</td></tr><tr><td>SS-2</td><td>Black</td></tr><tr><td>VPWR</td><td>White / Black</td></tr></table> <ul style="list-style-type: none">Connection should show infinite resistance (no continuity).Does connection show continuity?				Solenoid	Wire	SS-1	White	SS-2	Black	VPWR	White / Black
Solenoid	Wire										
SS-1	White										
SS-2	Black										
VPWR	White / Black										

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST A: DTCs: 617, 618, 619, SOLENOID CIRCUIT FAILURE 621, 622 (Continued)

TEST STEP		RESULT	ACTION TO TAKE								
A10	CHECK SOLENOID RESISTANCE AT SOLENOID										
<ul style="list-style-type: none">For SS-2 check solenoid resistance by connecting an ohmmeter at the outboard No. 2 terminal and + terminal of the solenoid assembly.Record resistance.For SS-1, connect the ohmmeter to the center No. 1 terminal of the solenoid assembly and to the + terminal.Record resistance.Resistance should be between 20 and 30 ohms. <div><p>D10233-B</p></div> <ul style="list-style-type: none">Is resistance for each solenoid between 20 and 30 ohms?		Yes No	➤ GO to A11. ➤ REPLACE solenoid assembly.								
A11	CHECK SOLENOID FOR SHORT TO GROUND										
<ul style="list-style-type: none">Check for continuity between BAT- jack (engine ground) and appropriate terminal with ohmmeter or other low current tester (less than 200 milliamps). <table border="1"><thead><tr><th>Solenoid</th><th>Terminal</th></tr></thead><tbody><tr><td>SS-1</td><td>1</td></tr><tr><td>SS-2</td><td>2</td></tr><tr><td>PWR</td><td>+</td></tr></tbody></table> <ul style="list-style-type: none">Connection should show infinite resistance (no continuity).Does connection show continuity?		Solenoid	Terminal	SS-1	1	SS-2	2	PWR	+	Yes No	➤ REPLACE solenoid assembly. ➤ REFER to Hydraulic / Mechanical diagnosis.
Solenoid	Terminal										
SS-1	1										
SS-2	2										
PWR	+										

TD10436B

PINPOINT TEST B: DTCs: 636 TOT OUT OF SELF-TEST RANGE, 637 TOT CIRCUIT OPEN and 638 TOT CIRCUIT GROUNDED

TEST STEP		RESULT	ACTION TO TAKE
B1	ELECTRONIC DIAGNOSTICS		
<ul style="list-style-type: none"> The following items must be checked before proceeding: <ul style="list-style-type: none"> Check the PCM for proper function (Self-Test). Check the vehicle wiring harness for continuity and shorts to ground. Make sure all connectors are engaged properly. Make sure all terminals in the connectors are properly seated. Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals. Have the items above been checked? 		Yes	GO to B2.
		No	PERFORM checks.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST B: DTCs: 636 TOT OUT OF SELF-TEST RANGE, 637 TOT CIRCUIT OPEN and 638 TOT CIRCUIT GROUNDED (Continued)

TEST STEP		RESULT	ACTION TO TAKE																								
B2	CHECK HARNESS CONNECTIONS																										
<ul style="list-style-type: none">● Check that vehicle harness connector is fully engaged on transmission connector.● Check that vehicle harness connector terminals are fully engaged in connector.● Are connector and terminals fully engaged?		Yes No	▶ GO to B3 . ▶ SERVICE as required.																								
B3	CHECK RESISTANCE OF TOT SENSOR/HARNESS																										
<p>NOTE: Refer to the Transmission Tester for terminal locations.</p> <ul style="list-style-type: none">● Vehicle must be at normal operating temperature.● Disconnect vehicle harness at transmission. <p>CAUTION: Do not attempt to pry connector. Depress tab and pull up on harness connector.</p> <ul style="list-style-type: none">● Install Transmission Tester 007-00085 or equivalent to transmission connector.● Set Bench/Drive switch to BENCH mode.● Rotate gear selector switch to OHMS/DIODE CHECK position.● Connect ohmmeter negative lead to -TOT jack and positive lead to +TOT jack on tester.● Perform tests 1 and 2. <p>NOTE: While performing Test 1 and 2 observe resistances. DTC 637 is set if resistance value exceeds 869K ohms (OPEN circuit). DTC 638 is set if resistance value falls below 597 ohms (short circuit).</p> <ul style="list-style-type: none">● Test 1● Record resistance.● Resistance should be approximately in the following ranges. <table><tr><th colspan="3">TRANSMISSION FLUID TEMPERATURE</th></tr><tr><th>°C</th><th>°F</th><th>Resistance (Ohms)</th></tr><tr><td>0-20</td><td>32-58</td><td>100K-37K</td></tr><tr><td>21-40</td><td>59-104</td><td>37K-16K</td></tr><tr><td>41-70</td><td>105-158</td><td>16K-5K</td></tr><tr><td>71-90</td><td>159-194</td><td>5K-2.7K</td></tr><tr><td>91-110</td><td>195-230</td><td>2.7K-1.5K</td></tr><tr><td>111-130</td><td>231-266</td><td>1.5K-0.8K</td></tr></table> <ul style="list-style-type: none">● Test 2● Check for intermittent short or open.● If resistance was between 0.8K and 100K ohms, perform following test. If transaxle is warm, allow transaxle to cool. Check TOT sensor resistance again. Compare resistance with initial resistance. Resistance should decrease if transaxle was heated and should increase if transaxle was allowed to cool. If correct change in resistance occurs, REPEAT On-Board Diagnostics.● Is resistance in range?		TRANSMISSION FLUID TEMPERATURE			°C	°F	Resistance (Ohms)	0-20	32-58	100K-37K	21-40	59-104	37K-16K	41-70	105-158	16K-5K	71-90	159-194	5K-2.7K	91-110	195-230	2.7K-1.5K	111-130	231-266	1.5K-0.8K	Yes No	▶ GO to B4 . ▶ GO to B5 .
TRANSMISSION FLUID TEMPERATURE																											
°C	°F	Resistance (Ohms)																									
0-20	32-58	100K-37K																									
21-40	59-104	37K-16K																									
41-70	105-158	16K-5K																									
71-90	159-194	5K-2.7K																									
91-110	195-230	2.7K-1.5K																									
111-130	231-266	1.5K-0.8K																									

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST B: DTCs: 636 TOT OUT OF SELF-TEST RANGE, 637 TOT CIRCUIT OPEN and 638 TOT CIRCUIT GROUNDED (Continued)

TEST STEP		RESULT	ACTION TO TAKE				
B4	CHECK TOT SENSOR / HARNESS FOR SHORT TO GROUND	Yes No	▶ GO to B5. ▶ REPEAT Quick Test if DTCs are still present. REFER to the Powertrain Control / Emissions Diagnosis Manual ²³ to diagnose harness or PCM concerns.				
	<ul style="list-style-type: none">● Check for continuity between BAT- jack (engine ground) and appropriate jack (-TOT and +TOT) with ohmmeter or other low current tester (less than 200 milliamps).● Connection should show infinite resistance (no continuity).● Is there continuity?						
B5	INTERNAL ELECTRONIC DIAGNOSTICS	Yes No	▶ GO to B6. ▶ SERVICE as required.				
	<ul style="list-style-type: none">● Drain transmission fluid.● Remove transmission pan.● Check that internal harness connector is fully engaged on TOT sensor.● Check that internal harness connector terminals are fully seated in connector.● Inspect the connector for damage.● Are above in good condition?						
B6	CHECK INTERNAL HARNESS (CONTINUITY)	Yes No	▶ GO to B7. ▶ REPLACE internal harness. GO to B8.				
	<ul style="list-style-type: none">● Disconnect internal harness from TOT sensor. <p>CAUTION: Do not probe into connector terminals.</p> <ul style="list-style-type: none">● For TOT, connect the positive lead from an ohmmeter to the tester +TOT jack and the negative lead at the White / Red wire of the TOT sensor connector.● Record resistance. Resistance should be less than 0.5 ohm.● Connect the positive lead from an ohmmeter to the tester -TOT jack and the negative lead at the red wire of the TOT wire connector.● Record resistance. Resistance should be less than 0.5 ohm.● Is resistance less than 0.5 ohm?						
B7	CHECK INTERNAL HARNESS (SHORTS TO GROUND)	Yes No	▶ REPLACE internal harness. GO to B8. ▶ GO to B8.				
	<ul style="list-style-type: none">● Check for continuity between BAT- jack (engine ground) and the appropriate wire (+TOT and -TOT) with ohmmeter or other low current tester (less than 200 milliamps). <table border="1"><thead><tr><th>Sensor</th><th>Wire</th></tr></thead><tbody><tr><td>TOT+</td><td>White / Red</td></tr><tr><td>TOT-</td><td>Red</td></tr></tbody></table> <ul style="list-style-type: none">● Connection should show infinite resistance (no continuity).● Is there continuity?			Sensor	Wire	TOT+	White / Red
Sensor	Wire						
TOT+	White / Red						
TOT-	Red						

23 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST B: DTCs: 636 TOT OUT OF SELF-TEST RANGE, 637 TOT CIRCUIT OPEN and 638 TOT CIRCUIT GROUNDED (Continued)

TEST STEP		RESULT	ACTION TO TAKE																						
B8	CHECK TOT SENSOR RESISTANCE	Yes No	► GO to B9. ► REPLACE TOT sensor.																						
<ul style="list-style-type: none">● Check sensor resistance by connecting an ohmmeter at the terminals of the TOT sensor assembly.● Record resistance.● Resistance should be in range of temperature of the vehicle.● Resistance should be approximately in the following ranges.																									
<table><tr><th colspan="3">TRANSMISSION FLUID TEMPERATURE</th></tr><tr><th>°C</th><th>°F</th><th>Resistance (Ohms)</th></tr><tr><td>0-20</td><td>32-58</td><td>100K-37K</td></tr><tr><td>21-40</td><td>59-104</td><td>37K-16K</td></tr><tr><td>41-70</td><td>105-158</td><td>16K-5K</td></tr><tr><td>71-90</td><td>159-194</td><td>5K-2.7K</td></tr><tr><td>91-110</td><td>195-230</td><td>2.7K-1.5K</td></tr><tr><td>111-130</td><td>231-266</td><td>1.5K-0.8K</td></tr></table> <ul style="list-style-type: none">● Is resistance in range?				TRANSMISSION FLUID TEMPERATURE			°C	°F	Resistance (Ohms)	0-20	32-58	100K-37K	21-40	59-104	37K-16K	41-70	105-158	16K-5K	71-90	159-194	5K-2.7K	91-110	195-230	2.7K-1.5K	111-130
TRANSMISSION FLUID TEMPERATURE																									
°C	°F	Resistance (Ohms)																							
0-20	32-58	100K-37K																							
21-40	59-104	37K-16K																							
41-70	105-158	16K-5K																							
71-90	159-194	5K-2.7K																							
91-110	195-230	2.7K-1.5K																							
111-130	231-266	1.5K-0.8K																							
B9	CHECK TOT SENSOR FOR SHORT TO GROUND	Yes No	► REPLACE TOT assembly. ► RERUN Quick Test if DTC is still present. REFER to the Powertrain Control/Emissions Diagnosis Manual ²⁴ to diagnose harness or PCM concerns.																						
<ul style="list-style-type: none">● Check for continuity between engine ground and appropriate terminal with ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Sensor</th><th>Terminal</th></tr><tr><td>TOT</td><td>+/-</td></tr></table> <ul style="list-style-type: none">● Connection should show infinite resistance (no continuity).● Is there continuity?				Sensor	Terminal	TOT	+/-																		
Sensor	Terminal																								
TOT	+/-																								

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PINPOINT TEST C: DTCs: 628 TCC ENGAGEMENT ERROR, 652 TCC CIRCUIT FAILURE and 656 TCC EXCESSIVE SLIP DETECTED

TEST STEP		RESULT	ACTION TO TAKE
C1	ELECTRONIC DIAGNOSTICS	Yes No	▶ GO to C2. ▶ PERFORM checks.
<ul style="list-style-type: none">• The following items must be checked before proceeding:<ul style="list-style-type: none">— Check the PCM for proper function (On-Board Diagnostics).— Check vehicle wiring harness for continuity and shorts to ground.— Make sure all connectors are engaged properly.— Make sure all terminals in connectors are properly seated.— Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals.• Have items been checked?			
C2	CHECK HARNESS CONNECTIONS	Yes No	▶ GO to C3. ▶ SERVICE as required.
<ul style="list-style-type: none">• Check that vehicle harness connector and terminals are fully engaged on transmission connector.• Are connector and terminals fully engaged?			

24 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST C: DTCs: 628 TCC ENGAGEMENT ERROR, 652 TCC CIRCUIT FAILURE and 656 TCC EXCESSIVE SLIP DETECTED (Continued)

TEST STEP		RESULT	ACTION TO TAKE				
C3	TRANSMISSION FUNCTIONAL TEST						
<ul style="list-style-type: none">Disconnect vehicle harness at transmission. CAUTION: Do not pry connector. Press the tab and pull on vehicle harness connector.Install Transmission Tester (007-00085) or equivalent to transmission connector.Using tests outlined under Tester Instructions, perform TCC solenoid function test. <p>NOTE: LED will turn GREEN when solenoid activates and turn OFF when deactivated. LED will turn RED if an ACTIVATED solenoid/harness is shorted to battery positive. LED will remain off if an ACTIVATED solenoid/harness is shorted to ground or no continuity (open circuit).</p> <ul style="list-style-type: none">Does MCCC (LED GREEN) activate when tester switch is pressed?		Yes No	➤ GO to C4. ➤ GO to C5.				
C4	TRANSMISSION DRIVE TEST						
<ul style="list-style-type: none">Perform Transmission Drive Test as outlined under testing instructions.While in second gear press the MCCC switch.Does the TCC activate (LED GREEN)?Does the engine rpm drop?		Yes No	➤ REFER to Powertrain Control/Emissions Diagnosis Manual ²⁵ to diagnose PCM and vehicle harness concerns. ➤ GO to C5.				
C5	CHECK RESISTANCE OF SOLENOID/HARNESS						
<p>NOTE: Refer to Transmission Tester for terminal locations.</p> <ul style="list-style-type: none">Set Bench/Drive switch to BENCH mode.Rotate Gear Selector switch to OHMS CHECK position.Connect ohmmeter negative lead to MCCC (jack) and positive lead to VPWR on tester. This is to test TCC.Record resistance.Resistance should be between 1 and 3 ohms.Is resistance between 1 and 3 ohms?		Yes No	➤ GO to C6. ➤ GO to C7. NOTE: Internal harness or solenoid may be damaged.				
C6	CHECK SOLENOID/HARNESS FOR SHORT TO GROUND						
<ul style="list-style-type: none">Check for continuity between BAT- jack (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Solenoid</th><th>Tester Jack</th></tr><tr><td>TCC</td><td>MCCC</td></tr></table> <ul style="list-style-type: none">Connection should infinite resistance (no continuity).Is there continuity?		Solenoid	Tester Jack	TCC	MCCC	Yes No	➤ GO to C7. ➤ REFER to Hydraulic/Mechanical Diagnosis.
Solenoid	Tester Jack						
TCC	MCCC						
C7	INTERNAL ELECTRONIC DIAGNOSTICS						
<ul style="list-style-type: none">Drain transmission fluid.Remove transmission pan.Check that internal harness connector is fully engaged on the TCC solenoid assembly.Check that internal harness connector terminals are fully seated in the connector.Inspect the connector for damage.Are above in good condition and engaged properly?		Yes No	➤ GO to C8. ➤ SERVICE as required.				

25 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST C: DTCs: 628 TCC ENGAGEMENT ERROR, 652 TCC CIRCUIT FAILURE and 656 TCC EXCESSIVE SLIP DETECTED (Continued)

TEST STEP		RESULT	ACTION TO TAKE				
C8	CHECK INTERNAL HARNESS (CONTINUITY)						
<ul style="list-style-type: none">Disconnect internal harness from TCC solenoid assembly (TCC wire connector). <p>CAUTION: Do not probe into connector terminals.</p> <ul style="list-style-type: none">Connect positive lead from an ohmmeter to tester MCCC jack and the negative lead at the Green wire of the TCC connector.Record resistance. Resistance should be less than 0.5 ohm.Connect the positive lead from an ohmmeter to the tester VPWR jack and the negative lead to the White / Green wire of the TCC connector.Record resistance. Resistance should be less than 0.5 ohm.Is resistance less than 0.5 ohm?		Yes No	► GO to C9 . ► REPLACE internal harness. GO to C10 .				
C9	CHECK INTERNAL HARNESS (SHORTS TO GROUND)						
<ul style="list-style-type: none">Check for continuity between BAT- jack (engine ground) and the appropriate wire with an ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Solenoid</th><th>Wire</th></tr><tr><td>TCC</td><td>Green White / Green</td></tr></table> <ul style="list-style-type: none">Connection should show infinite resistance (no continuity).Is there continuity?		Solenoid	Wire	TCC	Green White / Green	Yes No	► REPLACE internal harness. GO to C10 . ► GO to C10 .
Solenoid	Wire						
TCC	Green White / Green						
C10	CHECK SOLENOID RESISTANCE						
<ul style="list-style-type: none">For TCC, check solenoid resistance by connecting an ohmmeter to the terminals of the TCC solenoid assembly.Record resistance.Resistance should be between 1 and 3 ohms.Is resistance between 1 and 3 ohms?		Yes No	► GO to C11 . ► REPLACE TCC solenoid assembly.				
C11	CHECK SOLENOID FOR SHORT TO GROUND						
<ul style="list-style-type: none">Check for continuity between BAT- jack (engine ground) and appropriate solenoid terminals with ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Solenoid</th><th>Terminal</th></tr><tr><td>TCC</td><td>+ / -</td></tr></table> <ul style="list-style-type: none">Connection should infinite resistance (no continuity).Is there continuity?		Solenoid	Terminal	TCC	+ / -	Yes No	► REPLACE TCC solenoid assembly. ► REFER to Hydraulic / Mechanical Diagnosis.
Solenoid	Terminal						
TCC	+ / -						

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DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST D: DTC: 522 MLP NOT IN PARK AND 634, MLP OUT OF RANGE

TEST STEP		RESULT	ACTION TO TAKE																							
D1	ELECTRONIC DIAGNOSTICS																									
	<ul style="list-style-type: none">The following items must be checked before proceeding:<ul style="list-style-type: none">Check the Powertrain Control Module (PCM) for proper function (Self-Test).Check the vehicle wiring harness for continuity and shorts to ground.Make sure all connectors are engaged properly.Make sure all terminals in the connectors are properly seated.Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals.Have the items above been checked?	Yes No	► GO to D2. ► PERFORM checks.																							
D2	CHECK HARNESS CONNECTIONS																									
	<ul style="list-style-type: none">Check that vehicle harness connector is fully engaged on transmission manual lever position (MLP) sensor connector.Check that vehicle harness connector terminals are fully engaged in connector and in good condition.Are connector and terminals fully engaged?	Yes No	► GO to D3. ► SERVICE as required.																							
D3	ADJUST MANUAL LEVER POSITION SENSOR																									
	<ul style="list-style-type: none">Apply parking brake.Place transmission gear selector in NEUTRAL.Verify manual lever position using Gear Position Sensor Adjuster Tool T92P-70010-AH.Verify that MLP sensor retaining bolts are tightened to proper specifications.Is sensor adjusted properly?	Yes No	► GO to D4. ► ADJUST sensor as outlined under Transmission Assembly. REPEAT Self-Test.																							
D4	CHECK OPERATION OF MANUAL LEVER POSITION SENSOR																									
	<ul style="list-style-type: none">Disconnect vehicle harness at transmission. CAUTION: Do not pry connector. Squeeze tabs and pull up on vehicle harness connector.Insert MLP sensor tester or equivalent into MLP sensor.Plug ohmmeter into MLP sensor tester.Using procedures provided with tester verify sensor functions in all positions.<ul style="list-style-type: none">Check continuity and resistances in all positions. Refer to the following chart: <table><tr><th rowspan="2">Transmission Shift Position</th><th colspan="2">Resistance (ohms)</th></tr><tr><th>Min</th><th>Max</th></tr><tr><td>P</td><td>3770</td><td>4607</td></tr><tr><td>R</td><td>1304</td><td>1593</td></tr><tr><td>N</td><td>660</td><td>807</td></tr><tr><td>OD</td><td>361</td><td>442</td></tr><tr><td>2/D</td><td>190</td><td>232</td></tr><tr><td>1</td><td>78</td><td>95</td></tr></table> <ul style="list-style-type: none">Is MLP sensor OK? <p>NOTE: The second gear position on the tester has the same resistance in the DRIVE detent.</p>	Transmission Shift Position	Resistance (ohms)		Min	Max	P	3770	4607	R	1304	1593	N	660	807	OD	361	442	2/D	190	232	1	78	95	Yes No	► REFER to Powertrain Control/Emissions Diagnosis Manual ²⁶ for diagnosis of PCM assembly and vehicle wiring harness concern. ► REPLACE MLP Sensor and RERUN Self-Test.
Transmission Shift Position	Resistance (ohms)																									
	Min	Max																								
P	3770	4607																								
R	1304	1593																								
N	660	807																								
OD	361	442																								
2/D	190	232																								
1	78	95																								

26 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST E: DTCs: 624, EPC CIRCUIT FAILURE AND 625 EPC DRIVER CIRCUIT FAILURE (PCM)

TEST STEP		RESULT	ACTION TO TAKE
E1	ELECTRONIC DIAGNOSTICS		
	<ul style="list-style-type: none"> The following items must be checked before proceeding: <ul style="list-style-type: none"> Check the PCM for proper function (On-Board Diagnostics). Check the vehicle wiring harness for continuity and shorts to ground. Make sure all connectors are engaged properly. Make sure all terminals in the connectors are properly seated. Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals. Have the items above been checked? 	Yes No	► GO to E2 . ► PERFORM checks.
E2	CHECK HARNESS CONNECTIONS		
	<ul style="list-style-type: none"> Check that vehicle harness connector is fully engaged on transmission connector. Check that vehicle harness connector terminals are fully engaged in connector. Are connector and terminals fully engaged? 	Yes No	► GO to E3 . ► SERVICE as required.
E3	TRANSMISSION FUNCTIONAL TEST		
	<ul style="list-style-type: none"> Disconnect vehicle harness at transmission. <p>CAUTION: Do not attempt to pry the connector. Depress tab and pull up on harness connector.</p> <ul style="list-style-type: none"> Install line pressure gauge at line tap on case. Install Transmission Tester 007-00085 or equivalent to transmission connector. Set Bench/Drive switch to DRIVE mode. Rotate Gear Selector Switch to 1st gear position. Using tests outlined under tester instructions perform the EPC function test. <p>NOTE: LED will turn GREEN when solenoid activates and turn OFF when deactivated. LED will turn RED if an ACTIVATED solenoid/harness is shorted to battery positive. LED will remain off if an ACTIVATED solenoid/harness is shorted to ground or no continuity (open circuit).</p> <ul style="list-style-type: none"> Does the EPC (GREEN LED) activate when EPC switch is pressed? Observe line pressure on the gauge while pressing EPC switch (vehicle must be running). Does the line pressure drop? 	Yes No	► REFER to Powertrain Control/Emissions Diagnosis Manual ²⁷ to diagnose PCM or vehicle harness concerns. ► GO to E4 .
E4	CHECK RESISTANCE OF SOLENOID/HARNESS		
	<p>NOTE: Refer to the Transmission Tester for terminal locations.</p> <ul style="list-style-type: none"> Set Bench/Drive switch to BENCH mode. Rotate Gear Select switch to OHMS CHECK position. Connect ohmmeter negative lead to VPWR jack and positive lead to EPC jack on tester. This is to test EPC solenoid. Record resistance. Resistance should be between 2.48 and 5.66 ohms. Is resistance between 2.48 and 5.66 ohms? 	Yes No	► GO to E5 . ► GO to E6 . NOTE: Out of specification may be caused by internal harness or EPC solenoid concerns.

27 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST E: DTCs: 624, EPC CIRCUIT FAILURE AND 625 EPC DRIVER CIRCUIT FAILURE (PCM) (Continued)

TEST STEP		RESULT	ACTION TO TAKE				
E5	CHECK SOLENOID / HARNESS FOR SHORT TO GROUND	Yes No	▶ GO to E6. ▶ REFER to Hydraulic / Mechanical Diagnosis charts.				
<ul style="list-style-type: none">Check for continuity between BAT- jack (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Solenoid</th><th>Tester Jack</th></tr><tr><td>EPC</td><td>EPC VPWR</td></tr></table> <ul style="list-style-type: none">Connection should show infinite resistance (no continuity).Is there continuity?				Solenoid	Tester Jack	EPC	EPC VPWR
Solenoid	Tester Jack						
EPC	EPC VPWR						
E6	INTERNAL ELECTRONIC DIAGNOSTICS						
<ul style="list-style-type: none">Drain transmission fluid.Remove transmission pan.Check that internal harness connector is fully engaged on EPC solenoid assembly.Check that internal harness connector terminals are fully seated in connector.Inspect connector for damage.Are above properly engaged and in good condition?		Yes No	▶ GO to E7. ▶ SERVICE as required.				
E7	CHECK INTERNAL HARNESS (CONTINUITY)	Yes No	▶ GO to E8. ▶ REPLACE internal harness. GO to E9.				
<ul style="list-style-type: none">Disconnect internal harness from EPC solenoid assembly.Connect the positive lead from an ohmmeter to the tester EPC jack and the negative lead at the Blue wire at the EPC wire connector.Record resistance. Resistance should be less than 0.5 ohm.Connect the positive lead from an ohmmeter to the tester VPWR jack and the negative lead at the White / Blue wire at the EPC wire connector.Record resistance. Resistance should be less than 0.5 ohm.Is resistance less than 0.5 ohm?							
E8	CHECK INTERNAL HARNESS (SHORTS TO GROUND)						
<ul style="list-style-type: none">Check for continuity between BAT- jack (engine ground) and the appropriate wire with an ohmmeter or other low current tester (less than 200 milliamps). <table><tr><th>Solenoid</th><th>Wire</th></tr><tr><td>EPC</td><td>Blue (Signal) White / Blue (EPCPWR)</td></tr></table> <ul style="list-style-type: none">Connection should show infinite resistance (no continuity).Is there continuity?		Solenoid	Wire	EPC	Blue (Signal) White / Blue (EPCPWR)	Yes No	▶ REPLACE internal harness. GO to E9. ▶ GO to E9.
Solenoid	Wire						
EPC	Blue (Signal) White / Blue (EPCPWR)						
E9	CHECK SOLENOID RESISTANCE	Yes No	▶ GO to E10. ▶ REPLACE EPC solenoid.				
<ul style="list-style-type: none">Check solenoid resistance by connecting an ohmmeter at the EPC terminals of the solenoid.Record resistance.Resistance should be between 2.48 and 5.66 ohms.Is resistance between 2.48 and 5.66 ohms?							

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST E: DTCs: 624, EPC CIRCUIT FAILURE AND 625 EPC DRIVER CIRCUIT FAILURE (PCM) (Continued)

TEST STEP		RESULT	ACTION TO TAKE				
E 10	CHECK SOLENOID FOR SHORT TO GROUND	Yes No	▶ REPLACE EPC solenoid. ▶ REFER to Hydraulic / Mechanical Diagnosis.				
● Check for continuity between BAT -jack (engine ground) and appropriate terminal with ohmmeter or other low current tester (less than 200 milliamps).							
<table><tr><th>Solenoid</th><th>Terminal</th></tr><tr><td>EPC</td><td>+ / -</td></tr></table>				Solenoid	Terminal	EPC	+ / -
Solenoid	Terminal						
EPC	+ / -						
● Connection should show infinite resistance (no continuity).							
● Is there continuity?							

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PINPOINT TEST F: DTC: 639 TSS INSUFFICIENT INPUT

TEST STEP		RESULT	ACTION TO TAKE
F1	ELECTRONIC DIAGNOSTICS		
<ul style="list-style-type: none"> The following items must be checked before proceeding: <ul style="list-style-type: none"> Check the PCM for proper function (On-Board Diagnostics). Check vehicle wiring harness for continuity and shorts to ground. Make sure all connectors are engaged properly. Make sure all terminals in the connectors are properly seated. Check all connectors for damage, corrosion, water, bent pins and missing or damaged seals. Have items above been checked? 		Yes No	<ul style="list-style-type: none"> GO to F2. PERFORM checks.
F2	CHECK HARNESS CONNECTIONS		
<ul style="list-style-type: none"> Check that vehicle harness connector is fully engaged on transmission speed sensor (TSS). Check that vehicle harness connector terminals are fully engaged in connector. Are connector and terminals fully engaged? 		Yes No	<ul style="list-style-type: none"> GO to F3. SERVICE as required.
F3	TRANSMISSION FUNCTIONAL TEST		
<ul style="list-style-type: none"> Disconnect vehicle harness at TSS sensor. CAUTION: Do not attempt to pry on the connector. Pull on harness connector. Install Transmission Tester 007-00085 or equivalent onto TSS sensor. Connect voltmeter positive lead to +TSS and the negative lead to -TSS. Set voltmeter to AC. Perform TSS Function Test. Monitor voltmeter. Does the voltage increase with an increase in vehicle speed? 		Yes No	<ul style="list-style-type: none"> REFER to the Powertrain Control / Emissions Diagnosis Manual²⁸ to diagnose vehicle harness or PCM concerns. GO to F4.
F4	CHECK RESISTANCE OF TRANSMISSION SPEED SENSOR		
<p>NOTE: Refer to the Transmission Tester for terminal locations.</p> <ul style="list-style-type: none"> Connect ohmmeter negative lead to +OSS jack and positive lead to -OSS jack on tester. This is to test TSS sensor. Record resistance. Resistance should be between 450 and 750 ohms. Is resistance between 450 and 750 ohms? 		Yes No	<ul style="list-style-type: none"> GO to F5. REPLACE TSS sensor. RERUN TSS Function Test.

28 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST F: DTC: 639 TSS INSUFFICIENT INPUT (Continued)

TEST STEP		RESULT	ACTION TO TAKE						
F5	CHECK SENSOR FOR SHORT TO GROUND								
<ul style="list-style-type: none">Check for continuity between BAT- jack (engine ground) and appropriate jack with an ohmmeter or other low current tester (less than 200 milliamps). <table border="1"><thead><tr><th>Solenoid</th><th>Tester Jack</th></tr></thead><tbody><tr><td>TSS</td><td>+OSS</td></tr><tr><td></td><td>-OSS</td></tr></tbody></table> <ul style="list-style-type: none">Connection should show infinite resistance (no continuity).Is there continuity?		Solenoid	Tester Jack	TSS	+OSS		-OSS	Yes No	▶ REPLACE TSS sensor. RERUN TSS Function Test. ▶ GO to F6.
Solenoid	Tester Jack								
TSS	+OSS								
	-OSS								
F6	CHECK TSS MAGNETISM								
<ul style="list-style-type: none">Remove TSS from transmission.Place TSS against a metal surface to which a magnet would stick. The TSS should be magnetized and stick to the metal surface.Does TSS stick?		Yes No	▶ GO to F7. ▶ REPLACE TSS sensor. RERUN TSS Function Test.						
F7	CHECK OUTPUT SHAFT RING GEAR								
<ul style="list-style-type: none">With TSS removed and transmission in NEUTRAL, rotate driveshaft and observe through the TSS hole in case that all six holes or indentations in the ring gear are present and free of foreign material.Are holes present and free of foreign material?		Yes No	▶ REPLACE TSS sensor. RERUN TSS Function Test. ▶ REFER to Disassembly and Assembly to service output shaft ring gear. SERVICE or REPLACE as required.						

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Transmission Fluid Level Check

CAUTION: Vehicle should not be driven if fluid level is below the bottom hole.

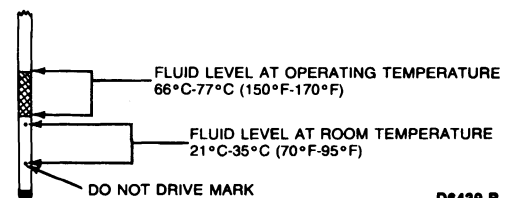
Transmission Hot — Operating Temperature

The automatic transmission should be checked at an operating temperature of 66°C-77°C (150°F-170°F) (dipstick hot to touch). The operating temperature may be obtained by driving 24-32 km (15-20 miles) of city-type driving with the outside temperature above 10°C (50°F).

CAUTION: If vehicle has been operated for an extended period at high speed, in city traffic, in hot weather, or vehicle is being used to pull a trailer, the fluid has to cool, approximately 30 minutes after engine has been turned off to obtain an accurate reading.

Dipstick Reading: Fluid level at operating temperature.

Fluid level on dipstick should be within the cross-hatched area.



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Transmission Cold — Room Temperature

If the transmission is not at an operating temperature of 66°C-77°C (150°F-170°F) and it becomes necessary to check the fluid level (such as pre-delivery), the fluid may be checked at room temperature of 21°C-35°C (70°F-95°F) (dipstick cool to touch).

Dipstick Reading: Fluid level at room temperature.

Fluid level on the dipstick should read between the holes at room temperature.

Check fluid level as follows:

1. With transmission in PARK, engine at curb idle rpm, foot brakes applied and vehicle on level surface, move the transmission selector lever through each range. Allow time in each range to engage transmission, return to PARK, apply parking brake and block wheels. **Do not turn off the engine during the fluid level check.**

DIAGNOSIS AND TESTING (Continued)

2. Clean all dirt from the transmission fluid dipstick cap before removing the dipstick from the filler tube.
3. Pull the dipstick out of the tube, wipe it clean, and push all the way back into the tube. **Ensure it is fully seated.**
4. Pull the dipstick out of the tube again and check the fluid level.

NOTE: The fluid level indication on the dipstick will be different at operating temperature and room temperature. For the correct fluid level reading on the dipstick, follow the appropriate instructions stated previously.

Before adding fluid, ensure that the correct type will be used. Only use fluid that meets or exceeds the specification stamped on the dipstick.

CAUTION: Use of a fluid other than MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or DDX (E4AZ-19582, ESP-M2C166-H, and ESR-M2C163-A2) or equivalent could result in transmission malfunction and/or failure.

If necessary, add enough fluid through the filler tube to raise the level to the correct position. Do not overfill the transmission. This will result in foaming, loss of fluid through the vent and possible transmission malfunction. If overfill occurs, excess fluid must be removed.

5. Install the dipstick, making sure it is fully seated in the tube.

If the transmission fluid level is correctly established at 21°C-35°C (70°F-95°F), it will appear in the cross-hatch area on the dipstick when the transmission reaches an operating temperature of 66°C-77°C (150°F-170°F). Do not overfill or underfill.

Underfill can result in transmission loss of engagement or slipping. This condition is most evident in cold weather or when the vehicle is parked or being driven on a hill.

If the transmission fluid level is checked when the fluid is at room temperature, the dipstick could indicate that fluid should be added if the dipstick is misread. If fluid is added at this time, an overfill condition could result when the fluid reaches operating temperatures of 66°C-77°C (150°F-170°F) (dipstick hot to touch).

Transmission Fluid Condition Check

1. Make the normal fluid check as outlined.
2. Observe color and odor of the fluid. It should be dark reddish, not brown or black. Odor can sometimes indicate that there is an overheating condition or clutch disc or band failure.

3. Use an absorbent white facial tissue to wipe the dipstick. Examine the stain for evidence of solids (specks of any kind) and for antifreeze signs (gum or varnish on dipstick).

If specks are present in the oil or there is evidence of antifreeze, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive solids in the oil pan, the transmission must be disassembled and completely cleaned and serviced. This includes cleaning the torque converter and transmission cooling system. It would be a waste of time to perform any further checks before cleaning and servicing the transmission. During disassembly and assembly, all overhaul checks and adjustments of clearances and end play must be made. After the transmission has been serviced, all diagnosis tests and adjustments listed in the Diagnosis chart must be completed to ensure the concern has been corrected.

Transmission Fluid Leakage Checks

Check the vehicle speed (VSS) sensor, transmission speed sensor (TSS) and the connector at transmission. Replace the rubber seal, if necessary.

NOTE: Fluid from other external sources can collect between the case and pan rail and give the appearance of a pan gasket leak. If fluid is present check the following positions as outlined.

Check for leakage at oil pan gasket.

Leakage at the oil pan gasket often can be stopped by tightening the retaining bolts to 8-13.5 N·m (7-11 lb-in). Do not over-tighten pan bolts. If necessary, replace the gasket.

Check the fluid filler tube connection at the transmission case or oil pan. If leakage is found here, install a new O-ring and press the filler tube to the case. The filler tube bracket should align properly and be attached to the transmission or engine.

Check the fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear or damage. When fluid is found to be leaking between the case and the cooler line fitting, tighten the fitting to 31 N·m (23 lb-ft). **Do not try to stop the fluid leak by increasing the torque beyond specification. This may cause damage to the case threads.**

If the leak continues, replace the cooler line fitting and tighten to 24-31 N·m (18-23 lb-ft). The same procedure should be followed for fluid leaks between the radiator cooler and cooler line fittings.

Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the transmission cooler in the radiator is probably leaking.

DIAGNOSIS AND TESTING (Continued)

The cooler can be further checked for leaks by disconnecting the lines from the cooler fittings and applying 345-517 kPa (50-75 psi) air pressure to the fittings. Remove the radiator pressure cap to relieve the pressure buildup at the exterior of the oil cooler tank. If the cooler is leaking and/or will not hold pressure, the cooler must be replaced. Refer to Group 03 for coolant replacement procedure.

If leakage is found at the manual lever shaft, replace the seal.

Pipe Plugs

The 4R70W (AODE-W) has five pipe plugs: four on the RH side of the case and one on the LH side. Inspect the plugs for leakage. Ensure they are tightened to 8-16 N·m (6-12 lb·ft). If tightening does not stop the leak, replace the plug.

When a converter drain plug leaks, remove the drain plug with a six-point wrench. Coat the threads with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent and install plug. Tighten the drain plug to 11-38 N·m (8-28 lb·ft). Fluid leakage from the converter housing may also be caused by engine oil leaking past the rear main bearing seal, or from oil galley plugs. Verify the exact cause of the leak before starting service procedures.

Oil soluble aniline or fluorescent dyes premixed at the rate of 2.5ml (1/2-teaspoon) of dye powder to 0.23 l (1/2-pint) of transmission fluid have proved helpful in locating the source of fluid leakage. Such dyes may be used to determine whether an engine oil or transmission fluid leak is present, or if the fluid in the oil cooler leaks into the engine coolant system. A black light must be used with the fluorescent dye solution.

Converter and Fluid Cooler**Tool Required:**

- Rotunda Torque Converter Cleaner 014-00028

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and **MUST** be removed from the system before the transmission is put back into service.

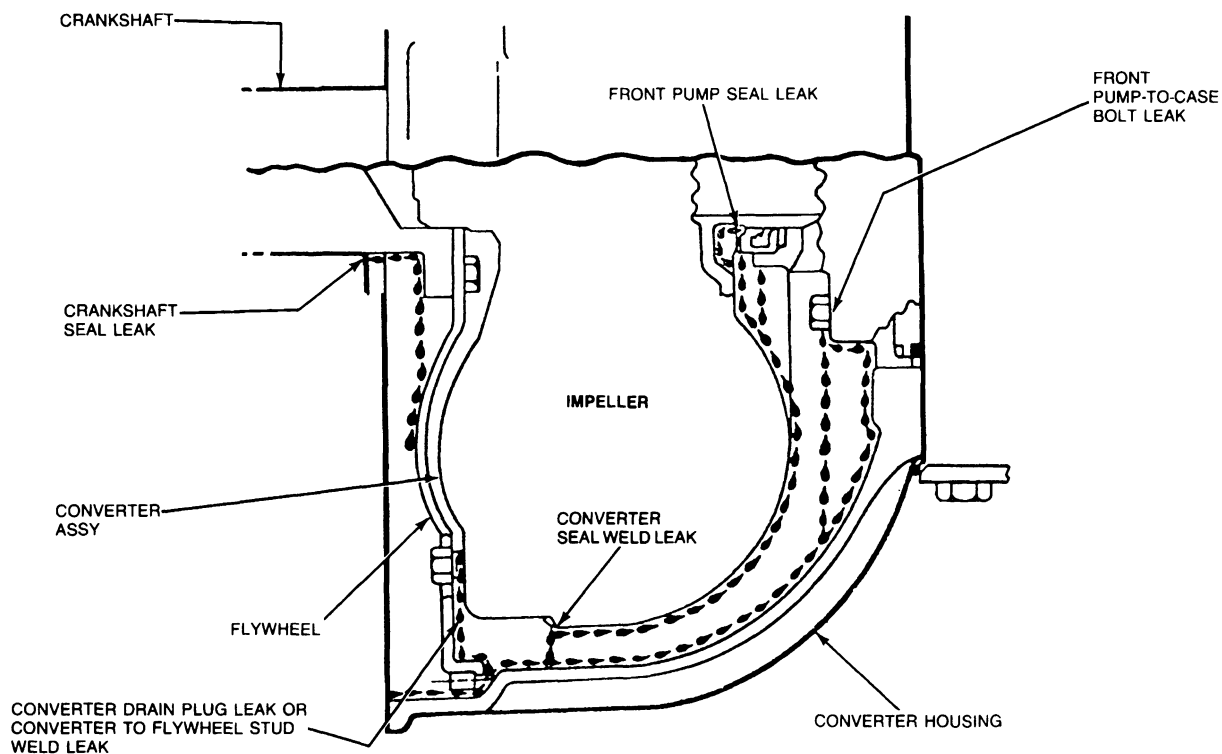
CAUTION: Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the converter, oil and oil cooler lines MUST be cleaned and flushed by using the Rotunda Torque Converter Cleaner 014-00028 or equivalent. Under NO circumstances should an attempt be made to clean converters by hand agitation with solvent.

Fluid Leakage in Converter Area

In diagnosing and correcting fluid leaks in the front pump and converter area, use the following procedures to locate the exact cause of the leakage. Leakage at the front of transmission, as evidenced by fluid around the converter housing, may have several sources. By careful observation, it is possible, in many instances, to pinpoint the source of leak before removing the transmission from the vehicle. The paths which the fluid takes to reach the bottom of the converter housing are shown in the following illustration.

DIAGNOSIS AND TESTING (Continued)

Converter Leakage



NOTE: BECAUSE OF A ONE PIECE CASE, LEAKAGE FROM THE PUMP GASKET WILL RUN DOWN THE INSIDE OF THE CONVERTER HOUSING ON AUTOMATIC OVERDRIVE TRANSMISSION.

D2871-G

1. Fluid leaking by the front pump seal lip will tend to move along the impeller hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the housing.
2. Fluid leakage by the outside diameter of the seal and front pump body will follow the same path which the leaks by the front pump seal follow.
3. Fluid that leaks by a front pump-to-case bolt will be deposited on the inside of the converter housing only. Fluid will not be deposited on the back of the converter.
4. Fluid leakage from the converter drain plugs or converter-to-flywheel stud weld will appear at the outside diameter of the converter on the back face of the flywheel, and in the converter housing only near the flywheel. Fluid leaks from the torque converter will leave a ring of fluid around the inside of the transmission converter housing.

NOTE: White tissue paper may aid in determining the color (red is transmission fluid) and source of the leaking fluid.

5. Engine oil leaks are sometimes improperly diagnosed as transmission front pump seal leaks. The following areas of possible leakage should also be checked to determine if engine oil leakage is causing the concern.
 - a. Leakage at the rocker arm cover may allow oil to flow over the converter housing or seep down between the converter housing and cylinder block causing oil to be present in or at the bottom of the converter housing.
 - b. Oil galley plug leaks will allow oil to flow down the rear face of the block to the bottom of the converter housing.
 - c. Leakage at the crankshaft seal will work back to the flywheel, and then into the converter housing.
 - d. Leakage at oil sender.

DIAGNOSIS AND TESTING (Continued)

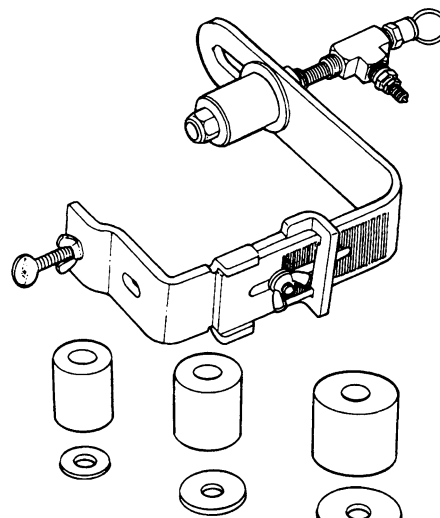
6. Fluid leakage from other areas, such as the power steering system forward of the transmission, could cause fluid to be present around the converter housing due to blowback or road draft. The following procedures should be used to determine the cause of the leakage before service.
 - a. Remove the transmission dipstick and note the color of the fluid. Original factory fill fluid is dyed red to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the red color should assist in pinpointing the leak. However, a power steering leak may be mistaken for a transmission leak since the fluid color for both looks the same. Observe the power steering system for leaks that could be misidentified as a transmission leak.
 - b. Remove the converter housing cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case and rear face of the engine and engine oil pan. Clean the converter area by washing with a suitable non-flammable solvent and blow dry with compressed air.
 - c. Wash out the converter housing, the front of the flywheel and the converter drain plugs. The converter housing may be washed out using cleaning solvent and a squirt-type oil can. Blow all washed areas dry with compressed air.
 - d. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist and run the engine at fast idle, then at engine idle, occasionally shifting to the OVERDRIVE and REVERSE ranges to increase pressure within the transmission. Observe the front of the flywheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

Converter Leakage Check**Tool Required:**

- Rotunda Torque Converter Leak Detector 021-00054

If welds on the torque converter indicate leakage remove the converter and make the following check:

Assemble Rotunda Torque Converter Leak Detector 021-00054 or equivalent to the converter. Test the converter for leaks, following the directions supplied with the detector kit.



ROTUNDA TORQUE CONVERTER LEAK
TEST KIT 021-00054

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Transmission Fluid Cooler Flow Check

The linkage, fluid and control pressure must be within specifications before performing this flow check.

Remove the transmission dipstick from the filler tube. Place a funnel in the transmission filler tube. Raise the vehicle and remove the cooler return line from its fitting in the case. Attach a hose to the cooler return line and fasten the free end of the hose in the funnel installed in the filler tube.

Start the engine and set idle speed at 1000 rpm with the transmission in NEUTRAL.

Observe the fluid flow at the funnel. When the flow is solid (air bleeding has been completed), the flow should be liberal. If there is not a liberal flow at 1000 rpm in NEUTRAL, low pump capacity, main circuit system leakage, or cooler system restriction is indicated.

Check both metal cooler lines between the transmission and radiator for restrictions. Check for restrictions in the metal or rubber cooler lines to and from the auxiliary cooler, if so equipped. Visually check and physically feel all bends for kinks, especially rubber cooler lines, that would restrict flow and could result in transmission overheating or lack of lubrication.

To separate transmission trouble from cooler system trouble, observe the flow at the transmission case converter-out fitting.

DIAGNOSIS AND TESTING (Continued)**Stall Speed Test**

The stall speed test checks torque converter clutch operation and installation, the holding ability of the forward clutch, reverse clutch (the low-reverse bands), the planetary one-way clutch, and engine performance.

Conduct this test with the engine coolant and transmission fluid at proper levels and at normal operating temperature.

Apply the service and parking brakes firmly for each stall speed test.

1. Find the specified stall rpm for the vehicle by referring to the Special Specifications booklet. Use a grease pencil to mark the rpm on the dial of a tachometer.

2. Connect tachometer to engine.

NOTE: If the engine speed recorded by the tachometer exceeds the maximum limits given in the Special Specifications booklet, release the accelerator immediately because clutch or band slippage is indicated.

3. In each of the following ranges: \odot , 2, 1, R, press the accelerator to the floor and hold it just long enough to let the engine get to full rpm. While making this test, do not hold the throttle open for more than five seconds at a time.
4. Note the results in each range.
5. After each range, move the selector lever to NEUTRAL and run the engine at 1000 rpm for about 15 seconds to cool the converter before making the next test.
6. Refer to the following chart for corrective actions.

Selector Position	Stall Speeds High	Stall Speeds Low
\odot	Planetary One-Way Clutch	
\odot , 2 and 1	Forward Clutch or Intermediate Clutch	
\odot , 2, 1 and R	General Problems Pressure Test	Converter Stator One-Way Clutch or Engine Performance
R	Reverse Clutch or Low Reverse Band or Servo	

Air Pressure Tests**Reverse Clutch**

Apply air pressure to the reverse clutch passage in the service tool. A dull thud can be heard when the clutch piston applies. In addition, movement of the reverse clutch drum may also be detected.

Forward Clutch

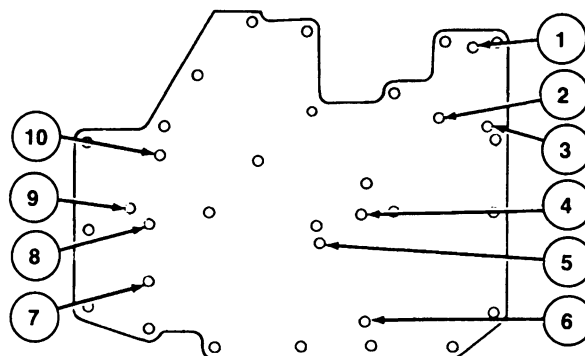
Apply air pressure to the forward clutch apply passage in the service tool plate. A dull thud can be heard or movement of the piston can be felt on the case as the clutch piston is applied.

Intermediate Clutch

Apply air pressure to the intermediate clutch passage in the service tool plate. A dull thud can be heard or felt when the clutch applies.

Overdrive Servo

Apply air pressure to the overdrive (O/D) servo apply passage in the service tool plate. Operation of the band is indicated by the tightening of the band around the reverse clutch drum. The O/D servo will return to the release position as a result of spring force from the release spring. Also, when the servo returns to the release position, a thud can be felt on the O/D servo cover. The band will then relax.



D10447-A

Item	Description
1	Converter Bypass
2	1-2 Accumulator Apply
3	Intermediate Clutch
4	Overdrive Servo Release
5	Reverse Servo
6	Overdrive Servo Apply
7	2-3 Accumulator Bottom
8	2-3 Accumulator Top
9	Forward Clutch
10	Direct Clutch

DIAGNOSIS AND TESTING (Continued)

Low-Reverse Servo

Apply air pressure to the low-reverse servo passage in the service tool plate. A dull thud can be heard when the low-reverse band tightens around the planetary assembly drum surface. Also, movement of the ring gear can be detected.

Direct Clutch

Apply air pressure to the direct clutch apply passage. A dull thud should be heard or felt on the driveshaft if the clutch is operating.

2-3 Accumulator

Apply air pressure to the 2-3 accumulator passage. The accumulator piston should unseat. This can be detected by inserting a metal rod into the 2-3 piston hole. When the piston unseats, the rod will move. Also, a thud can be heard when the piston applies.


Engine Idle Speed Check

Including Throttle Positioner Application

If the idle speed is too low, the engine will run rough. An idle speed that is too high will cause the vehicle to creep, have harsh engagements, and harsh closed throttle downshifts.

Check and if necessary adjust the engine idle speed with the throttle positioner (if applicable) or the injection pump linkage adjustment. Refer to the Powertrain Control/Emissions Diagnosis Manual²⁹ for the appropriate procedure according to throttle positioner application.

Shift Linkage Check

This is a **CRITICAL** adjustment. Be sure the  detent in the transmission corresponds exactly with the stop in the steering column or console. Hydraulic leakage at the manual valve can cause delay in engagements and/or slipping while operating if the linkage is not correctly adjusted.

NOTE: Check for a misadjustment in shift linkage. Do this by matching the detents in the shift lever with those in the transmission. If they match, the misadjustment is in the indicator. Do not adjust the shift linkage.

Direct Clutch Pressure Test

The direct clutch pressure test outlined below will diagnose a low-pressure condition or leakage in the direct clutch circuit. A difference of 103 kPa (15 psi) or more between direct clutch pressure and line pressure (read at the forward clutch pressure tap) will prevent a normal 3-4 shift.

CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken not to accelerate or decelerate rapidly. Possible transmission failure could result.

1. Attach 0-2000 kPa (0-300 psi) pressure gauges to the forward clutch pressure tap and to the direct clutch pressure tap. Gauges must be accurate enough to distinguish a 103 kPa (15 psi) difference. (If this test is done in conjunction with a control pressure test, pressure gauges will be attached to all pressure taps.) Have sufficient flexible hose to read the gauges in the vehicle.
2. Drive the vehicle. When pressure is applied to the direct clutch, note the difference between the pressure read at forward clutch pressure tap and the direct clutch pressure.
3. If the difference in pressures is less than 103 kPa (15 psi), the direct clutch circuit is OK.
4. If the difference is greater than 103 kPa (15 psi), there could be a leak in the direct clutch pressure circuit. If the difference does not exceed 103 kPa (15 psi), the gauges on the line pressure and direct clutch pressure can be switched to confirm that gauge calibration difference is not the cause.

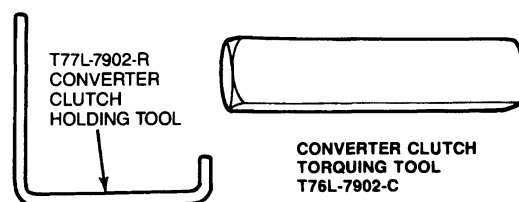
Torque Converter One-Way Clutch Check

Tools Required:

- Converter Clutch Holding Tool T77L-7902-R
- Converter Clutch Torquing Tool T76L-7902-C

Converter One-Way Clutch Check

1. Insert the Converter Clutch Holding Tool T77L-7902-R in one of the grooves in the stator thrust washer.



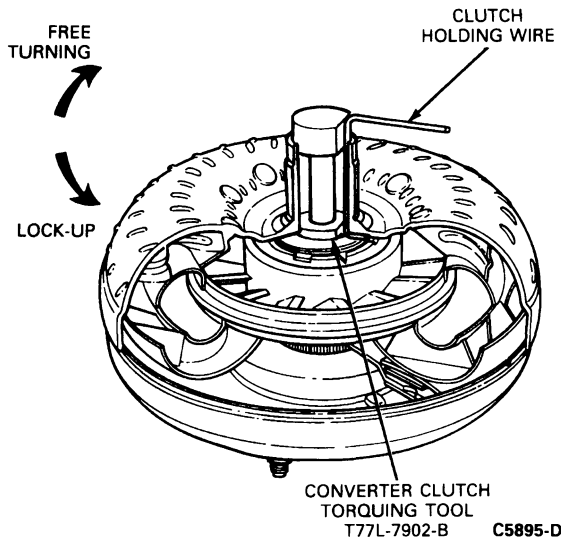
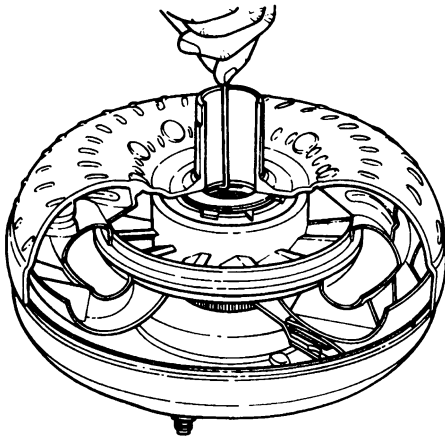
D2877-J

2. Insert the Converter Clutch Torquing Tool T76L-7902-C in converter pump drive hub to engage one-way clutch inner race.
3. Attach a torque wrench to the one-way clutch tightening tool. With the one-way clutch holding tool held stationary, turn the torque wrench counterclockwise. The converter one-way clutch should lock up and hold a 13 N·m (10 lb-ft) force. The converter one-way clutch should rotate freely in a clockwise direction until torquing tool contacts the holding tool. Try the clutch for lock up and hold in at least five different locations around the converter.

²⁹ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

4. If the clutch fails to lock up and hold a 13 N·m (10 lb-ft) torque, replace the converter unit.

**Stator to Impeller Interference Check**

NOTE: Stator support may remain in pump assembly during this test.

1. Position the stator support on a bench with the spline end of the shaft pointing up.

CONVERTER
ASSEMBLY

STATOR
SUPPORT SHAFT

D10443-B

2. Mount a converter on the stator support with the splines on the one-way clutch inner race, engaging the mating splines of the stator support.
3. Hold the stator stationary, and try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.
4. If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the converter.

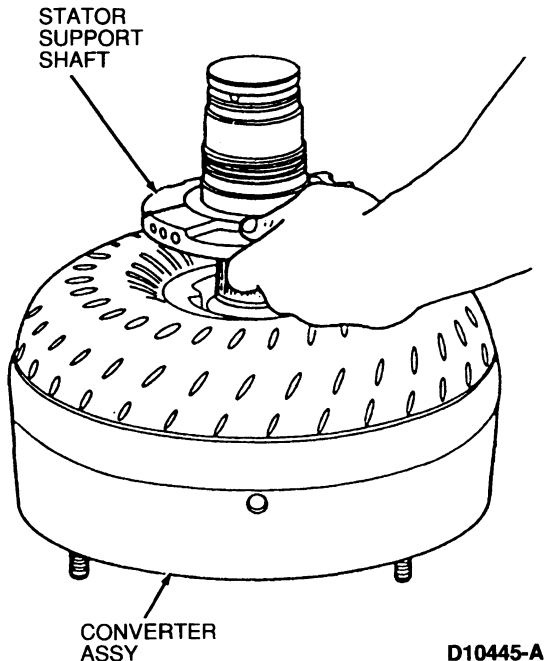
Stator to Turbine Interference Check

NOTE: Stator support may remain in pump assembly during this test.

1. Position the converter on the bench, front side down.
2. Install a stator support to engage the mating splines of the stator support shaft.

DIAGNOSIS AND TESTING (Continued)

3. Install the input shaft, engaging the splines with the turbine hub.



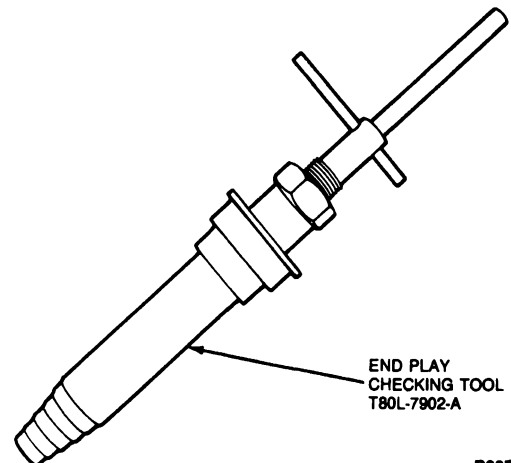
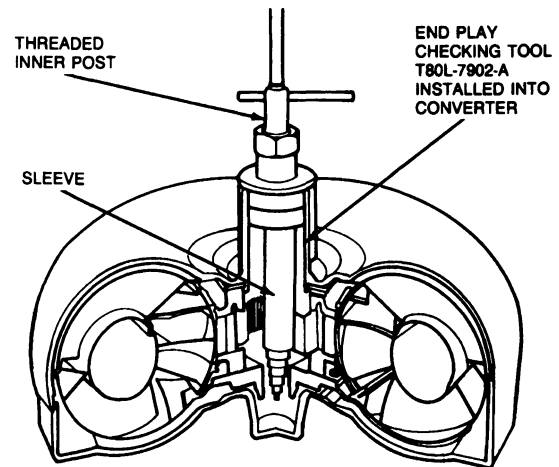
4. Hold the stator shaft stationary and attempt to rotate the turbine with the input shaft. The turbine and torque converter clutch assemblies should rotate in both directions not exceeding maximum torque of 9.5 N·m (7 lb-ft) without any signs of metallic interference or scraping noise.
5. If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. In such cases, the converter must be replaced.

The converter crankshaft pilot should be checked for nicks or damaged surfaces that could cause interference when installing the converter into the crankshaft. Check the converter front impeller hub for nicks or sharp edges that would damage the pump seal.

Converter End Play**Tools Required:**

- End Play Checking Tool T80L-7902-A
 - Dial Indicator with Bracketry TOOL-4201-C
1. Insert Tool T80L-7902-A into the converter pump drive hub until it bottoms.

2. Expand the sleeve in the turbine spline by tightening the threaded inner post until the tool is securely locked in to the spline.



D2878-D

3. Attach Dial Indicator with Bracketry TOOL-4201-C or equivalent to the tool. Position the indicator button on the converter pump drive hub, and set the dial face at 0 (zero).
4. Lift the tool upward as far as it will go and note the indicator reading. The indicator reading is the total end play which the turbine and stator share. Replace the converter unit if the total end play exceeds the limits indicated in the following chart.
5. Loosen the threaded inner post to free the tool and remove the tool from the converter.

DIAGNOSIS AND TESTING (Continued)

Torque-Converter End-Play		
Transmission Model	Converter End-Play	
	New or Rebuilt Converter	Used Converter
4R70W (AODE-W)	1.27 / 19.56 mm (0.05 / 0.077 inch) max	2.5 mm (0.100 inch) max

REMOVAL**Fluid Cooler Lines****Tube Fittings**

When fluid leakage is found at the oil cooler, the cooler must be replaced. Refer to Group 03 for coolant replacement procedure.

When one or more of the fluid cooler steel tubes must be replaced, each replacement tube must be fabricated from the same size steel tubing as the original line.

Using the old tube as a guide, bend the new tube as required. Add the necessary fittings, and install the tube.

NOTE: Some vehicles come equipped with double flare threaded fittings. For these vehicles, service as outlined under threaded fittings.

After the fittings have been tightened to specification, add fluid as needed and check for fluid leaks.

Transmission Assembly

NOTE: Completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. In addition, the cleaning of debris from the direct clutch check ball is often omitted. This omission can lead to a repeat servicing of the transmission. Cleaning and flushing procedures for check ball, can be found in the cleaning and inspection area of this section.

NOTE: Do not soak oil filter in solvent cleaner. The filter material could disintegrate. Replace filter if transmission fluid is contaminated.

Removal

1. Disconnect the battery negative cable.
2. Raise the vehicle on a hoist and support with suitable safety stands.
3. Place a drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the bolts and allow the fluid to drain. Finally remove all of the pan bolts except two at the front, to allow the fluid to further drain. With fluid drained, install two bolts on the rear side of the pan to temporarily hold the pan in place.

4. Remove the converter drain plug access cover from the lower end of the converter housing.
5. Remove the converter-to-flywheel nuts. Place a wrench on the crankshaft pulley bolt to turn the converter to gain access to the nuts.
6. Place a drain plug under the converter to catch the fluid. With the wrench on the crankshaft pulley bolt, turn the converter to gain access to the converter drain plug and remove the plug. After the fluid has been drained, reinstall the plug.

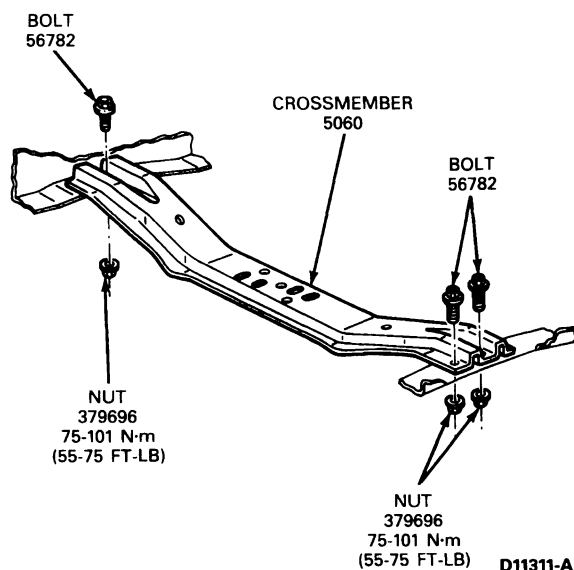
NOTE: To maintain initial driveshaft balance, mark the REAR driveshaft yoke and axle companion flange so they may be installed in their original positions.
7. Disconnect the driveshaft from the rear axle and slide shaft rearward from the transmission.

Install a seal installation tool in the extension housing to prevent fluid leakage.

8. Disconnect the cable from the terminal on the starter motor. Remove the two bolts and remove the starter motor. Disconnect the MLP sensor wires at the plug connector.
9. Remove the rear mount-to-crossmember bolts and the two crossmember-to-frame bolts.
10. Remove the two engine rear support-to-extension housing bolts.
11. Raise the transmission with a transmission jack to provide clearance to remove the crossmember. Remove the rear mount from the crossmember and remove the crossmember from the side supports.
12. Lower the transmission to gain access to the oil cooler lines.
13. Disconnect each oil line from the fittings on the transmission.
14. Remove the bolt(s) that secure the transmission fluid filler tube to the cylinder block. Lift the filler tube and the dipstick from the transmission.
15. Secure the transmission to the jack with a chain.
16. Remove the converter housing-to-cylinder block bolts.
17. Carefully move the transmission and converter assembly away from the engine and, at the same time, lower the jack to clear the underside of the vehicle.

REMOVAL (Continued)

18. Remove the converter and mount the transmission in a suitable holding fixture.

**DISASSEMBLY AND ASSEMBLY**

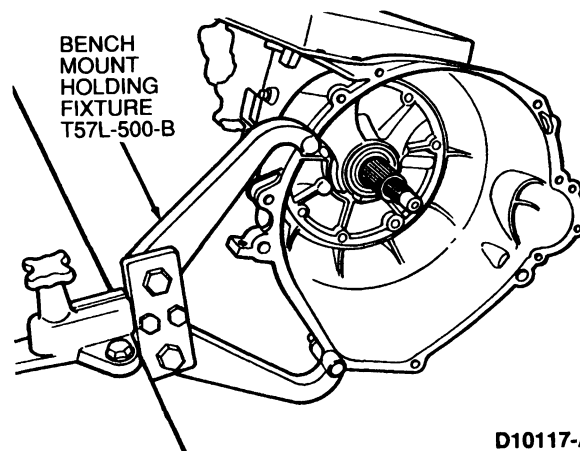
NOTE: Before beginning Disassembly, perform / inspect the following:

- The transmission service area should be kept clean, well organized and supplied with clean, lint-free shop cloths.
- Thorough cleaning of the transmission exterior will reduce the possibility that damaging contaminants might enter the subassemblies during disassembly and assembly.
- If the transmission is being removed for major overhaul, it is important to completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, all clutches and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is returned to service.
The cleaning of debris from the direct clutch check ball is often omitted. This omission can lead to a repeat servicing of the transmission.
- Debris that collects and builds up in the corners of the stamped clutches must be removed.
- The magnet should be removed from oil pan and wiped clean along with the pan.
- Whenever a seal is removed from a piston, shaft or servo, note the type of seal and when applicable, the direction of the sealing lip.

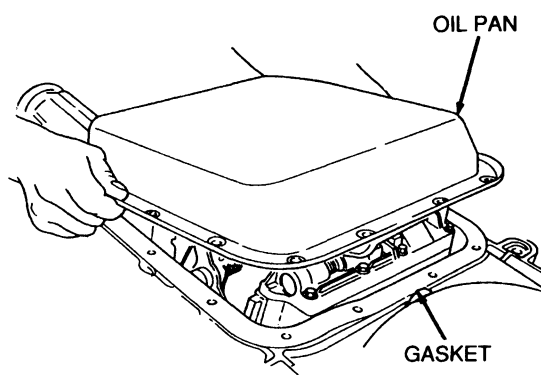
Transmission**Disassembly****Tools Required:**

- Bench Mounted Holding Fixture T57L-500-B
- Servo Piston Remover / Replacer T92P-70023-A
- Seal Remover T74P-77248-A
- Extension Housing Bushing Remover T77L-7697-A
- Impact Slide Hammer T59L-100-B
- Front Pump Remover Adapters T80L-77 103-A
- Bearing Cup Puller T77F-1102-A
- Front Pump Seal Remover TOOL-1175-AC

1. Mount transmission in Bench Mounted Holding Fixture T57L-500-B or equivalent.

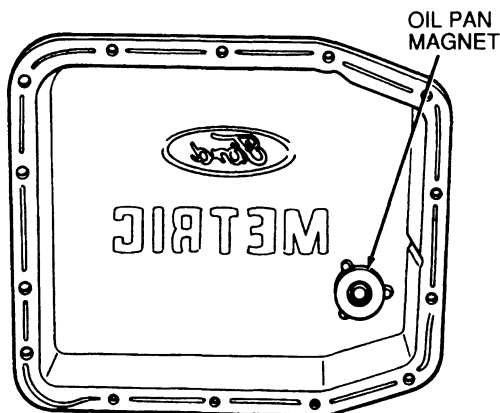


2. Using a 10mm socket, remove fourteen oil pan retaining bolts, oil pan and pan gasket. Discard gasket.



DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove oil pan magnet. Clean pan and magnet.

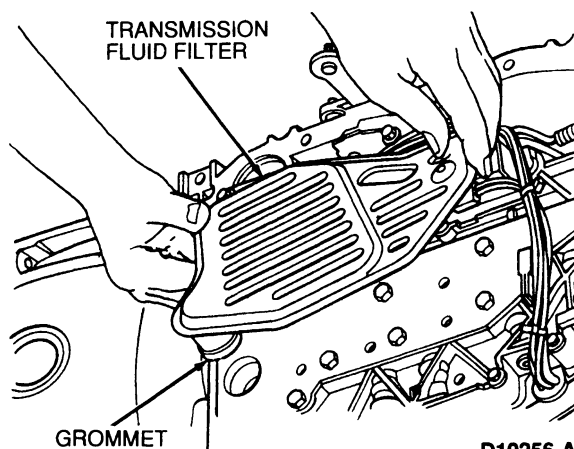


D10254-A

4. Using both hands, remove filter by pulling upward.

NOTE: Always use a new filter and grommet. Never attempt to clean or reuse a dirty filter.

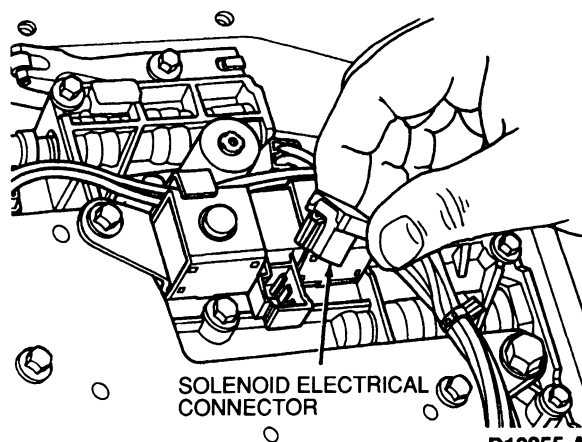
CAUTION: If grommet remains in main control bore, use a small screwdriver to pry it out. Take care not to damage main control bore.



D10256-A

CAUTION: Do not pull on wires. If required, carefully pry up on locking tab and disconnect the connector.

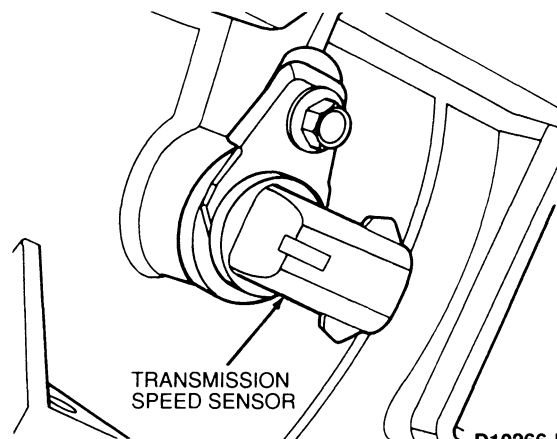
5. Grasp connector at each solenoid or sensor and pull straight out to disconnect.



D10255-A

6. Using an 8mm socket, remove bolt attaching transmission speed sensor (TSS) to transmission case and remove TSS.

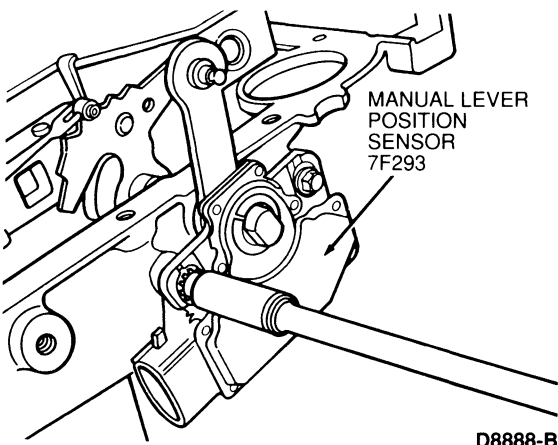
NOTE: Removal of the TSS at this time will prevent sensor damage when removing the output shaft assembly.



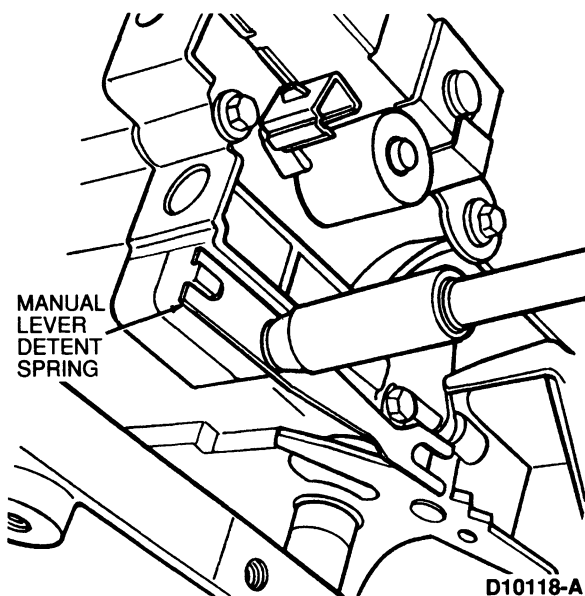
D10266-B

DISASSEMBLY AND ASSEMBLY (Continued)

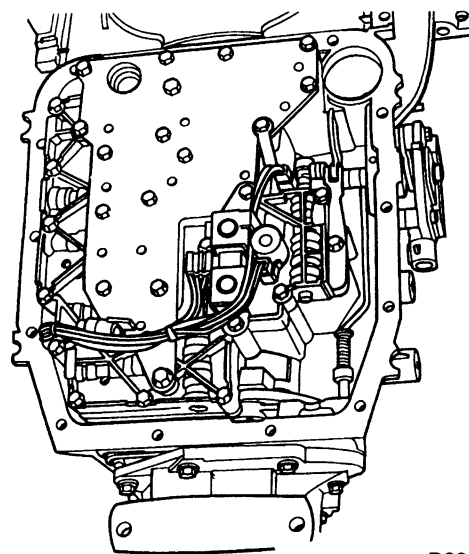
7. Using an 8mm socket, remove two bolts retaining manual lever position (MLP) sensor to case. Remove MLP sensor from manual shaft.



8. Using an 8mm socket, remove one bolt retaining manual lever detent spring and roller assembly to the valve body.

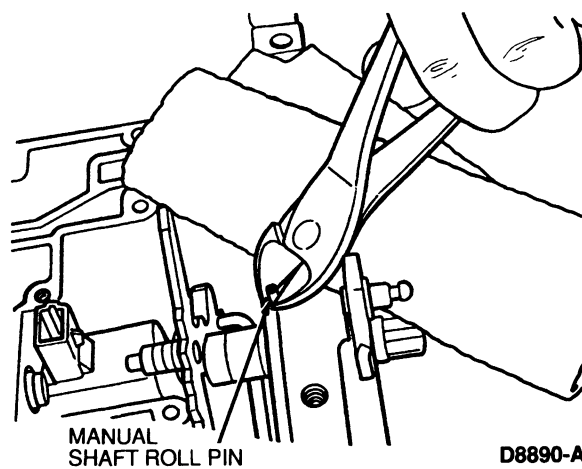


9. Using an 8mm socket, remove remaining twenty-four valve body-to-case retaining bolts, the valve body assembly and the valve-to-body gasket.



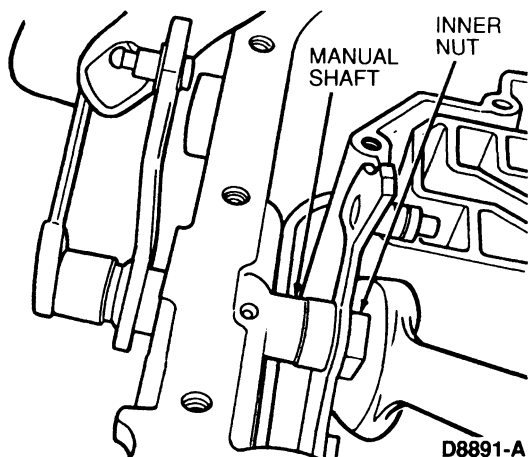
10. Remove manual shaft roll pin.

NOTE: Use a shop cloth to protect pan-to-case surface.



DISASSEMBLY AND ASSEMBLY (Continued)

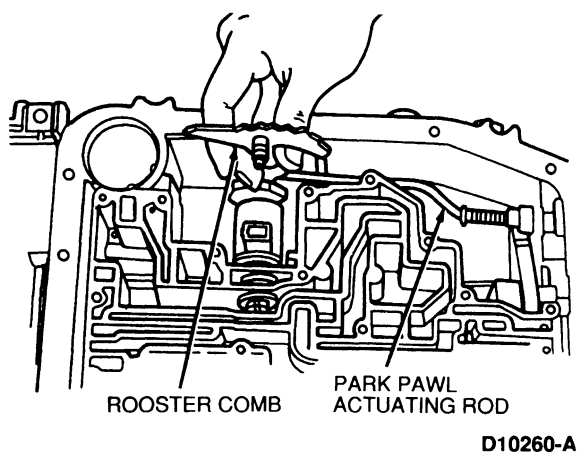
11. Using a 13/16-inch open-end wrench on the inner nut and a 12mm wrench on the manual shaft flats, loosen the inner nut.



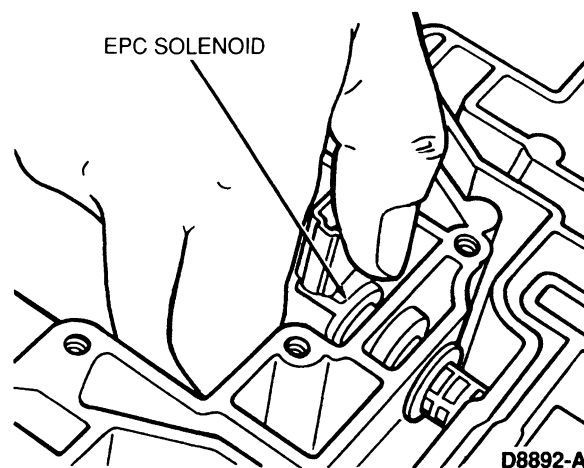
Slide manual shaft partially out of the case to complete removal of the inner nut from shaft.

NOTE: Do not damage bore with the prying tool.

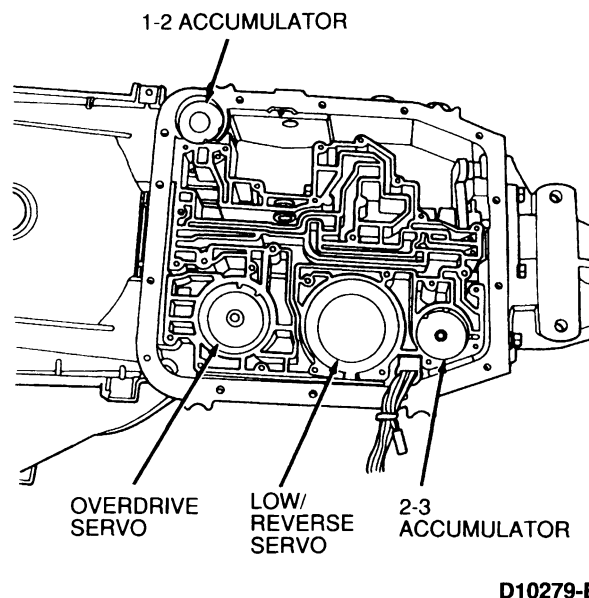
12. Using a screwdriver on the manual lever shaft seal lower edge, carefully pry seal out of case bore.
13. Lift rooster comb and park pawl actuating rod out of the case.



14. Remove electronic pressure control (EPC) solenoid by sliding it out of the case bore.

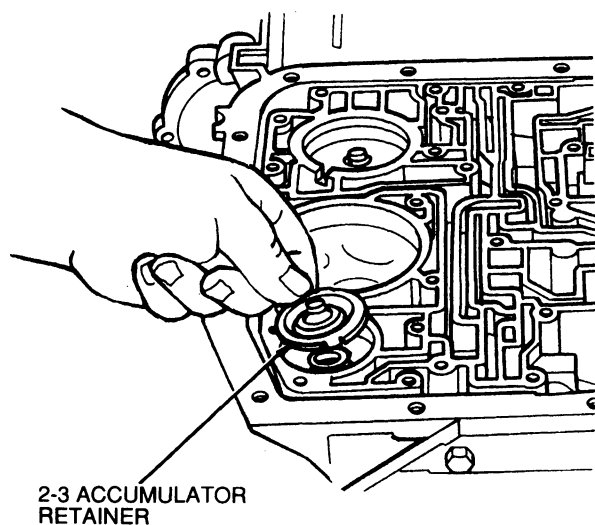


15. This illustration shows the position of the overdrive servo, the low reverse servo, 2-3 accumulator and the 1-2 accumulator.



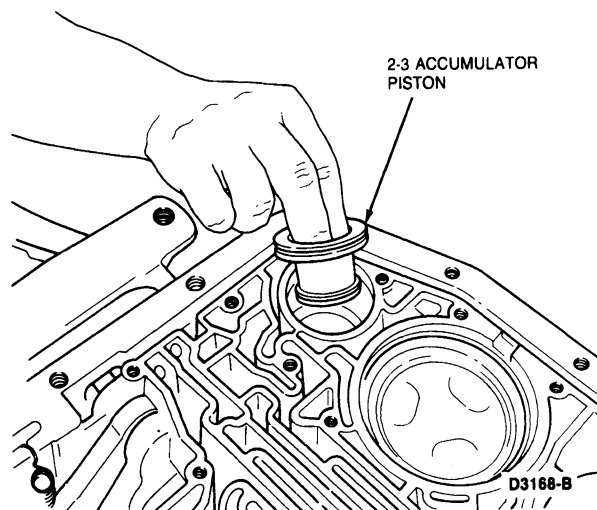
DISASSEMBLY AND ASSEMBLY (Continued)

16. Remove the 2-3 accumulator retainer.

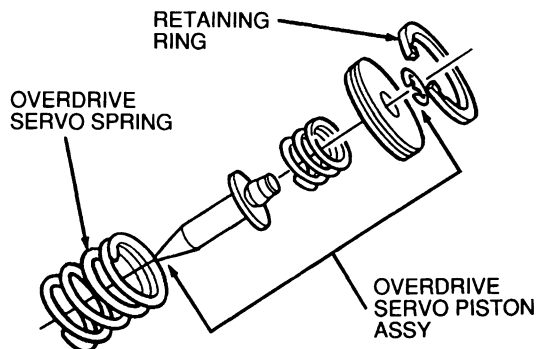


D10541-A

17. Remove 2-3 accumulator piston and spring.



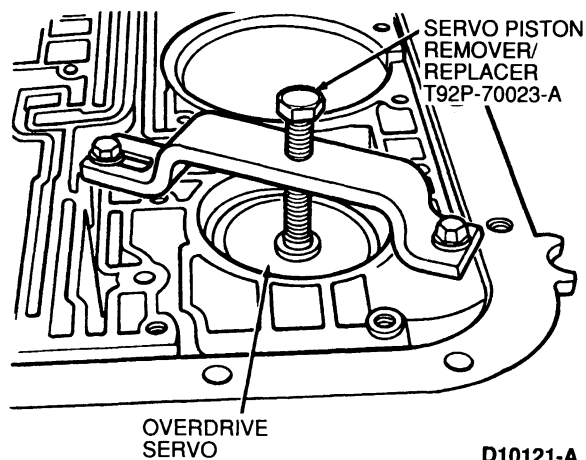
D3168-B

Overdrive Servo

D10189-A

NOTE: If tool is not available, extreme care must be taken. Spring pressure will force piston assembly out of case. Case bore damage may result from trying to pry on snap ring.

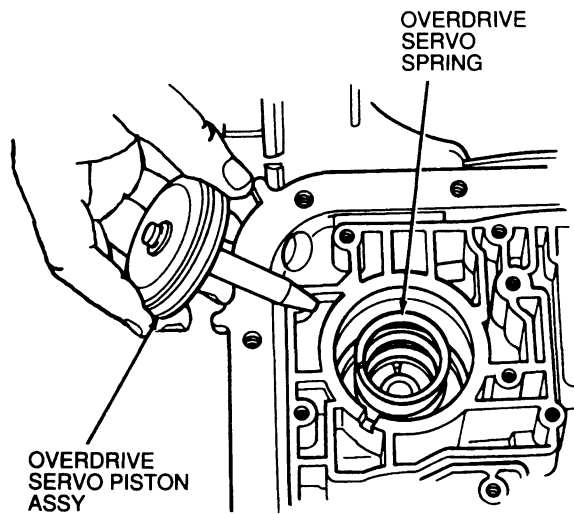
18. Use snap-ring pliers to remove snap ring. Use Servo Piston Remover / Replacer T92P-70023-A to compress the overdrive servo spring.



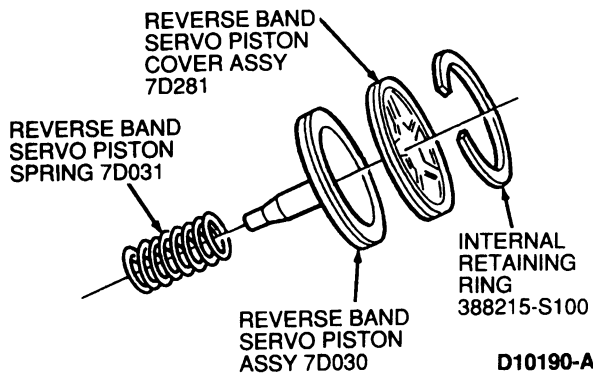
D10121-A

DISASSEMBLY AND ASSEMBLY (Continued)

19. Remove piston assembly. Remove spring.



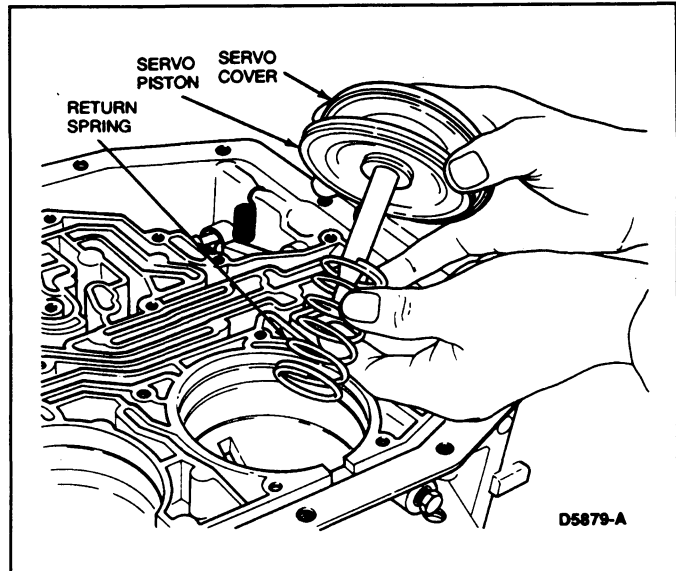
D8895-A

Low / Reverse Servo

D10190-A

20. Use Servo Piston Remover / Replacer T92P-70023-A to compress the low / reverse servo cover and remove retaining ring.
21. Remove servo cover, piston and piston return spring.

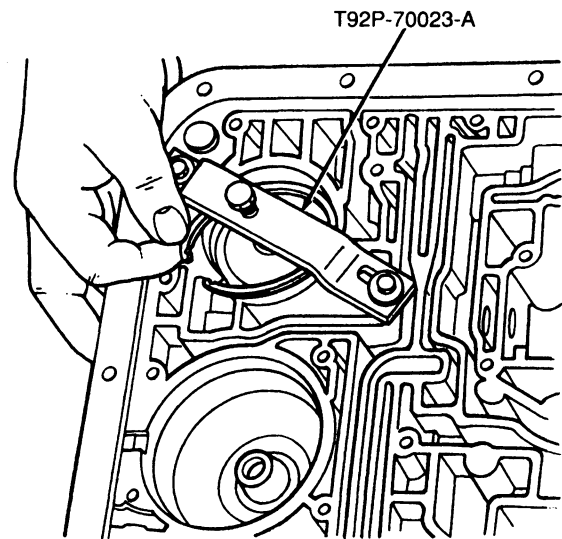
NOTE: The length of the rod attached to the piston may vary in length from transmission to transmission. Therefore, they should not be installed in any transmission other than the transmission they were removed from.



D5879-A

1-2 Accumulator

22. Apply downward pressure on 1-2 accumulator cover. Using snap-ring pliers, remove snap ring.

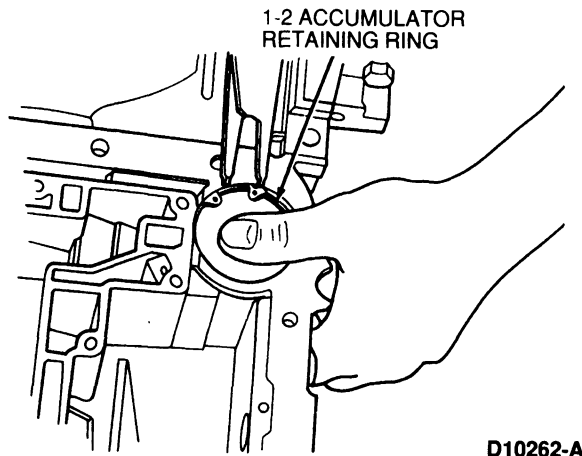


D10542-A

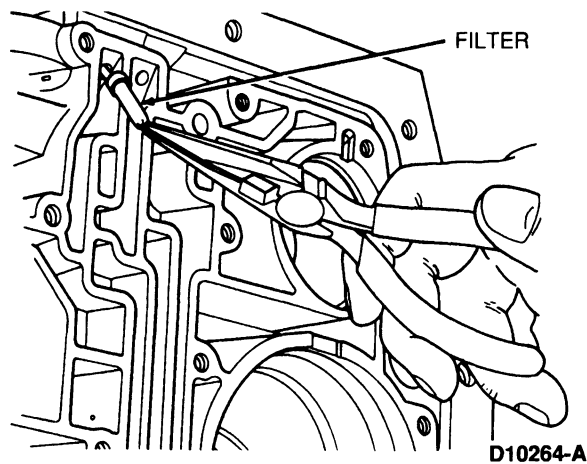
DISASSEMBLY AND ASSEMBLY (Continued)

23. Remove cover and spring. Use reverse snap-ring pliers to remove accumulator piston and spring.

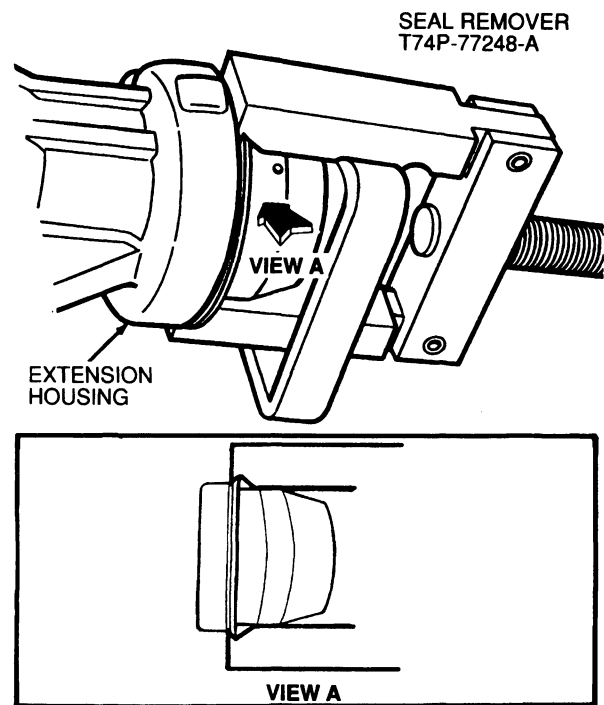
Carefully note the location of the 1-2 accumulator spring(s) and assemble in the same positions. Some models may use two springs. The piston may also vary with applications.



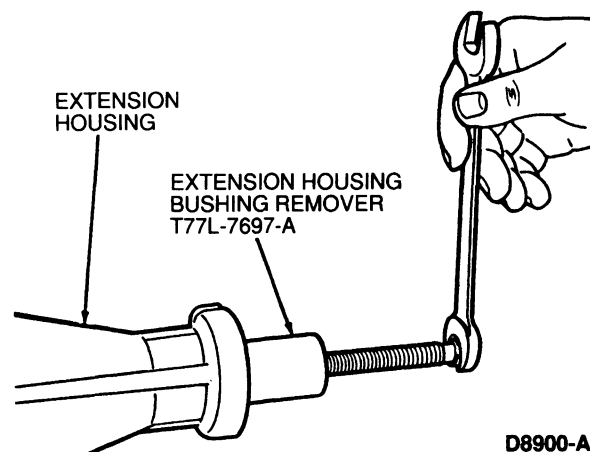
24. Remove filter from case.



25. Remove extension housing seal using Seal Remover T74P-77248-A. Ensure seal remover lips are firmly seated under the flange on the seal.



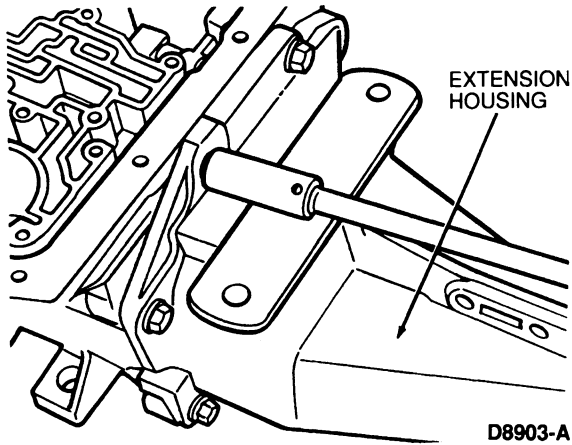
26. Inspect extension housing bushing. If required, remove the extension housing bushing using Extension Housing Bushing Remover T77L-7697-A.



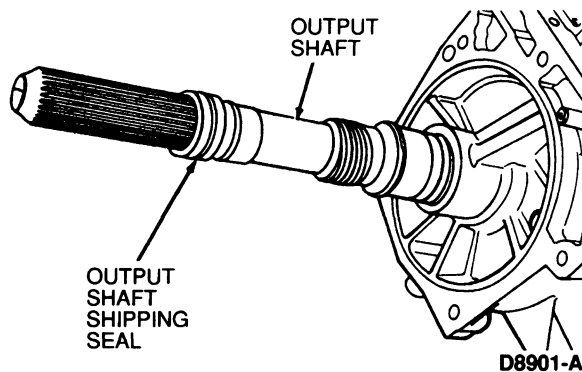
NOTE: The extension housing bolts have been coated with a sealant. More break torque may be required to remove these bolts.

DISASSEMBLY AND ASSEMBLY (Continued)

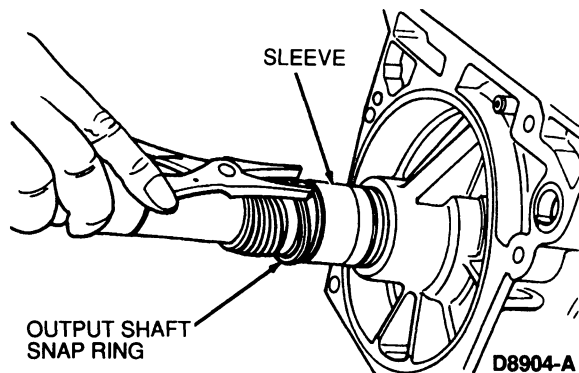
27. Using a 13mm socket, remove six extension housing bolts. Remove and discard extension housing gasket.



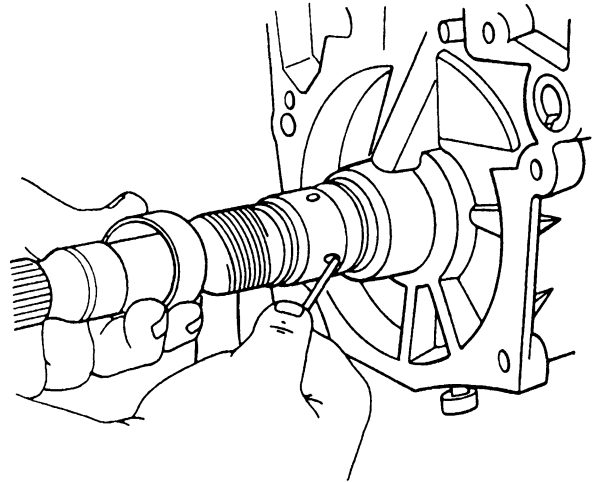
NOTE: The output shaft may have shipping seal still attached. Remove and discard. This seal is not required for assembly.



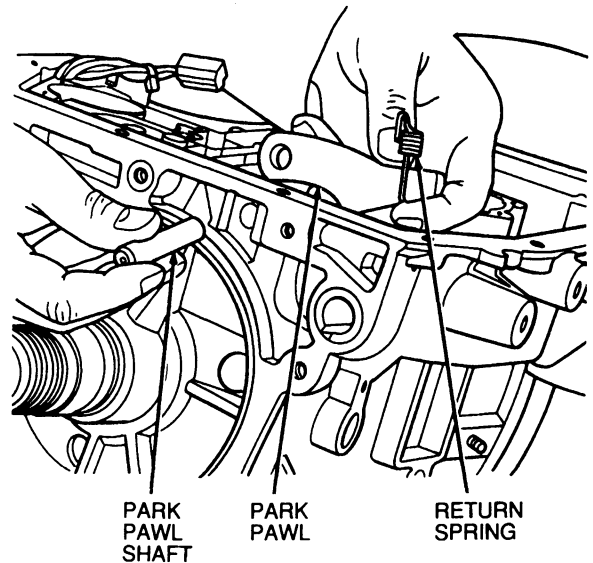
28. Remove output shaft snap ring and sleeve.



29. Remove sleeve and pin from output shaft.



30. Slide park pawl shaft out of the case and remove park pawl and return spring.
31. Place transmission in the vertical position with output shaft toward floor.

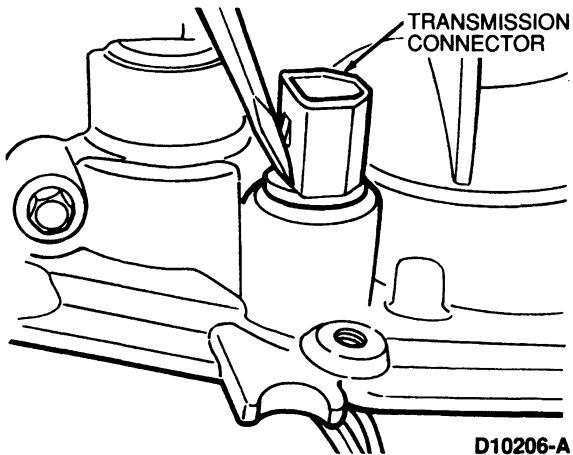


32. Remove transmission connector from case. Place a screwdriver on the flat portion of the connector and drive the connector out through the bottom of the case.

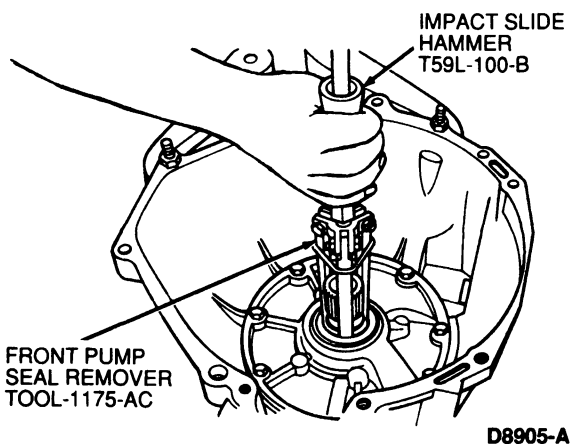
CAUTION: Extreme care must be taken during transmission connector removal.

DISASSEMBLY AND ASSEMBLY (Continued)

CAUTION: Do not pull on the wires, or use a hammer on the connector body.

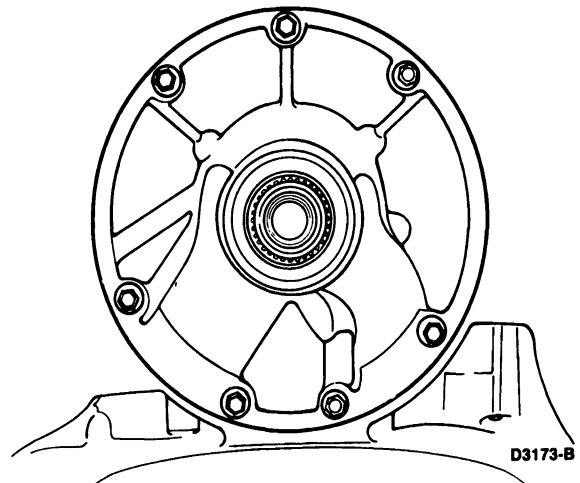


33. Remove pump seal using Front Pump Seal Remover TOOL-1175-AC or equivalent and Impact Slide Hammer T59L-100-B.

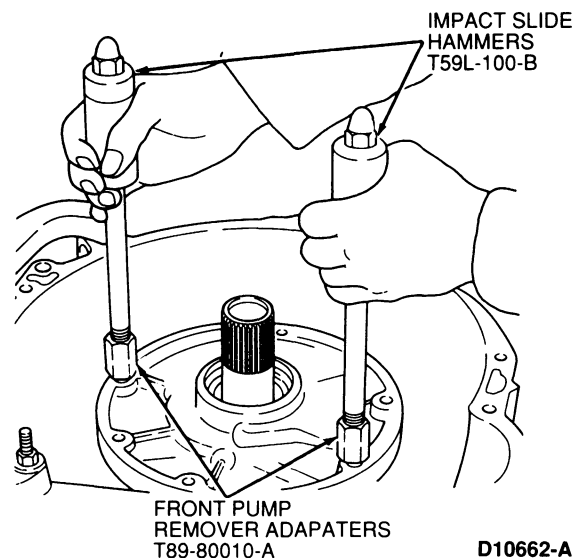


NOTE: All bolts have been coated with a sealant. More break torque might be required to remove bolts.

34. Using a 10mm socket, remove seven pump body retaining bolts.



35. Remove pump assembly using two Impact Slide Hammers T59L-100-B and Front Pump Remover Adapters T89T-70010-A.
36. Remove and discard pump-to-case gasket.

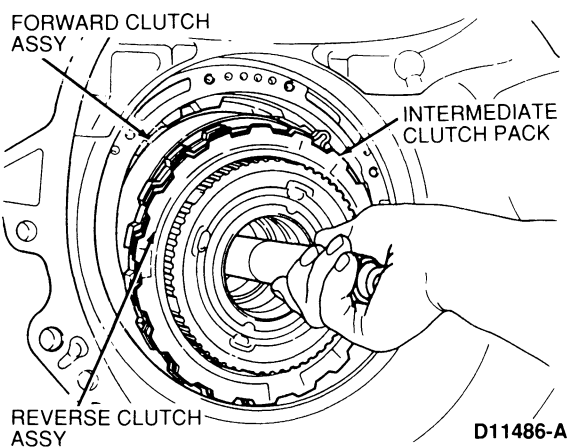


CAUTION: Remove the assembly carefully to prevent damage to the overdrive band friction material by the reverse clutch drive lugs.

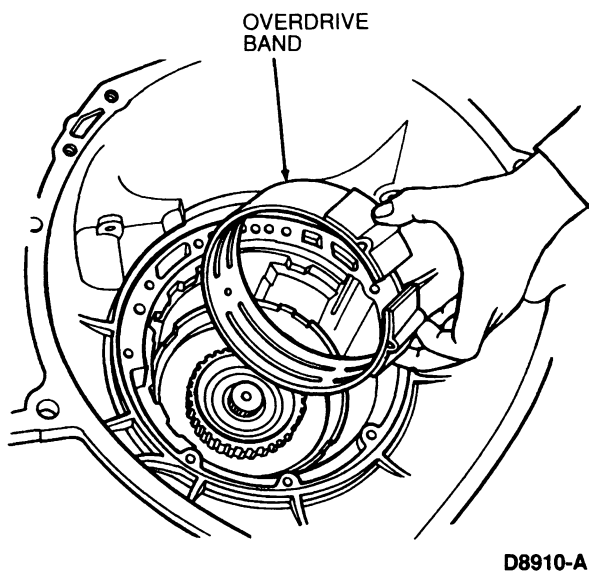
DISASSEMBLY AND ASSEMBLY (Continued)

37. Grasp the input shaft firmly and pull the following components out of the case as an assembly:

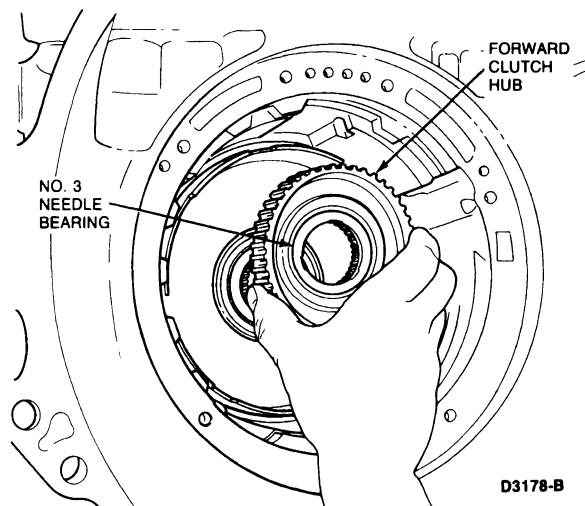
- Intermediate clutch pack
- Intermediate one-way clutch
- Reverse clutch assembly
- Forward clutch assembly



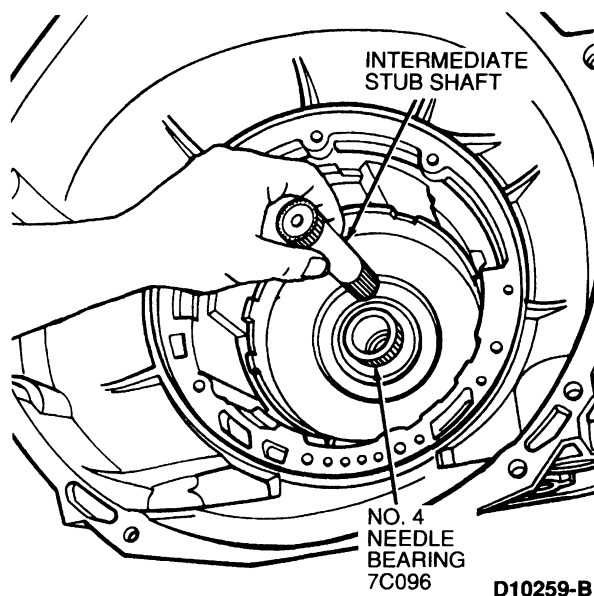
38. Disengage overdrive band from anchor pin and remove.



39. Remove forward clutch hub and the No. 3 needle bearing.

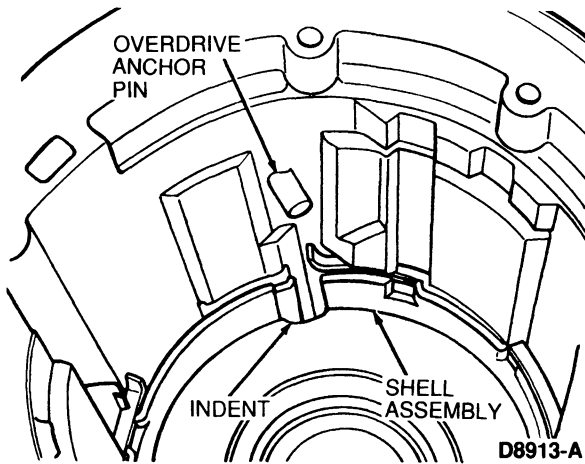


40. Remove intermediate stub shaft.

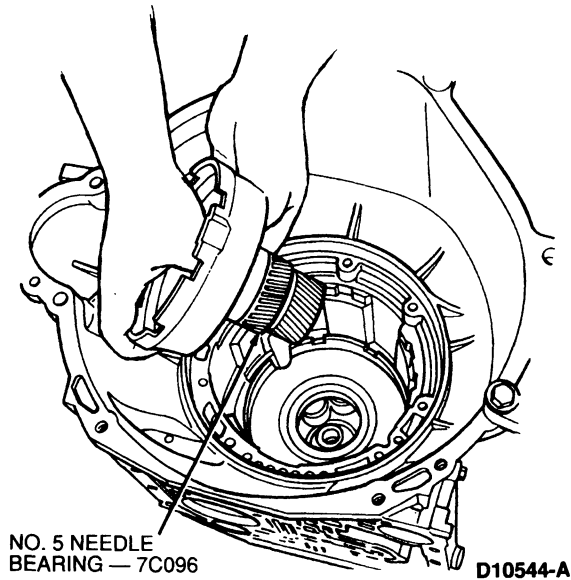


DISASSEMBLY AND ASSEMBLY (Continued)

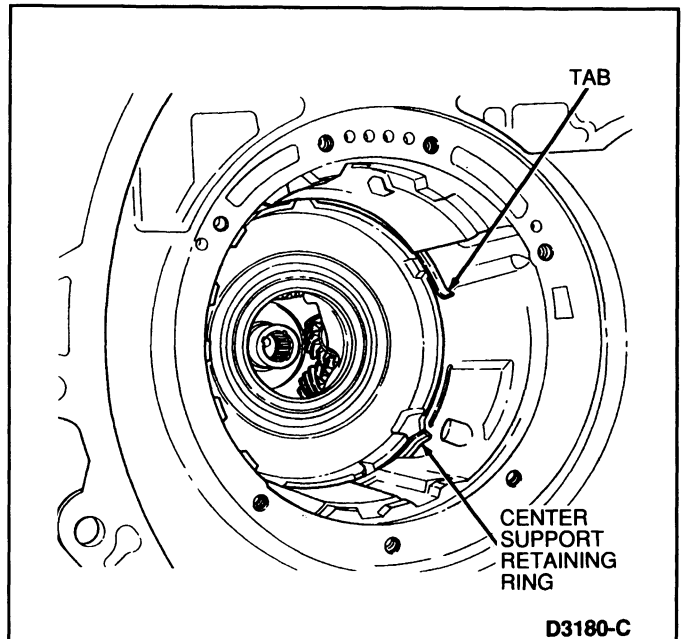
41. Rotate shell assembly to align indent with overdrive anchor pin.



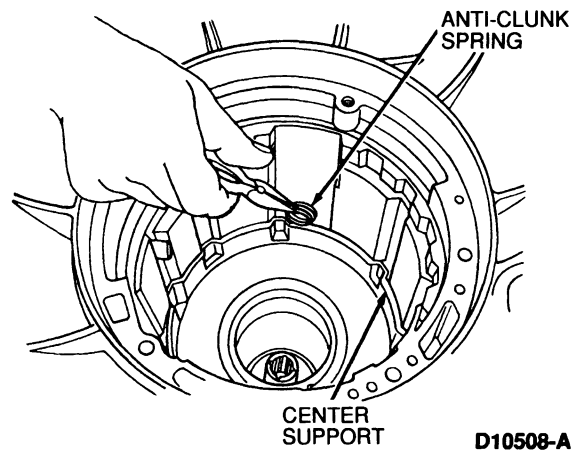
42. Remove forward sun gear, No. 5 needle bearing, reverse sun gear and drive shell assembly and the No. 4 needle bearing as an assembly.



43. Remove center support retaining ring. Note position of snap ring tabs for assembly.

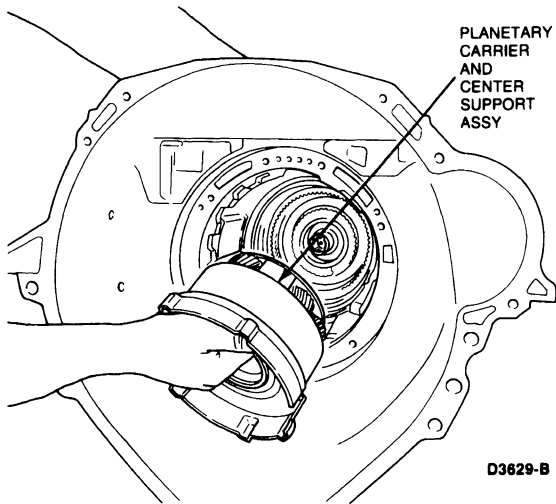


44. Using needle-nose pliers, remove anti-clunk spring out from between the center support and the case. Note location for assembly.

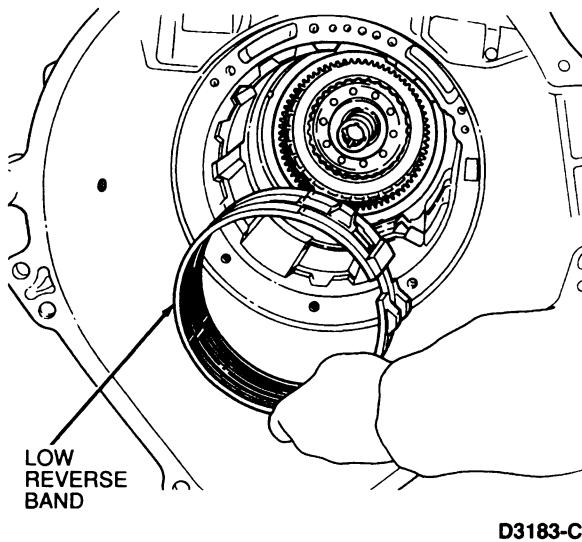


DISASSEMBLY AND ASSEMBLY (Continued)

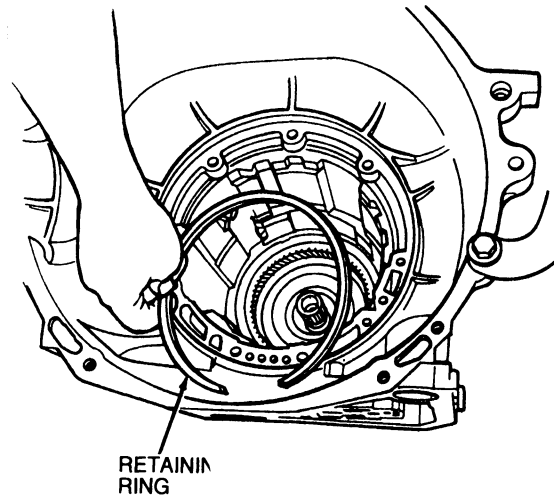
45. Remove center support and planetary carrier as an assembly.



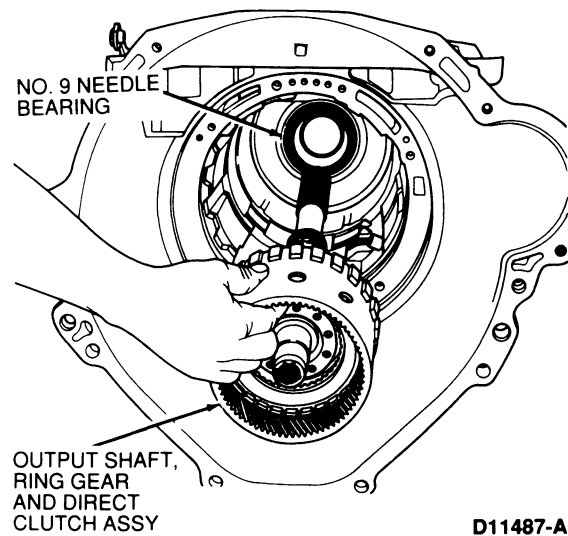
46. Remove low / reverse band.



47. Remove retaining ring.

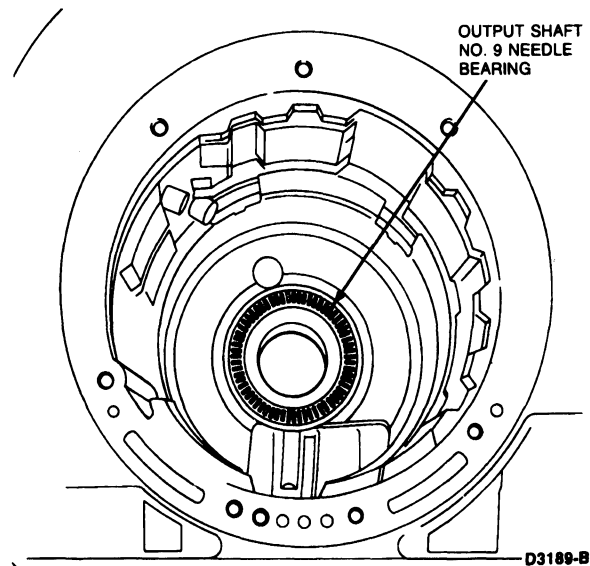


48. Remove output shaft, ring gear and direct clutch as a unit, from the front of the case.

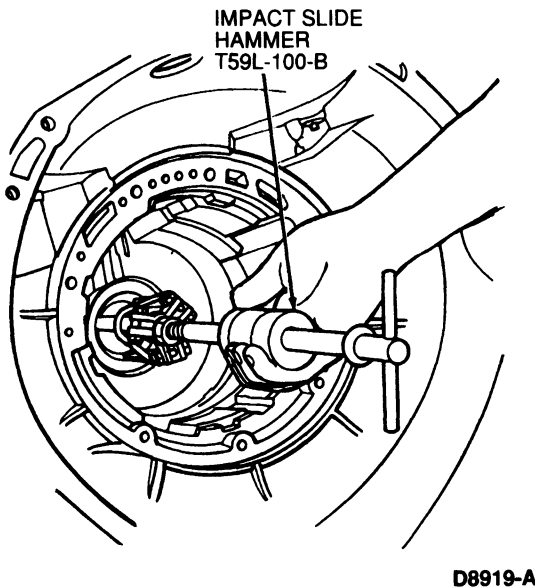


DISASSEMBLY AND ASSEMBLY (Continued)

49. Remove output shaft No. 9 needle bearing from rear of the case.



50. Inspect output shaft bushing. If removal is required, use Bearing Cup Puller T77F-1102-A and Impact Slide Hammer T59L-100-B.

**Subassemblies**

NOTE: Before beginning Assembly, perform / inspect the following:

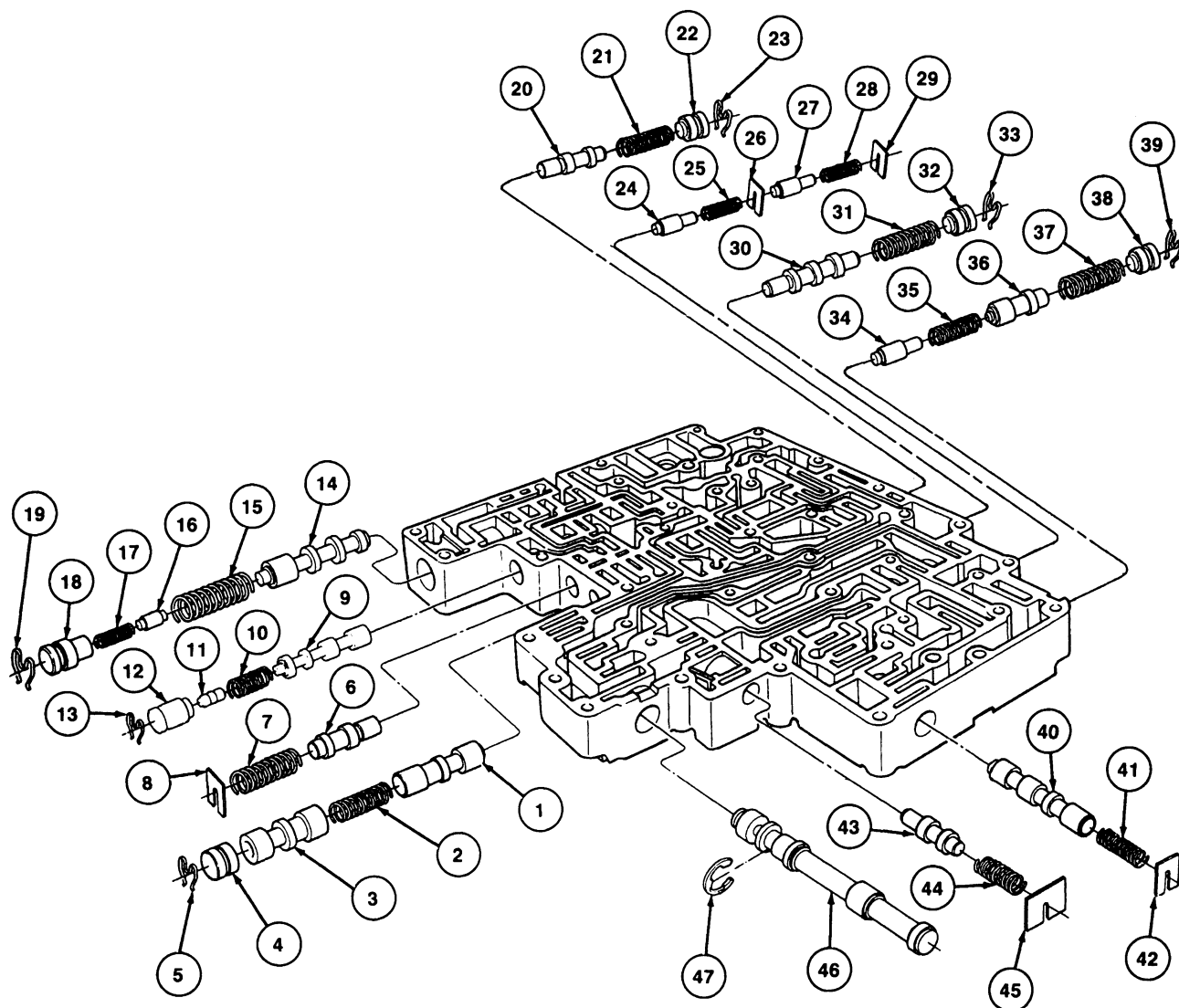
- All fasteners must be tightened to the torque indicated in the text. In addition to appearing in the text, the necessary torques can be found under Specifications.
- When building up subassemblies, each component part should be lubricated with clean transmission fluid. It is also good practice to lubricate the subassemblies as they are installed in the case.
- Needle bearings, thrust washers and seals should be lightly coated with petroleum jelly during subassembly build up or transmission assembly.
- Many components and surfaces in the transmission are precision machined. Careful handling during disassembly, cleaning, inspection and assembly can prevent unnecessary damage to machined surfaces.

When building up subassemblies and assembling the transmission, ALWAYS use new gaskets and seals.

DISASSEMBLY AND ASSEMBLY (Continued)

Valve Body

Exploded View



D10572-A

Item	Part Number	Description
1	7A334	1-2 Shift Valve
2	7A320	2-3 Shift Valve Spring
3	7E086	2-3 Shift Valve
4	7F187	Valve Retaining Plug
5	7G007	Valve Plug Retainer
6	7B200	Pressure Regulator Valve
7	7H172	Pressure Regulator Valve Spring
8	7F194	Spring Retaining Plate
9	7G179	Bypass Clutch Control Valve
10	7H140	Bypass Clutch Control Valve Spring

(Continued)

Item	Part Number	Description
11	7G320	Bypass Clutch Control Valve Plunger
12	7G319	Bypass Clutch Control Plunger Sleeve
13	7E170	Control Valve Plate
14	7C388	Main Regulator Valve
15	7A270	Main Oil Pressure Regulator Valve Spring
16	7D003	Main Oil Pressure Booster Valve
17	7F258	Main Oil Pressure Booster Valve Spring

(Continued)

DISASSEMBLY AND ASSEMBLY (Continued)

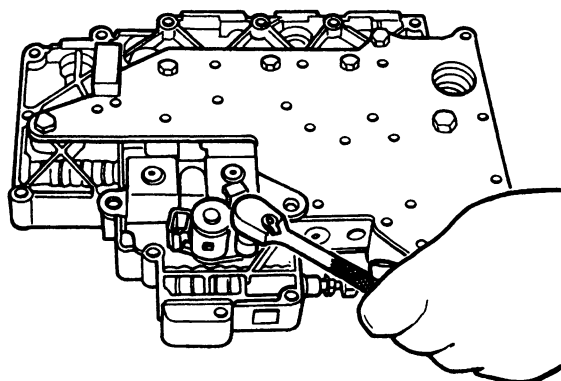
Item	Part Number	Description
18	7D002	Main Oil Pressure Booster Valve Sleeve
19	7G007	Valve Plug Retainer
20	7B200	Pressure Regulator Valve
21	7H172	Pressure Regulator Valve Spring
22	7F187	Valve Retainer Plug
23	7G007	Valve Plug Retainer
24	7H150	Capacity Modulator Valve
25	7F267	Capacity Modulator Valve Spring
26	7F194	Spring Retaining Plate
27	7H150	Capacity Modulator Valve
28	7F267	Capacity Modulator Valve Spring
29	7F194	Spring Retaining Plate
30	7F259	3-4 Shift Valve
31	7F260	3-4 Shift Valve Spring

(Continued)

Item	Part Number	Description
32	7F187	Valve Retainer Plug
33	7G007	Valve Plug Retainer
34	7H150	Capacity Modulator Valve
35	7F267	Capacity Modulator Valve Spring
36	7F186	Orifice Control Valve
37	7D303	Orifice Control Valve Spring
38	7F187	Valve Retainer Plug
39	7G007	Valve Plug Retainer
40	7D229	2-3 Backout Valve
41	7D230	2-3 Backout Valve Spring
42	7F194	Spring Retaining Plate
43	7B200	Pressure Regulator Valve
44	7H172	Pressure Regulator Valve Spring
45	7F194	Spring Retaining Plate
46	7C389	Control Manual Valve
47	97411-S	Retaining Ring

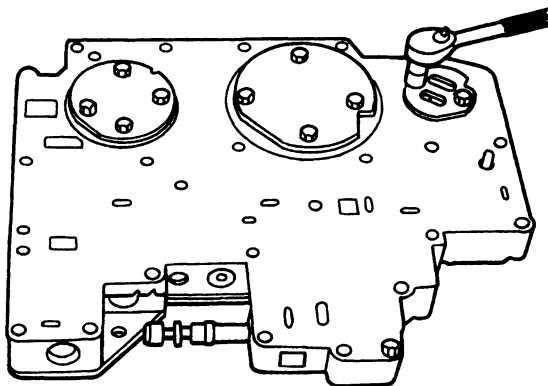
Disassembly

1. Remove retaining bolt and shift solenoid bracket.
2. Remove shift solenoid assembly and torque converter clutch solenoid by pulling straight up.



D10573-A

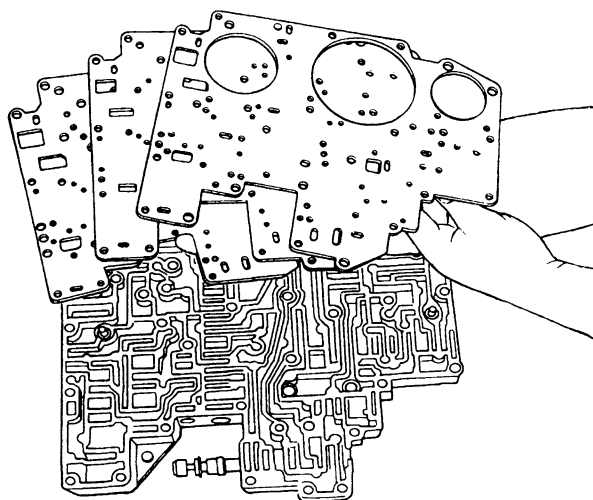
3. Turn valve body over and remove eleven bolts retaining reinforcement and separator plates.



D10574-A

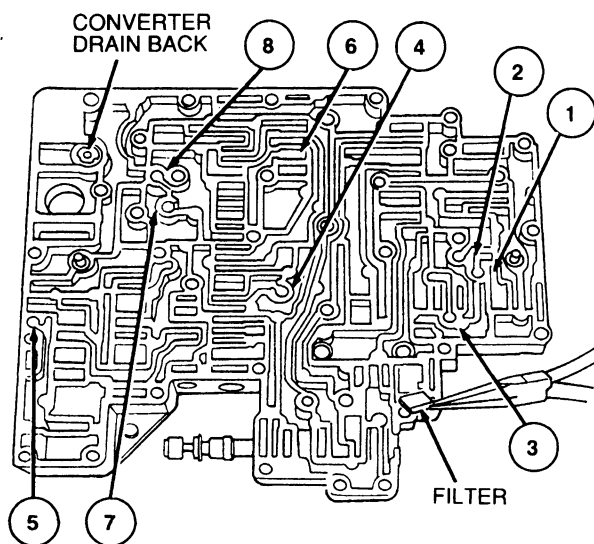
DISASSEMBLY AND ASSEMBLY (Continued)

4. Remove separator plate and gaskets. Discard gaskets.



D10575-A

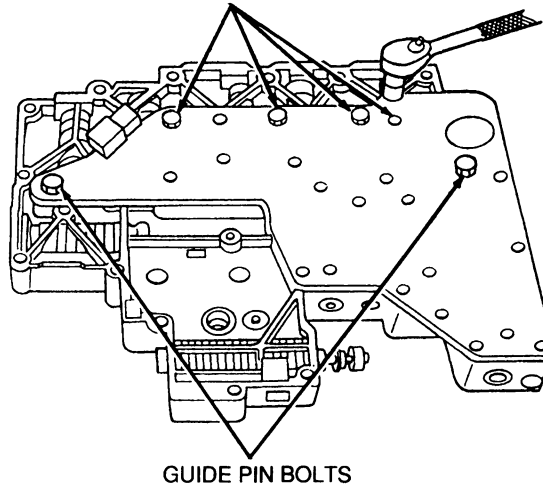
5. Note location and remove check balls. Remove filter.



D10576-A

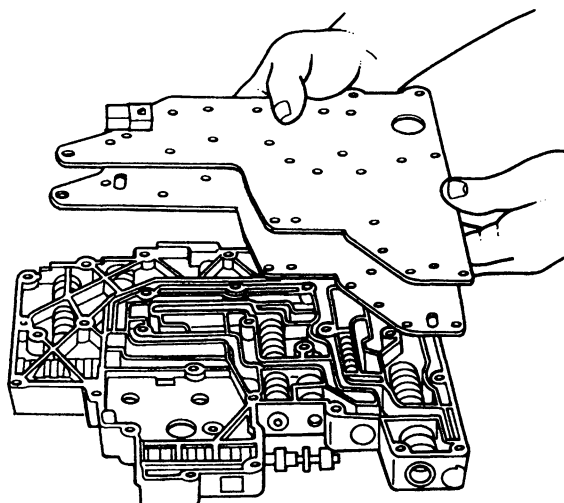
6. Remove converter drain back valve.
7. Remove four valve body cover plate bolts and two guide pin bolts.

COVER BOLTS



D10578-A

8. Remove valve body cover plate.



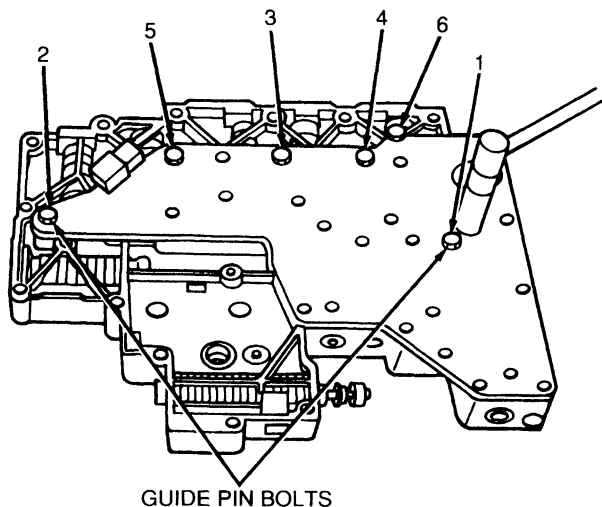
D10579-A

Assembly

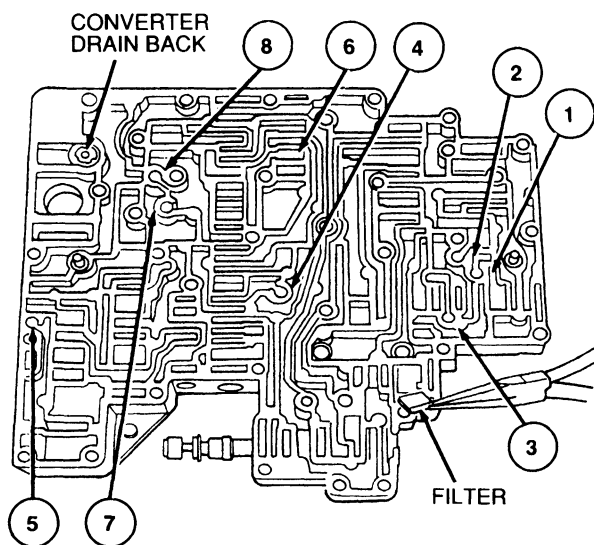
1. Install valve body cover plate.
2. Install, in sequence, two guide pin bolts. Tighten to 9-11 N·m (80-100 lb-in).

DISASSEMBLY AND ASSEMBLY (Continued)

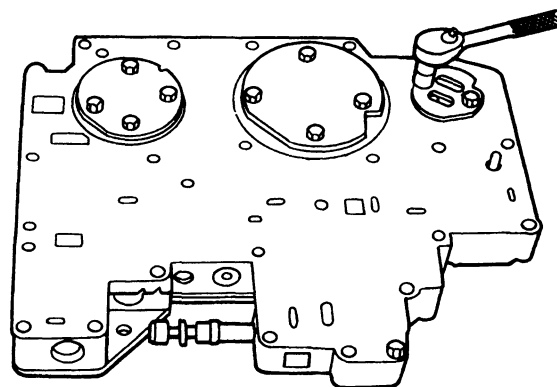
3. Install, in sequence, four valve body cover retaining bolts. Tighten to 9-11 N·m (80-100 lb-in).

**D10580-A**

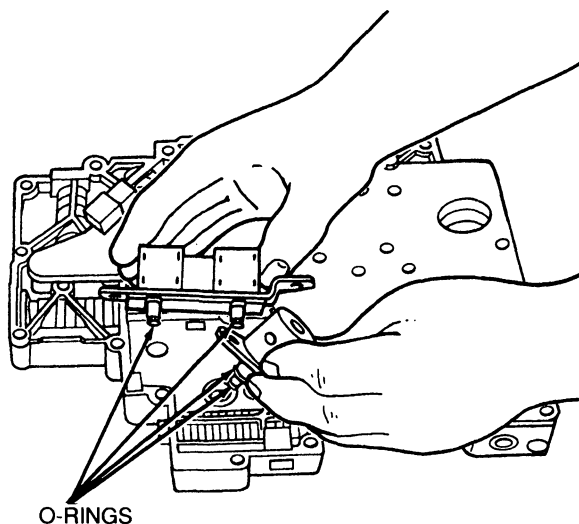
4. Install check balls, converter drain back valve and filter.

**D10576-A**

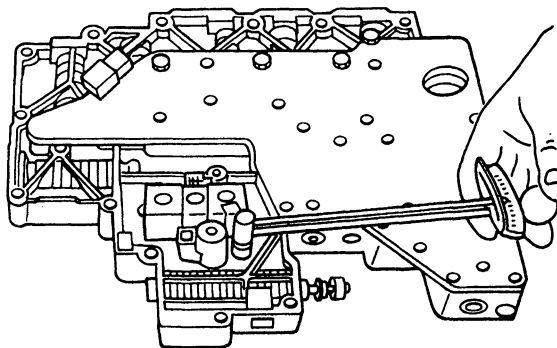
5. Install separator plate and new gaskets.
6. Install reinforcement plates. Tighten retaining bolts to 9-11 N·m (80-100 lb-in).

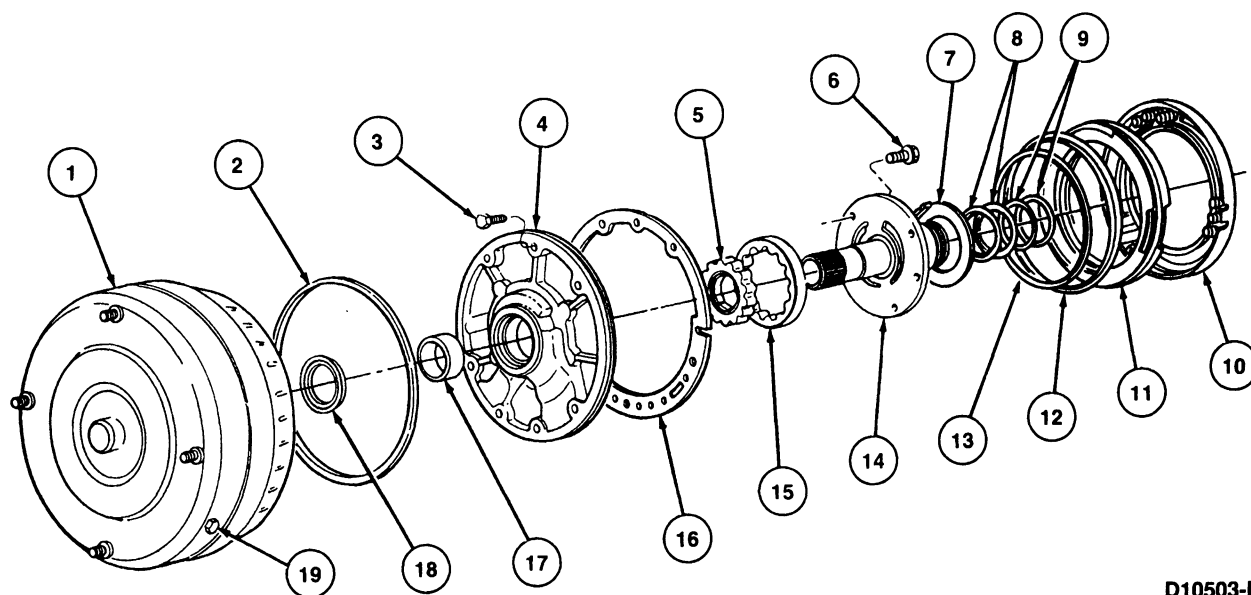
**D10574-A**

7. Inspect O-rings on solenoids for damage. Install shift solenoid assembly and torque converter clutch solenoid.

**D10581-A**

8. Install bracket and retaining bolt. Tighten to 9-11 N·m (80-100 lb-in).

**D10582-A**

DISASSEMBLY AND ASSEMBLY (Continued)**Pump and Intermediate Clutch Piston****Disassembled View**

D10503-B

Item	Part Number	Description
1	7902	Converter Assy
2	7A248	Front Pump Seal
3	N605-789-S100	Bolt (7 Req'd)
4	7A106	Front Pump Assy
5	7H169	Oil Pump Drive Gear
6	N605-789-S52	Bolt (5 Req'd)
7	7D014	Front Pump Support Thrust Washer
8	7A020	Seal
9	7D019	Seal

(Continued)

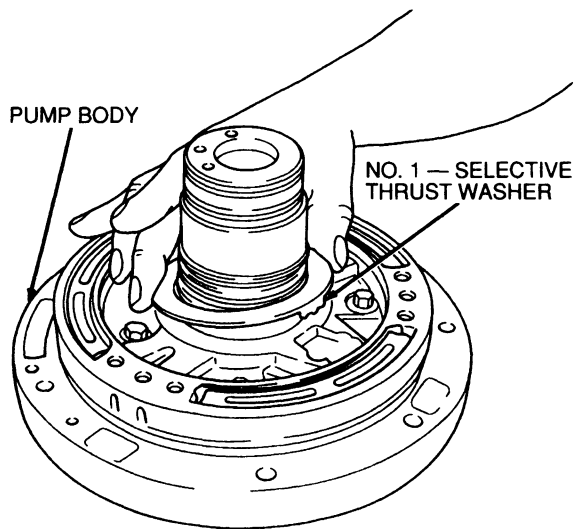
Item	Part Number	Description
10	7F222	Intermediate Clutch Retainer Spring Assy
11	7ED05	Intermediate Clutch Piston
12	7F224	Outer Seal
13	7F225	Inner Seal
14	7A108	Front Pump Support Assy
15	7H169	Oil Pump Driven Gear
16	7A136	Front Pump Gasket
17	7B258	Front Pump Bushing
18	7A248	Front Pump Inner Seal
19	87650-S2	Converter Drain Plug

Disassembly**Tools Required:**

- Front Pump Seal Replacer T63L-77837-A
- Seal Protector T80L-77005-A

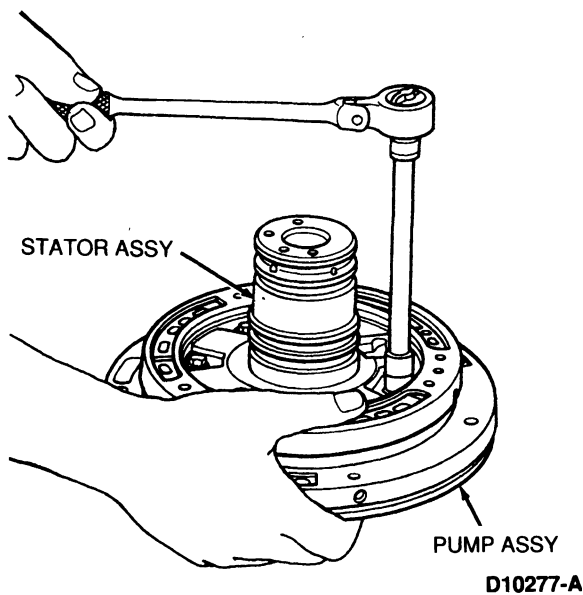
DISASSEMBLY AND ASSEMBLY (Continued)

1. Remove the No. 1 thrust washer.



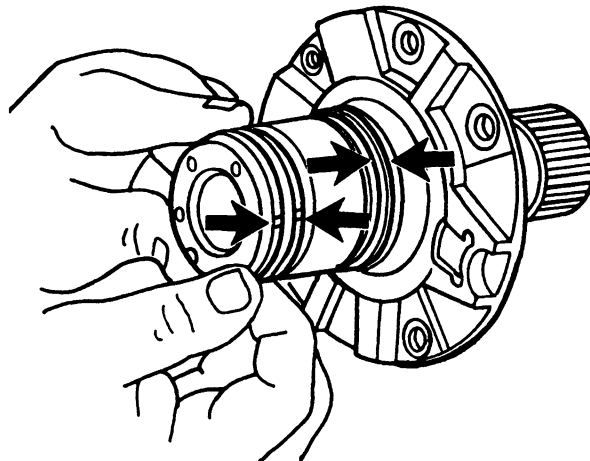
D3833-C

2. Using a 10mm socket, remove five stator support bolts. Separate stator and pump assembly.



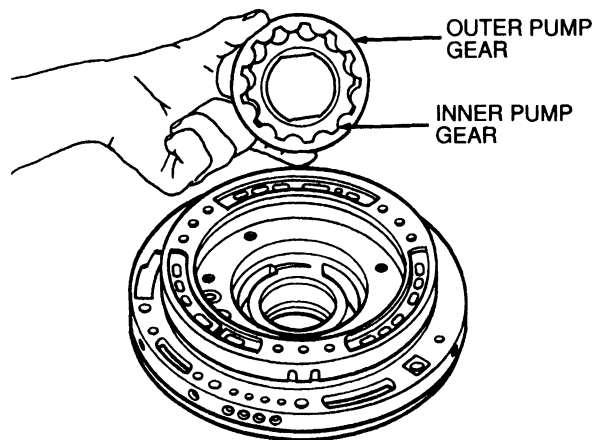
NOTE: The reverse clutch rings are larger than the forward clutch rings.

3. Remove four seal rings.



D11466-A

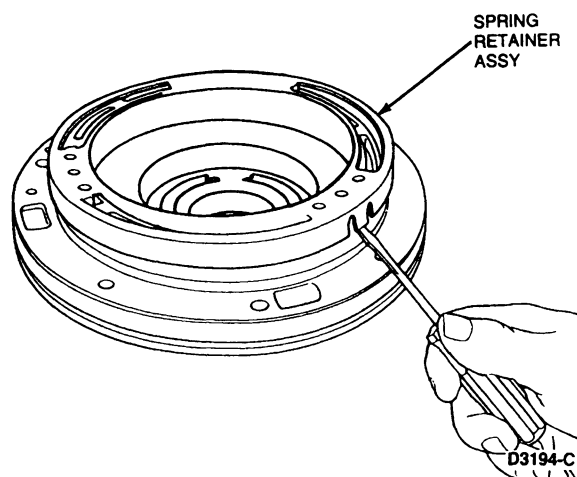
4. Remove inner and outer pump gears from pump body.



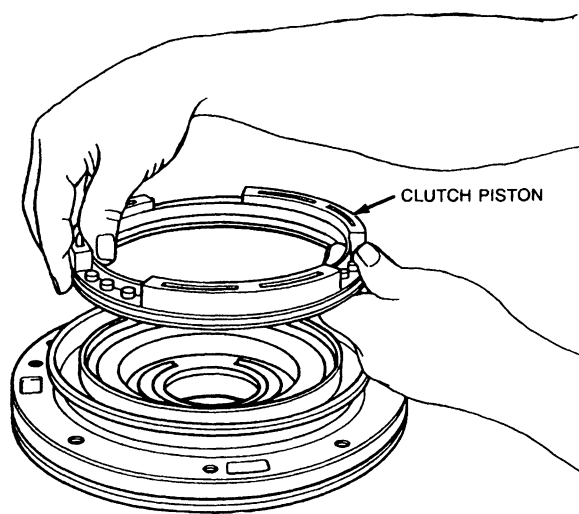
D10250-B

DISASSEMBLY AND ASSEMBLY (Continued)

5. Remove spring retainer assembly by carefully dislodging the tabs.

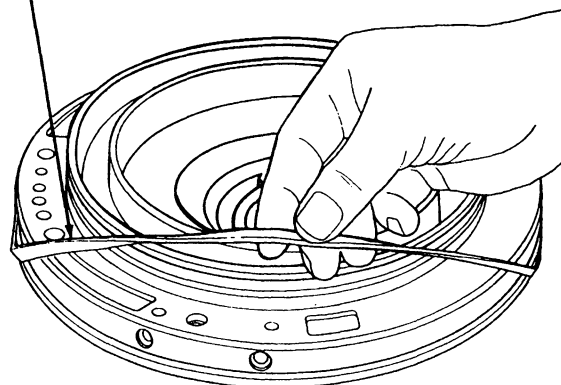


6. Remove clutch piston and inner and outer lip seals.



7. Remove pump body-to-case seal and discard.

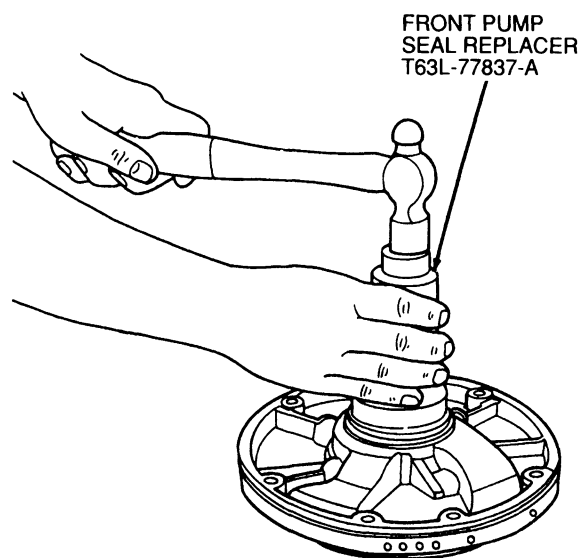
PUMP BODY
TO CASE SEAL



D3267-C

Assembly

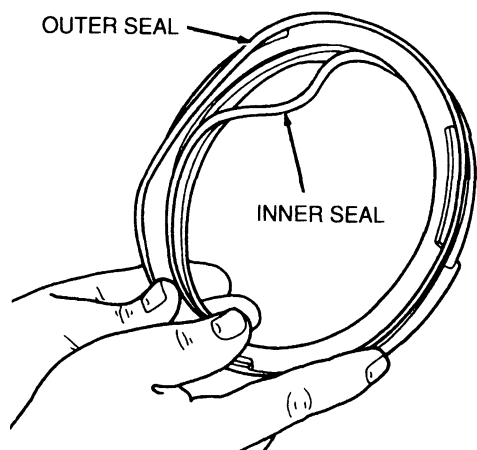
1. Install the seal using Front Pump Seal Replacer T63L-77837-A.



D10275-A

DISASSEMBLY AND ASSEMBLY (Continued)

2. Install new inner and outer seals on intermediate clutch piston.

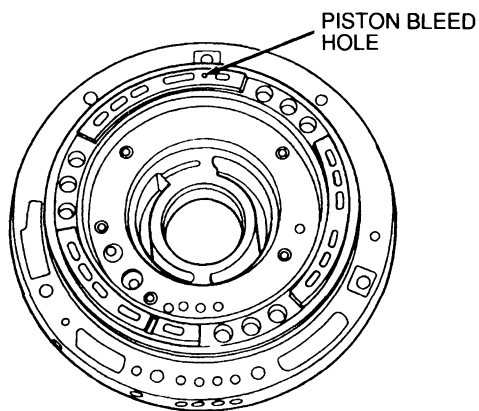


D10274-A

3. Note location of the piston bleed hole.

CAUTION: The piston bleed hole must be located at 12 o'clock position (toward top of transmission).

NOTE: Piston bleed hole is the only round hole in the piston assembly.

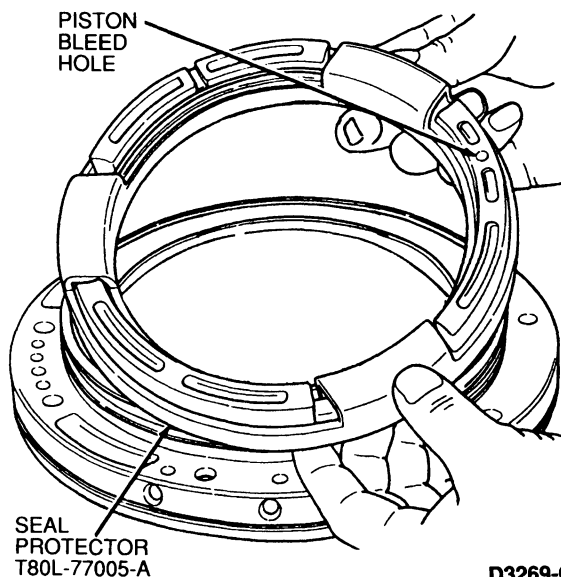


D10276-A

4. Install clutch piston as follows:

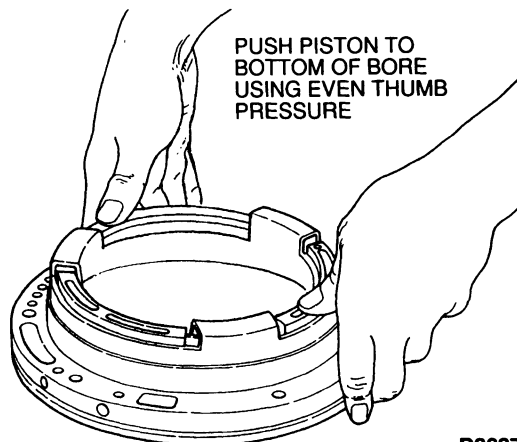
NOTE: Coat piston seals and pump body sealing area with petroleum jelly.

- a. Install piston in Seal Protector T80L-77005-A.



D3269-C

5. Install piston in pump body and push piston to the bottom of the bore by exerting even pressure.

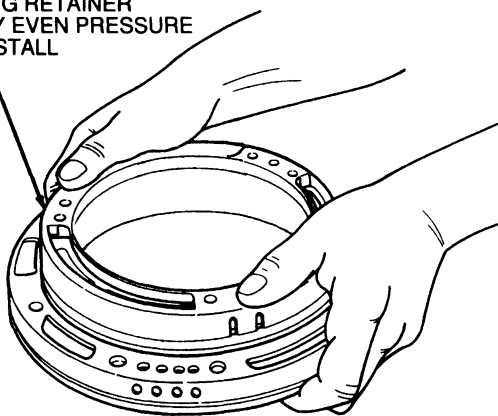


D3637-C

DISASSEMBLY AND ASSEMBLY (Continued)

6. Snap spring retainer assembly into place on pump body.

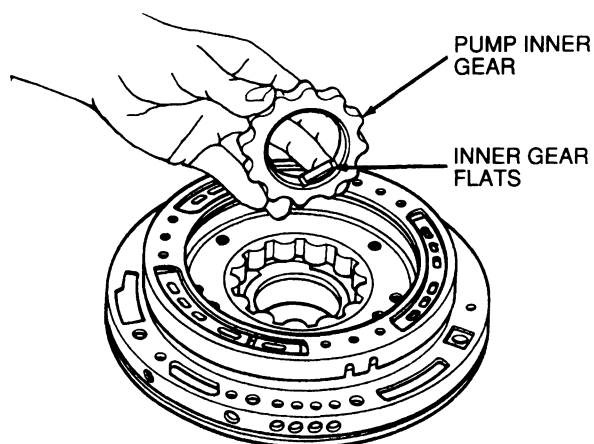
SPRING RETAINER
APPLY EVEN PRESSURE
TO INSTALL



D3270-C

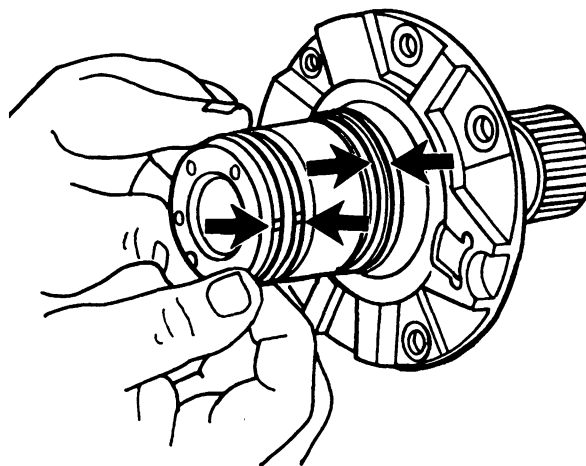
7. Install the inner and outer pump gears in pump body.

The flats have steps that must face the pump body for ease of installing the converter.



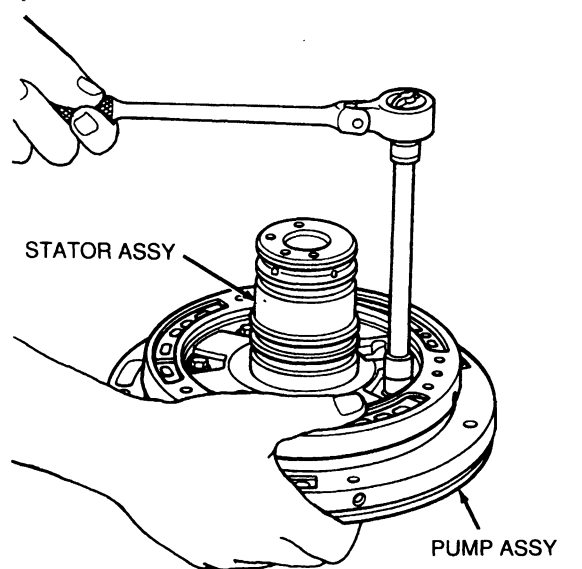
D10251-B

8. Install stator support seal rings.



D11466-A

9. Position stator support to pump body and install retaining bolts. Tighten to 20-26 N·m (15-19 lb-ft).



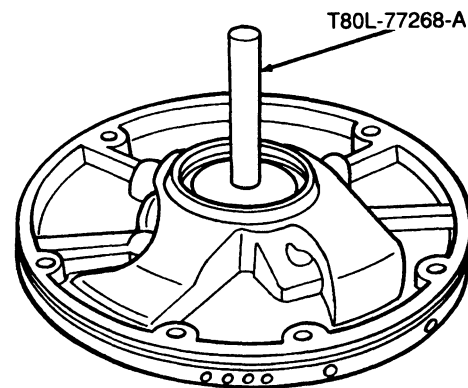
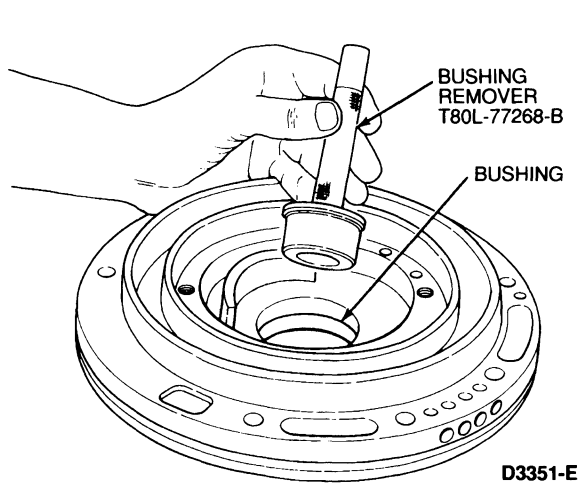
D10277-A

Pump Bushing**Tool Required:**

- Bushing Remover T80L-77268-B

DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

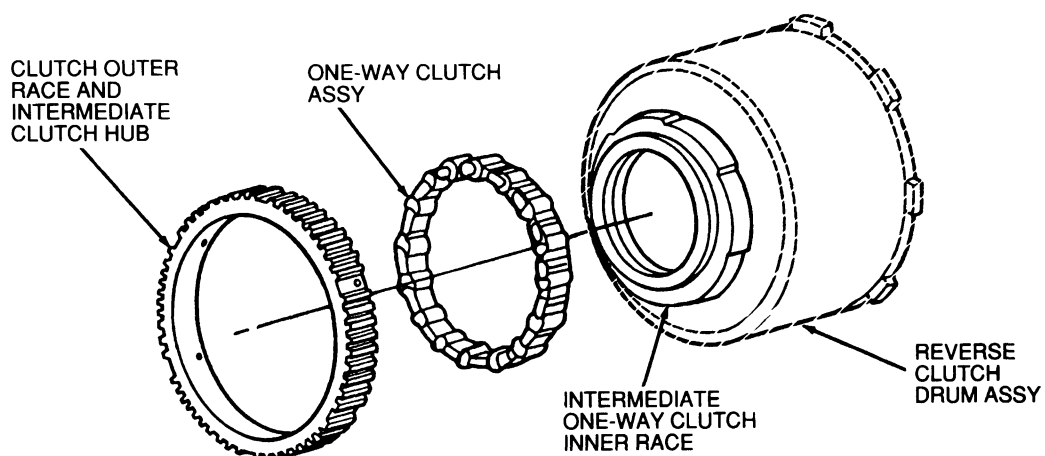
1. If required, remove bushing using Bushing Remover T80L-77268-B.



D10658-A

Assembly

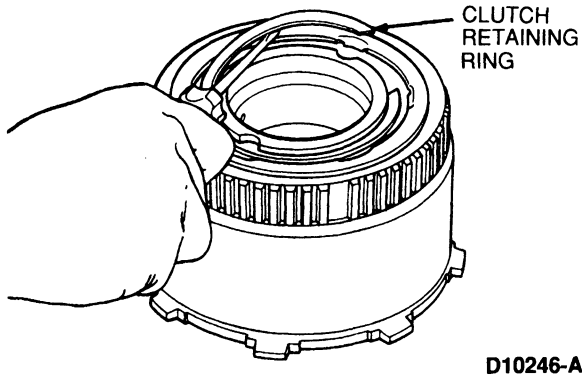
1. To install, press the bushing using Bushing Installer T80L-77268-A.

Intermediate One-Way Clutch**Disassembled View**

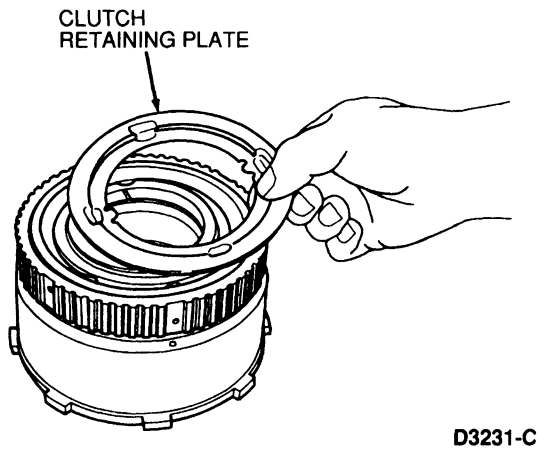
D10209-A

DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

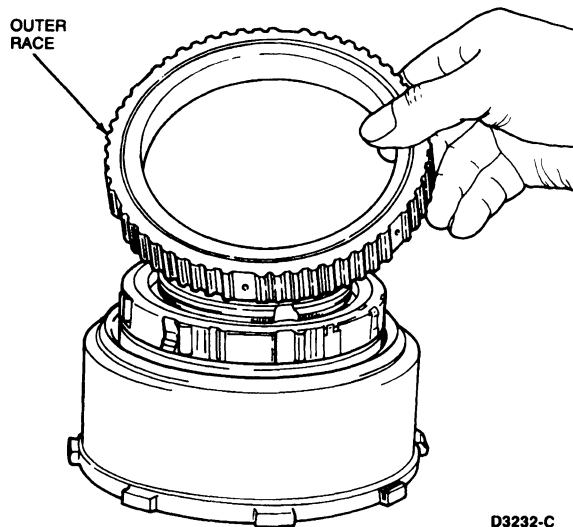
1. Remove clutch retaining ring.



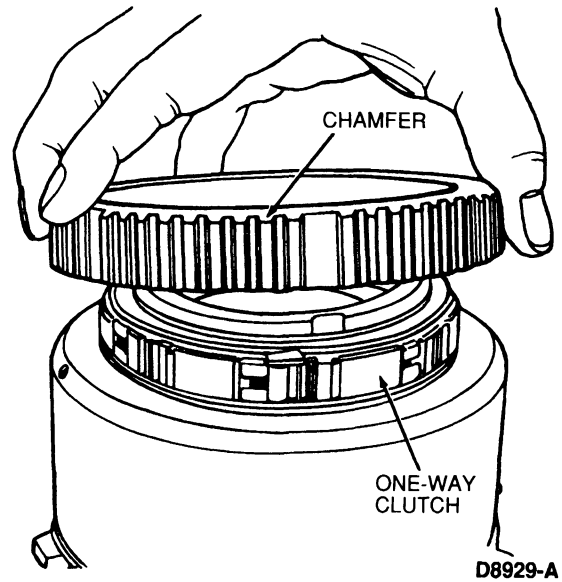
2. Remove clutch retaining plate.



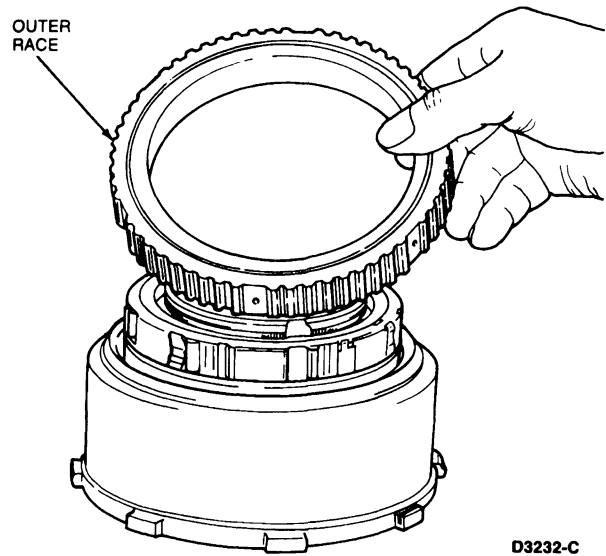
3. Remove clutch outer race by lifting on the race while turning counterclockwise.
Carefully lift one-way clutch from inner race.

**Assembly**

NOTE: For ease in assembly, the chamfer on the outer clutch race splines should face upward.

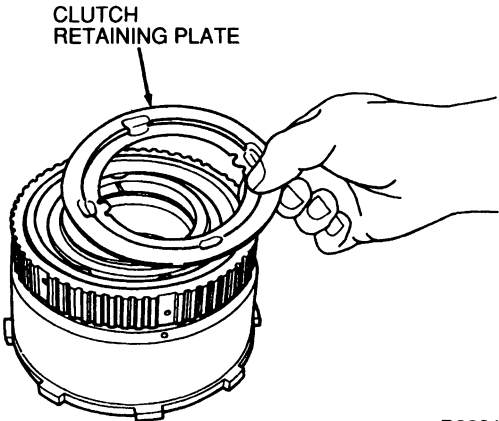


1. Install one-way clutch on inner race.
2. Install clutch outer race.



DISASSEMBLY AND ASSEMBLY (Continued)

3. Install clutch retaining plate.

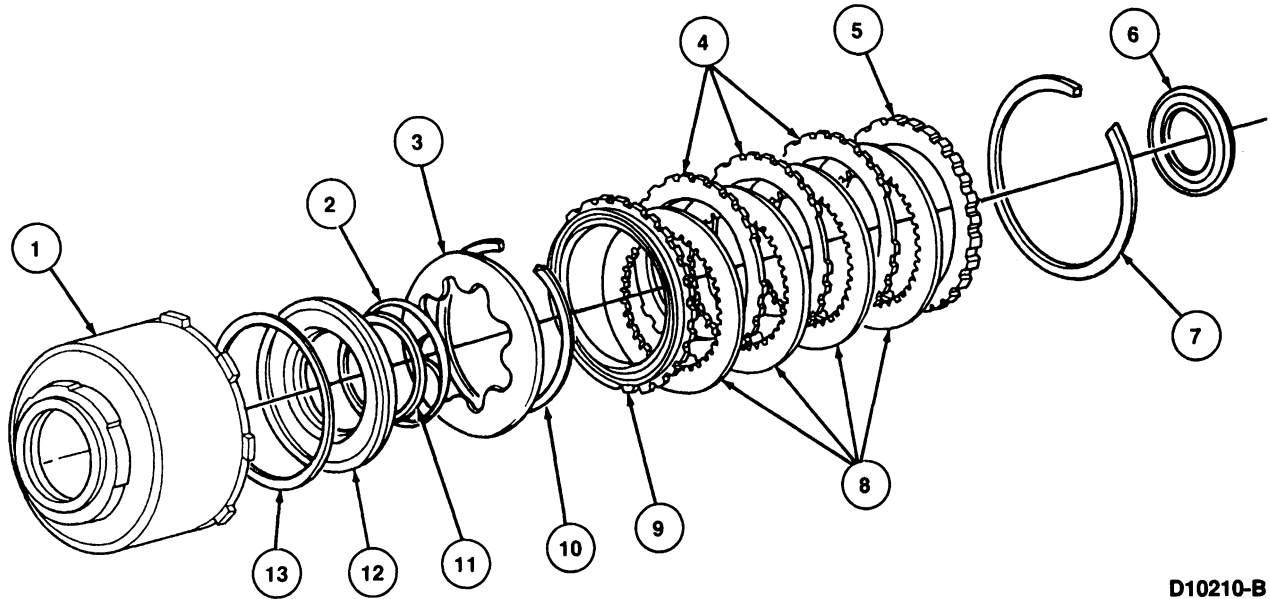


D3231-C

4. Install clutch retaining ring.

Reverse Clutch

Disassembled View



D10210-B

Item	Part Number	Description
1	7D044	Reverse Clutch Drum Assy
2	7D256	Ring
3	7B070	Piston Return Spring
4	7B442	Reverse Clutch External Spline (Steel) Plates
5	7B066	Reverse Clutch Rear Pressure Plate
6	7G008	Forward Clutch Bearing

(Continued)

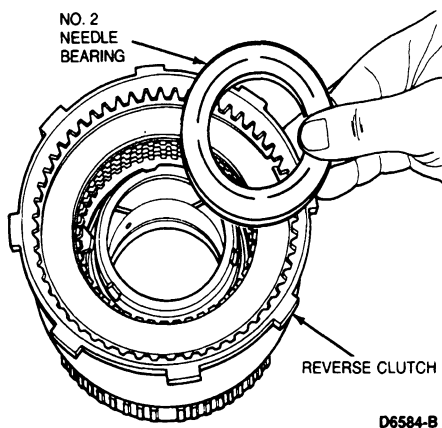
Item	Part Number	Description
7	7D483	Select Fit Retaining Ring
8	7B164	Reverse Clutch Internal Spline (Friction) Plates
9	7B066	Reverse Clutch Forward Pressure Plate
10	7A577	Retainer
11	7D404	Inner Seal
12	7D402	Reverse Clutch Piston Assy
13	7D403	Outer Seal

DISASSEMBLY AND ASSEMBLY (Continued)**Tools Required:**

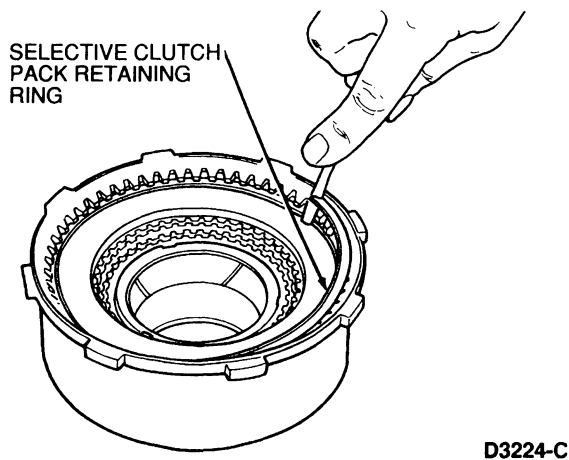
- Spring Compressor T65L-77515-A
- Reverse Clutch Spring Compressor T80L-77405-A
- Reverse Clutch (Inner) Seal Protector T80L-77403-B
- Reverse Clutch (Outer) Seal Protector T80L-77403-A
- Air Nozzle TOOL-7000-DE

Disassembly

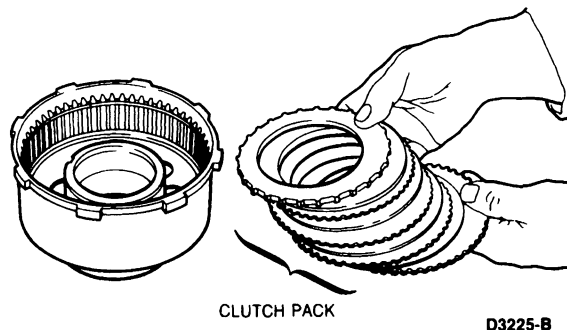
1. Remove No. 2 needle bearing.



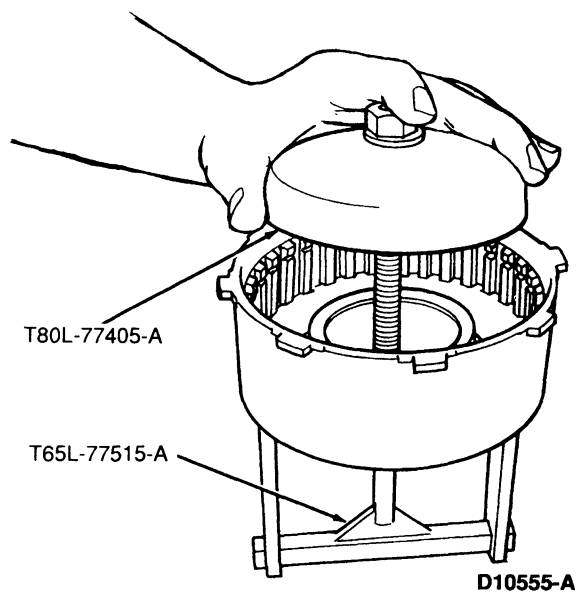
2. Remove selective clutch pack retaining ring.



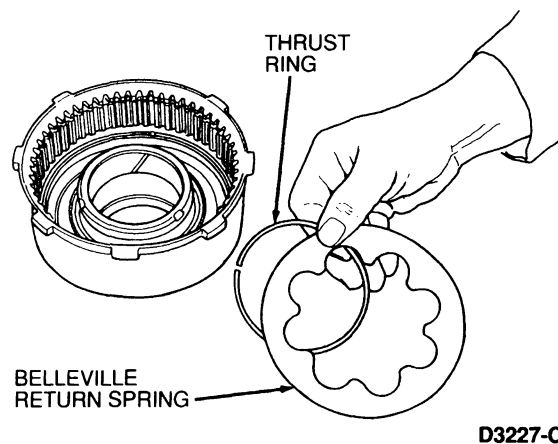
3. Remove clutch pack.



4. Install Spring Compressor Tool T80L-77405-A and Clutch Spring Compressor Tool T65L-77515-A onto reverse clutch. Tighten enough to compress return spring. Remove retaining ring.



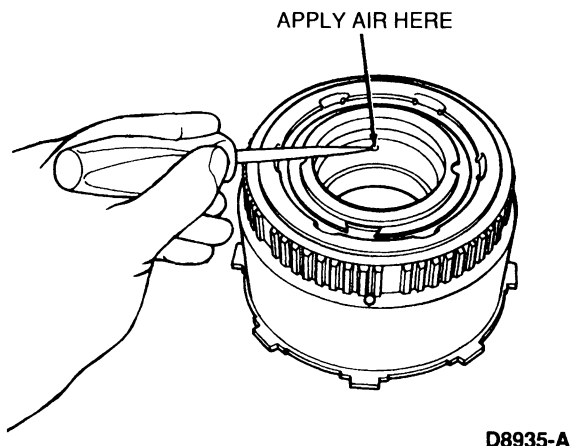
5. Remove piston, Belleville return spring and thrust ring.



DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: To aid in piston removal, it may be necessary to apply air pressure to the drum. Block the opposite hole with a finger.

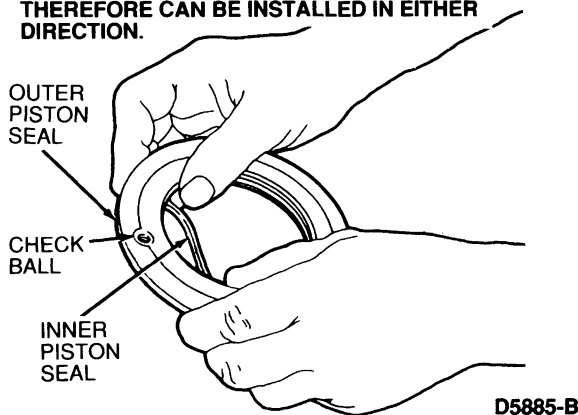
6. Remove clutch piston and inner and outer piston seals.

**Assembly**

1. Install new seals on clutch piston. Direction of installation is not important because seals are square cut.

NOTE: The piston check ball must be present and moving freely.

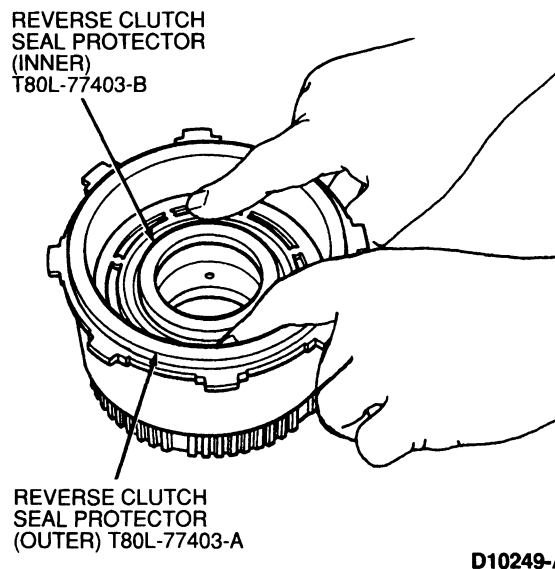
NOTE: THE SEALS ARE SQUARE AND THEREFORE CAN BE INSTALLED IN EITHER DIRECTION.



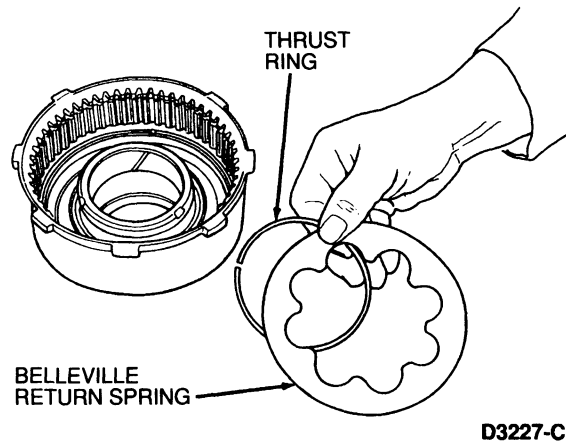
2. Install clutch piston as follows:

NOTE: Coat piston seals, clutch drum, sealing area and seal protector with petroleum jelly.

- a. Install Reverse Clutch Seal Protector (Inner) T80L-77403-B on the clutch hub and Reverse Clutch Seal Protector (Outer) T80L-77403-A over the piston.
- b. Position piston and push it to the bottom of the drum using even thumb pressure.

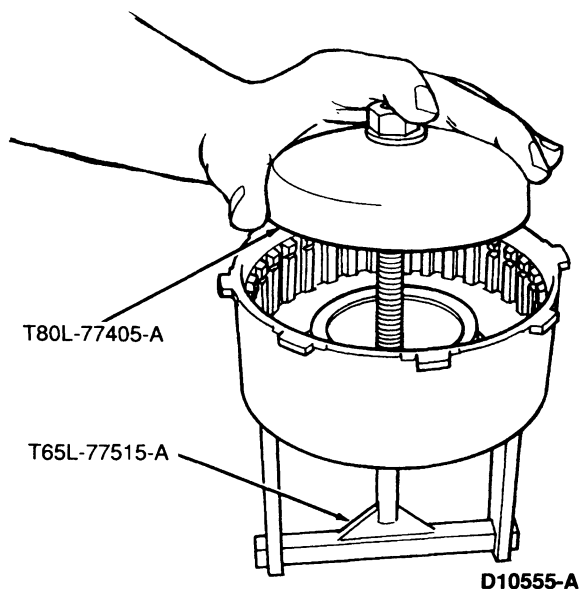


3. Install piston thrust ring and piston Belleville return spring. The dished side of spring must face toward the piston.

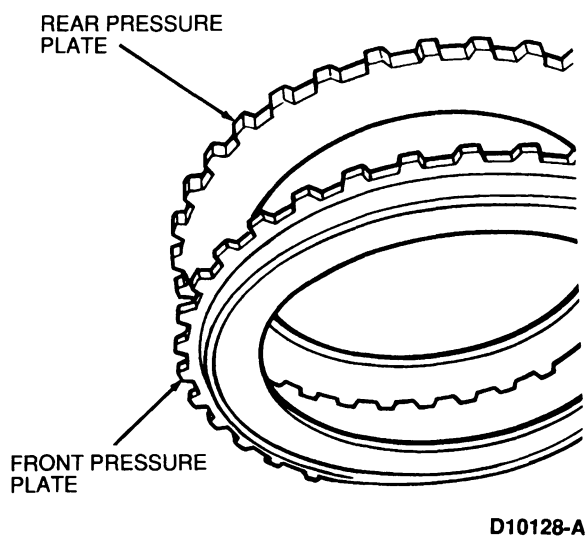


DISASSEMBLY AND ASSEMBLY (Continued)

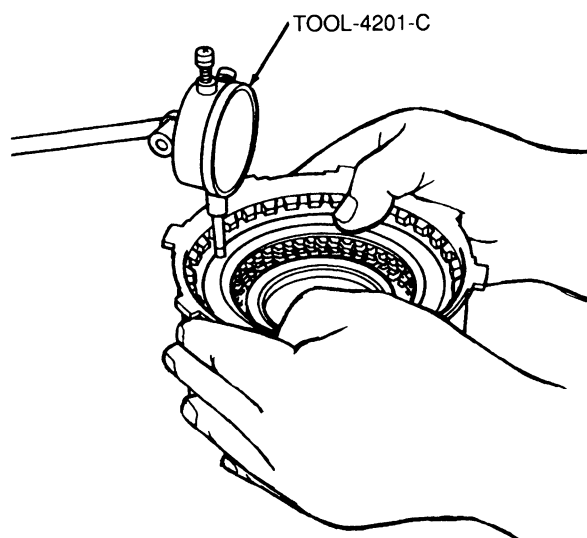
4. Install wave snap ring (with points down) using Reverse Clutch Spring Compressor T80L-77405-A and Spring Compressor T65L-77515-A.



5. Install front pressure plate, clutch pack and rear pressure plate. Position the stepped side of front pressure plate down with flat side toward clutch pack and rear pressure plate flat side toward clutch pack.



6. Install clutch pack retaining ring and check the clearance between the ring and the pressure plate using a feeler gauge. Pressure plate should be held downward as clearance is checked.



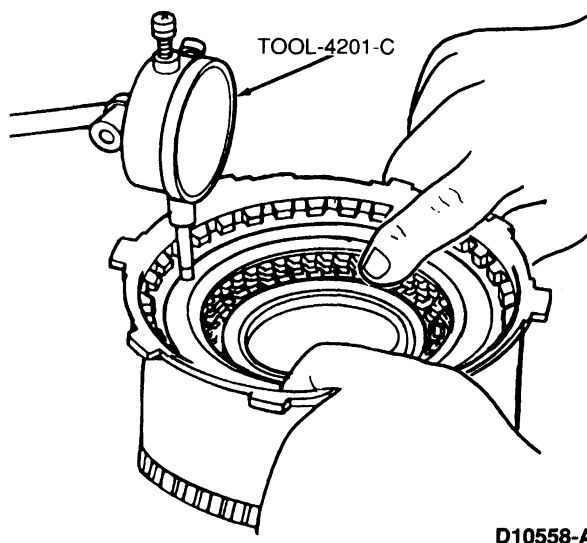
The clearance should be:

4 plate assembly

- 1.01-1.524mm (0.040-0.059 inch)

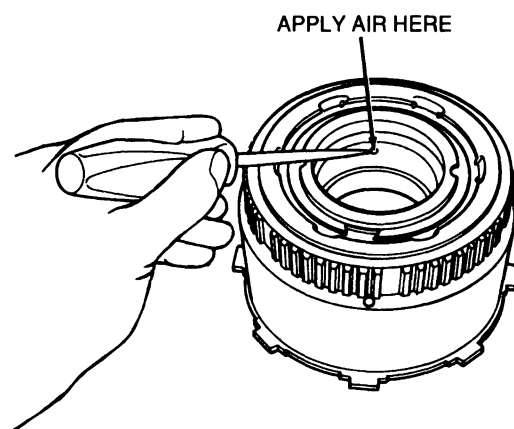
If clearance is not within specification, install correct size snap ring and check clearance. Selective snap rings are available in the following thicknesses:

Selective Snap Rings
1.27-1.37mm (0.060-0.064 inch)
1.87-1.98mm (0.074-0.078 inch)
2.23-2.33mm (0.088-0.092 inch)
2.59-2.69mm (0.102-0.106 inch)

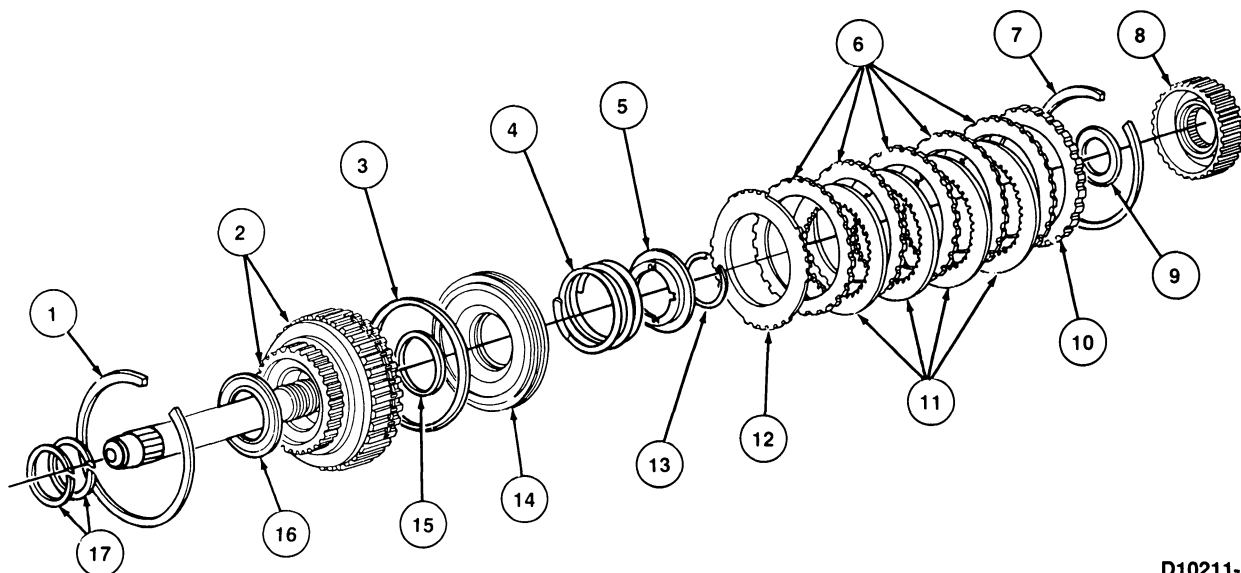


DISASSEMBLY AND ASSEMBLY (Continued)

7. Check clutch for proper operation using Air Nozzle TOOL-7000-DE. The clutch should be heard and felt to work smoothly and without leakage.



D8935-A

Forward Clutch**Disassembled View**

D10211-B

Item	Part Number	Description
1	7D483	Select Fit Retainer
2	7F207	Cylinder and Input Shaft Assy Forward Clutch
3	7A548	Outer Seal
4	7A480	Return Spring
5	7A527	Return Spring Retainer
6	7B442	Forward Clutch External Spline (Steel) Plates
7	7K548	Snap Ring
8	7B067	Forward Clutch Hub

(Continued)

Item	Part Number	Description
9	7F231	Front Bearing
10	7B066	Forward Clutch Pressure Plate
11	7B164	Forward Clutch Internal Spline (Friction) Plates
12	7E085	Rear Clutch Pressure Plate Spring
13	388099-S	Snap Ring
14	7A262	Forward Clutch Piston
15	7C099	Inner Seal
16	7A166	Forward Clutch Bearing
17	7B497	Input Shaft Seal

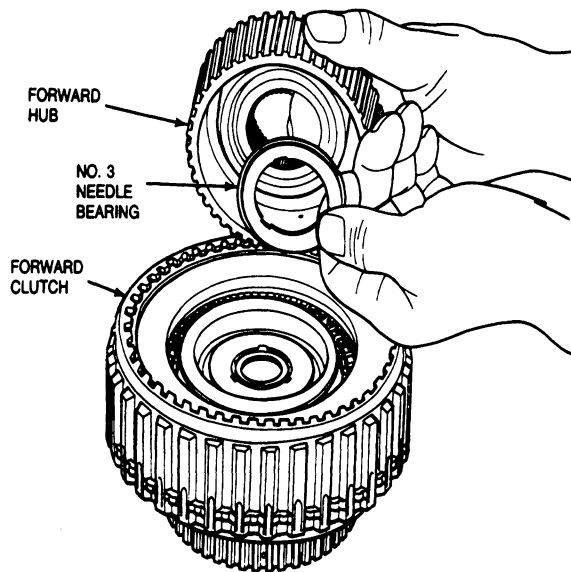
DISASSEMBLY AND ASSEMBLY (Continued)**Tools Required:**

- Clutch Spring Compressor T65L-77515-A
- Forward Clutch Lip Seal Protector (Inner) T80L-77140-A
- Forward Clutch Lip Seal Protector (Outer) T68L-7D158-A
- Dial Indicator with Bracketry TOOL-4201-C

Disassembly

1. Remove clutch hub and No. 3 needle bearing, if not already removed.

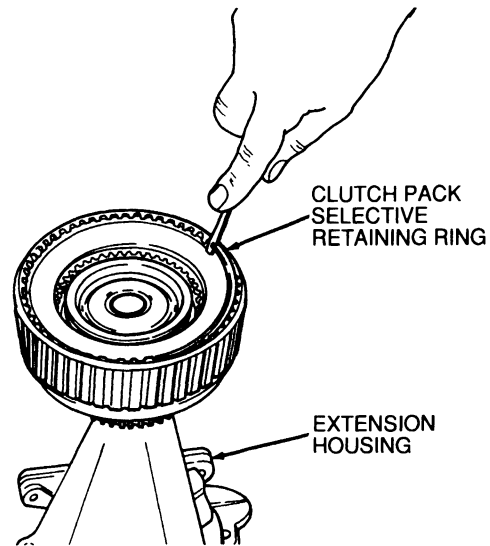
NOTE: Clutch hub may remain in shell during disassembly.



D3832-C

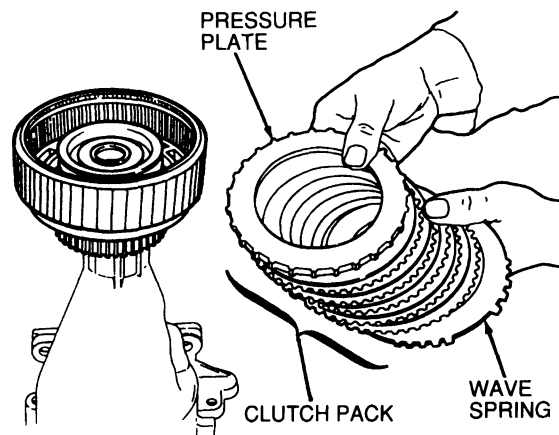
2. Remove clutch pack selective retaining ring.

NOTE: To aid handling, clutch may be set in the extension housing or a 51mm (2 inch) diameter hole may be cut in the work bench.



D3236-D

3. Remove clutch pack, pressure plate, clutch plates and wave spring.



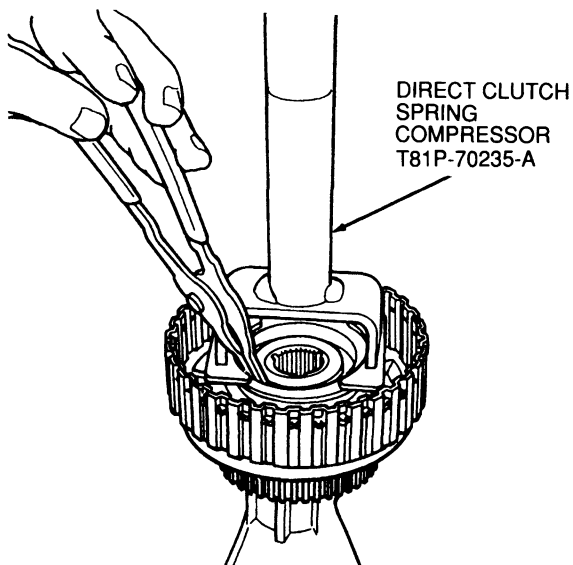
D3252-D

4. Compress piston return spring using Direct Clutch Spring Compressor T81P-70235-A.

Place into a shop arbor press and apply only enough pressure to release spring tension on the snap ring.

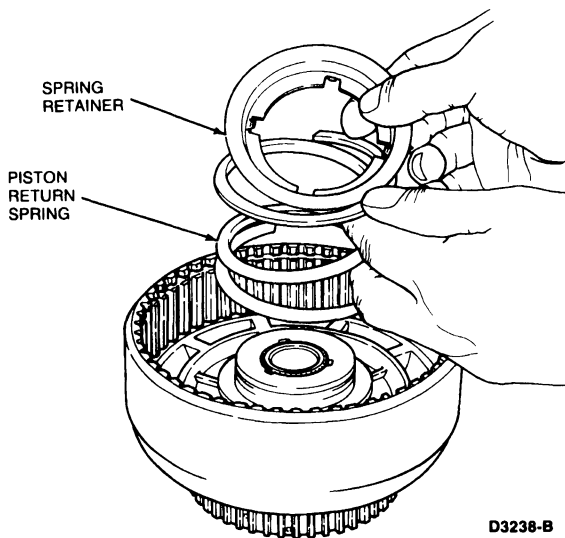
DISASSEMBLY AND ASSEMBLY (Continued)

Remove retaining ring and slowly release the press to remove spring compressor.



D10243-A

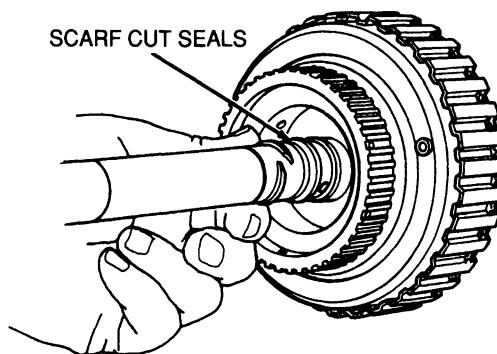
5. Remove spring retainer, return spring and piston.
 6. Remove piston and inner and outer piston seals.
- NOTE: Air pressure may be required to remove piston.



D3238-B

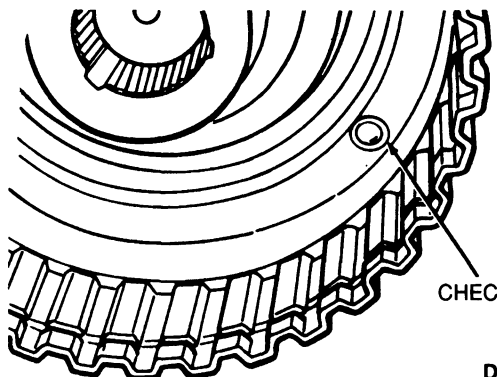
7. Remove scarf-cut seals from forward clutch cylinder shaft.

SCARF CUT SEALS



D10242-A

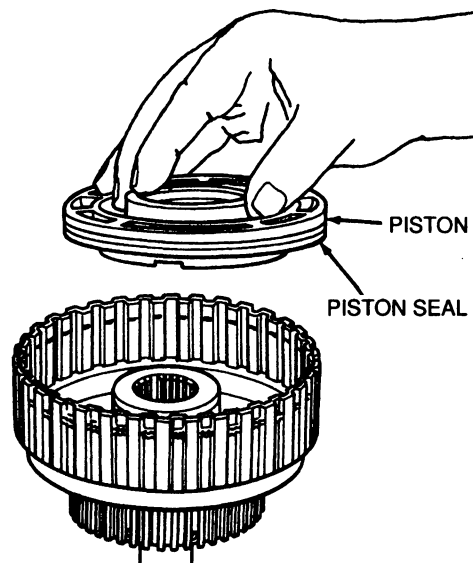
NOTE: Ensure check balls in clutch cylinder are free and clean. Check for proper seating.



D10214-A

Assembly

1. Install new seals on clutch piston. Note direction of the sealing lip before installation.

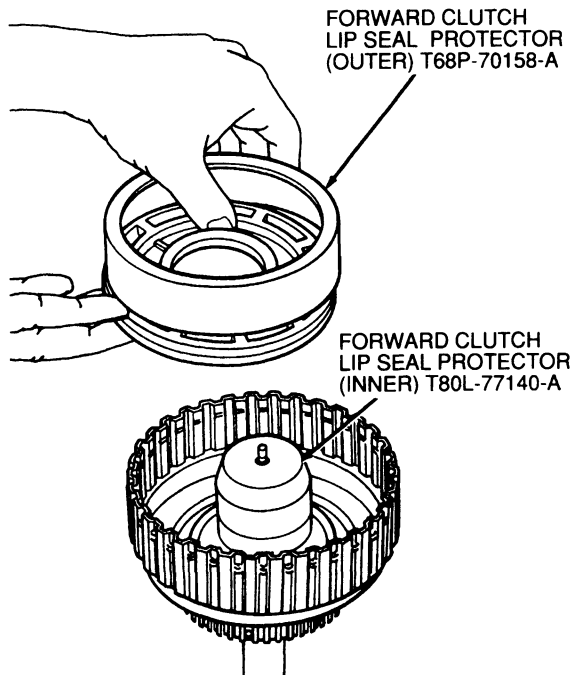


D10240-A

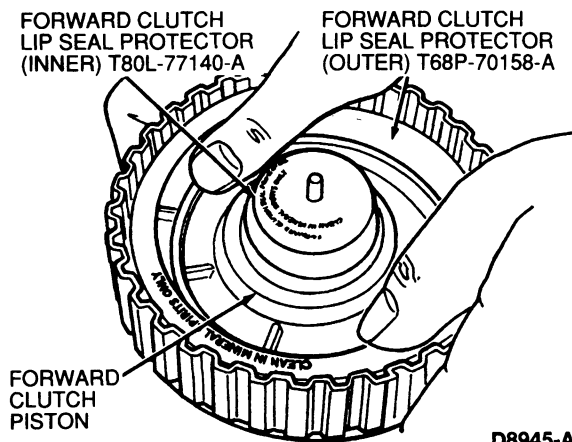
2. Install clutch piston as follows:
NOTE: Coat piston seals and clutch drum sealing area with petroleum jelly.

DISASSEMBLY AND ASSEMBLY (Continued)

- a. Install Forward Clutch Lip Seal Protector (Inner) T80L-77140-A over clutch cylinder hub.
- b. Install piston in Forward Clutch Lip Seal Protector (Outer), T68P-7D158-A.

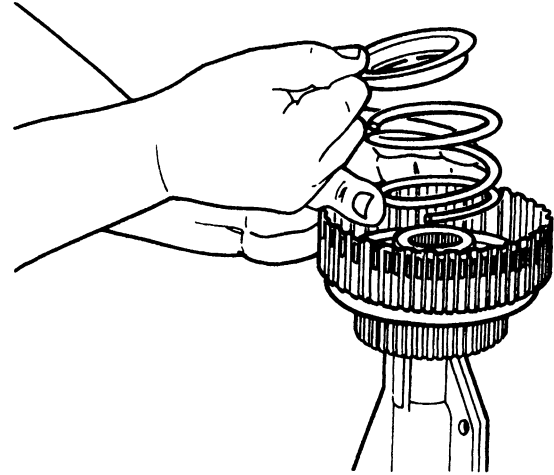
**D10241-A**

3. Position seal protector and piston in clutch drum. Push piston to the bottom of the drum using even thumb pressure. Remove seal protectors.

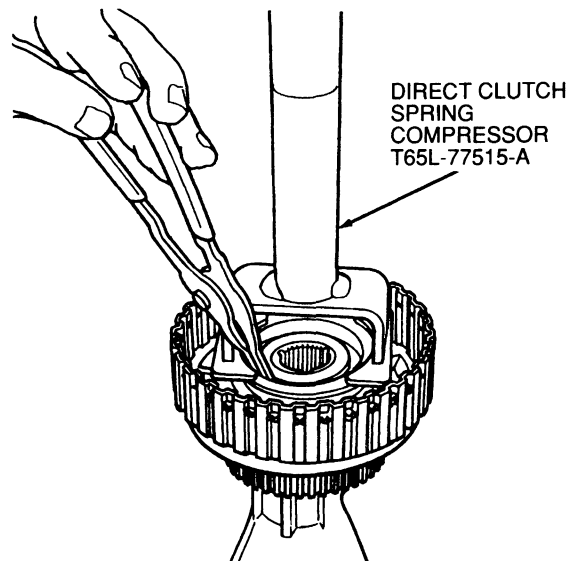
**D8945-A**

4. Install piston return spring and spring retainer.

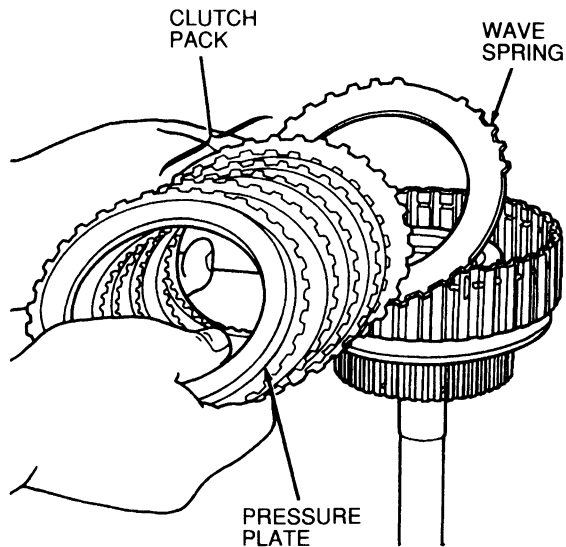
5. Install piston return spring and spring carrier.

**D10559-A**

6. Compress piston return spring using Clutch Spring Compressor T65L-77515-A. Compress piston only enough to allow clearance to install retaining ring.

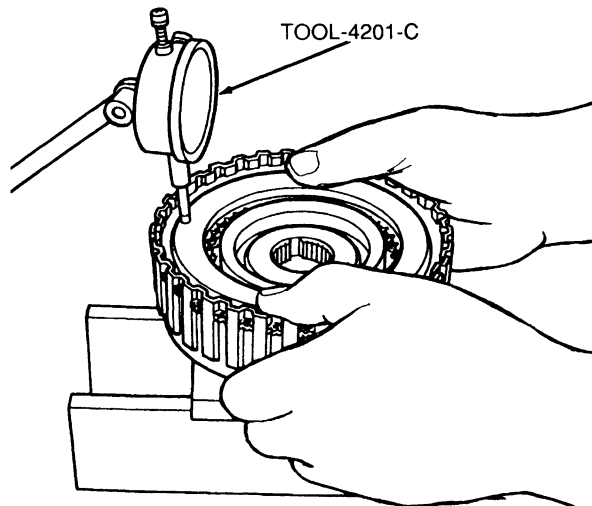
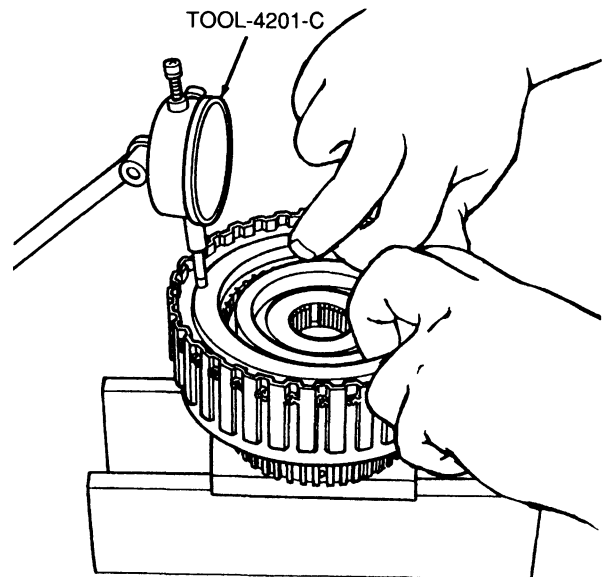
**D10243-B**

7. Install clutch pack in the following order:
 - a. Wave spring
 - b. Clutch pack

DISASSEMBLY AND ASSEMBLY (Continued)**c. Pressure plate****D10252-A**

8. Install clutch pack retaining ring and check the clearance between the ring and pressure plate using Dial Indicator with Bracketry TOOL-4201-C or equivalent.

Pressure plate should be held downward as the clearance is checked.

**D10560-A****D10561-A**

If the clearance is not within specification, install the correct size snap ring and recheck the clearance. Selective snap rings are available in the following thicknesses:

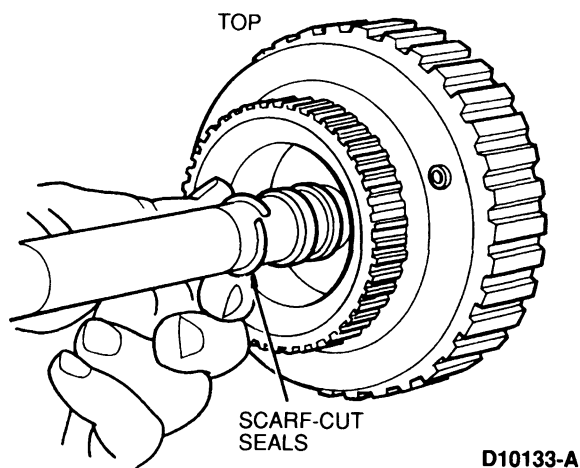
Selective Snap Ring
1.27-1.37mm (0.060-0.064 inch)
1.87-1.98mm (0.074-0.078 inch)
2.23-2.69mm (0.086-0.092 inch)
2.59-2.69mm (0.102-0.106 inch)

9. Install two scarf-cut seals on the forward clutch shaft.

NOTE: Scarf-cut seals must be installed with mating surfaces as shown.

**CORRECT****INCORRECT****D10657-A**

DISASSEMBLY AND ASSEMBLY (Continued)

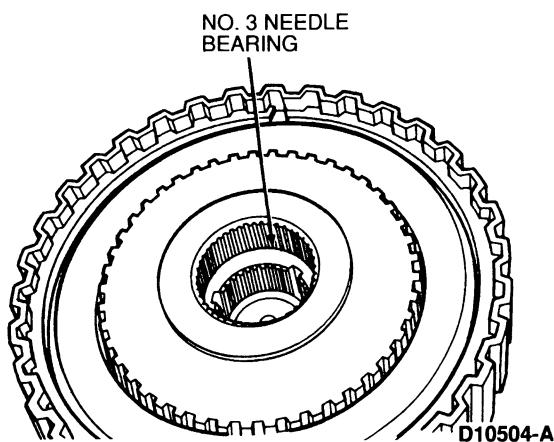


D10133-A

The clearance should be:

- 1.27-2.26mm (0.50-0.089 inch)

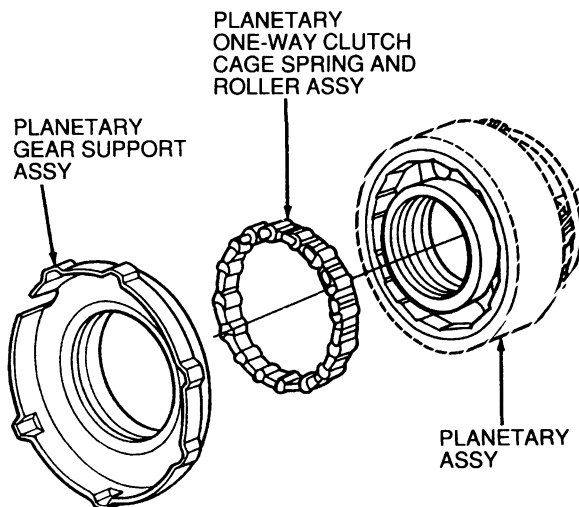
10. Install No. 3 needle bearing. Install hub into forward clutch, ensure hub is against No. 3 bearing.



D10504-A

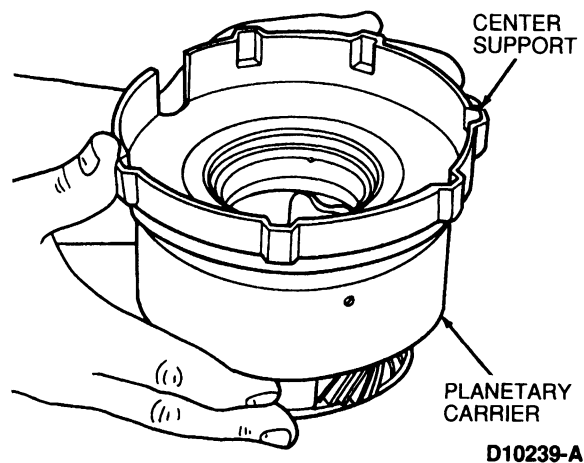
Center Support and Planetary Low One-Way Clutch

Disassembly



D10212-A

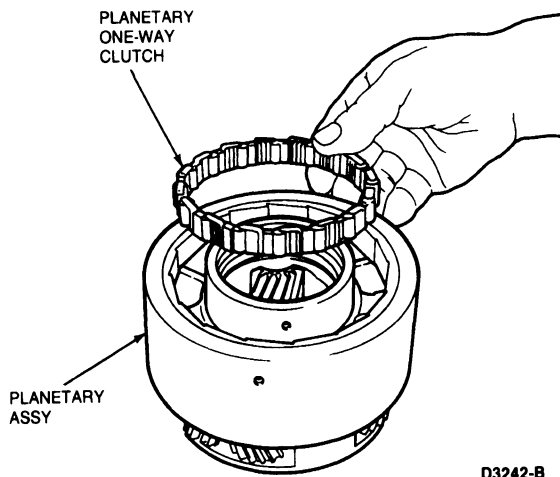
1. Remove center support from planetary carrier. Rotate the center support counterclockwise and lift.



D10239-A

DISASSEMBLY AND ASSEMBLY (Continued)

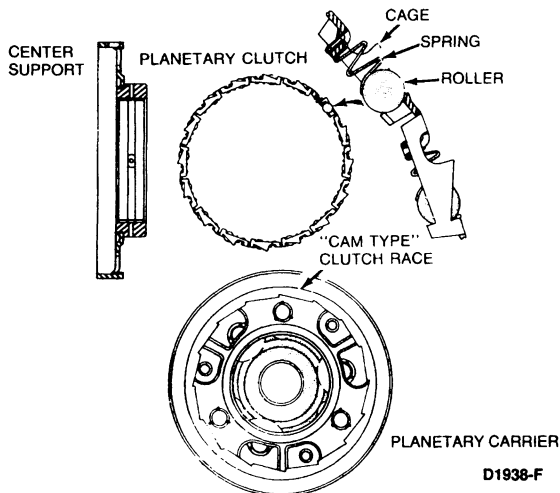
2. Carefully remove planetary one-way clutch from planetary assembly.



D3242-B

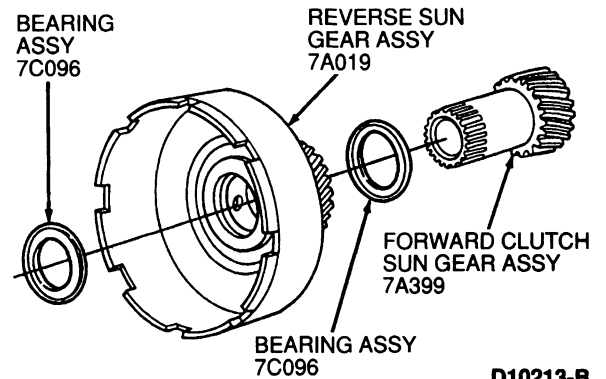
Assembly

1. Inspect clutch outer race, inner race, band surface, pinion gears, bearings and thrust washer for roughness.
Inspect center support bushing for roughness.
Inspect one-way clutch, rollers and springs for damaged rollers and broken springs.



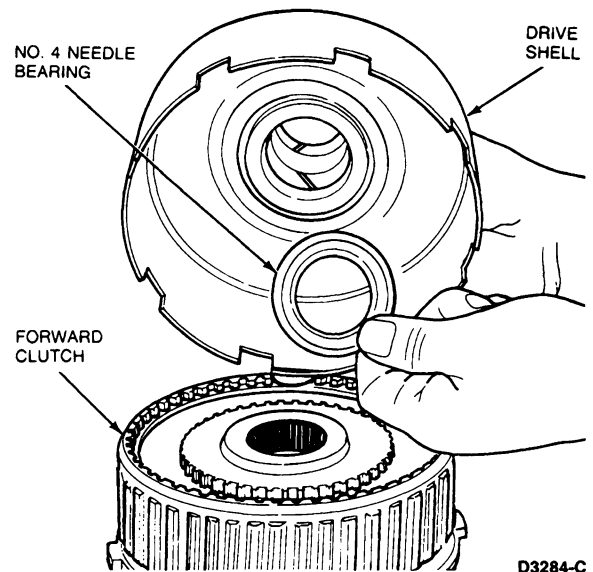
D1938-F

2. Install one-way clutch in planetary carrier.
 3. Install center support into one-way clutch by rotating the center support counterclockwise.
- Lubricate clutch races and clutch assembly with petroleum jelly to aid in assembly.

Sun Gear and Drive Shell**Disassembly**

D10213-B

1. Remove the No. 4 needle bearing from drive shell.

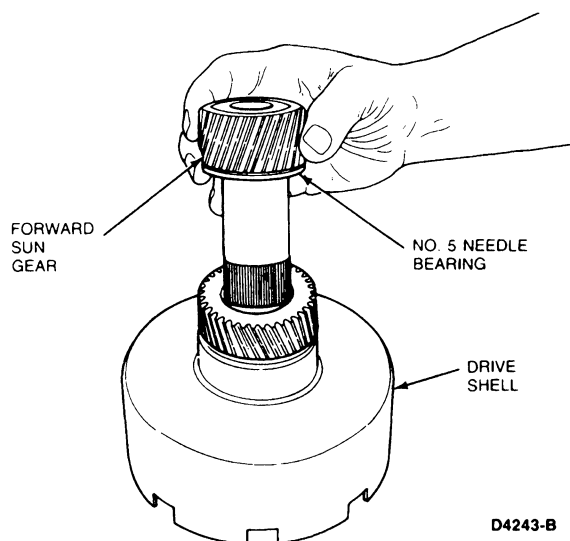
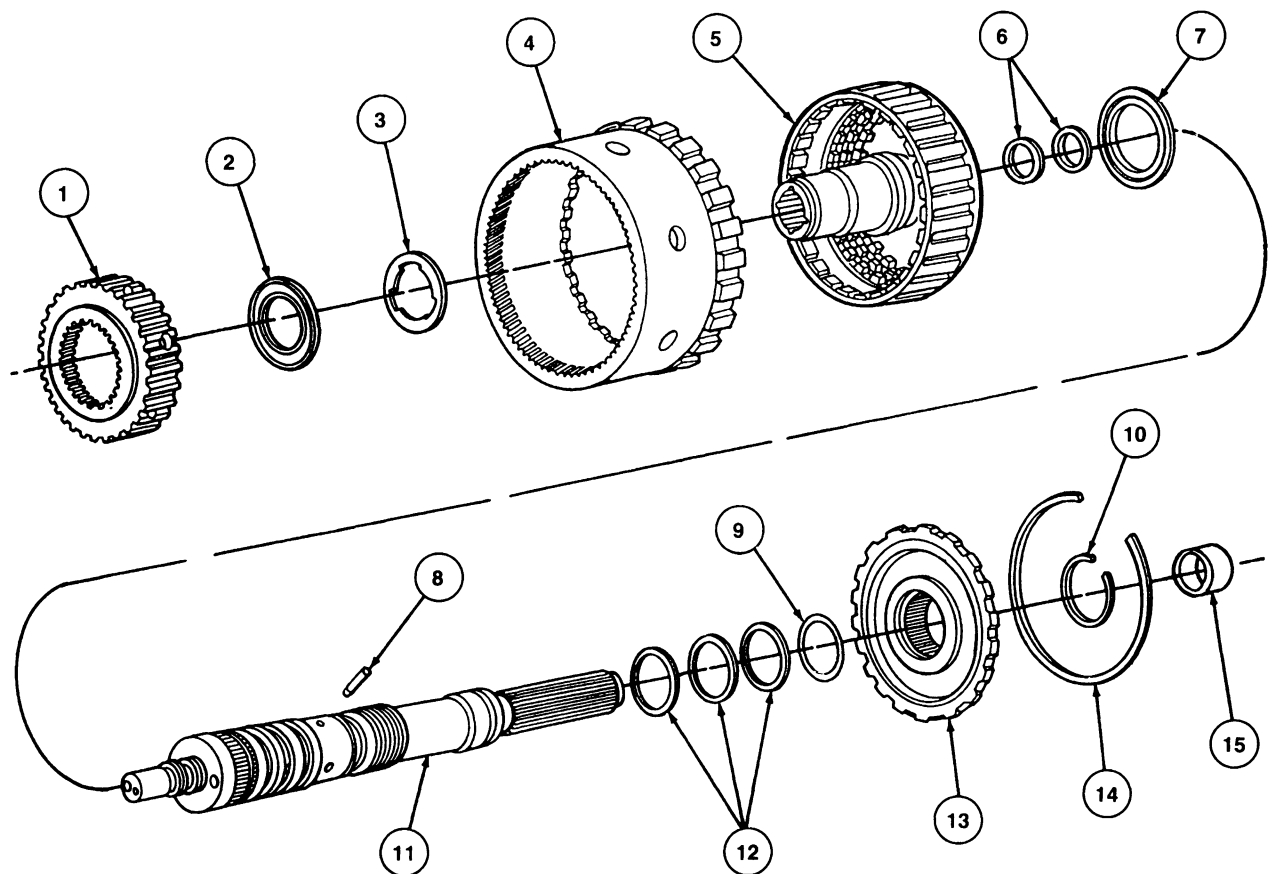


D3284-C

DISASSEMBLY AND ASSEMBLY (Continued)

2. Remove forward sun gear and No. 5 needle bearing from drive shell.

NOTE: The sun gear and drive shell is assembled as part of the transmission assembly procedure.

**Output Shaft and Direct Clutch****Disassembled View**

DISASSEMBLY AND ASSEMBLY (Continued)

Item	Part Number	Description
1	7F236	Direct Clutch Hub
2	7F243	Direct Clutch Inner Bearing
3	7F237	Direct Clutch Washer
4	7A153	Output Shaft Ring Gear
5	7F283	Direct Clutch Cylinder
6	7F274	Seal
7	7F240	Direct Clutch Outer Bearing

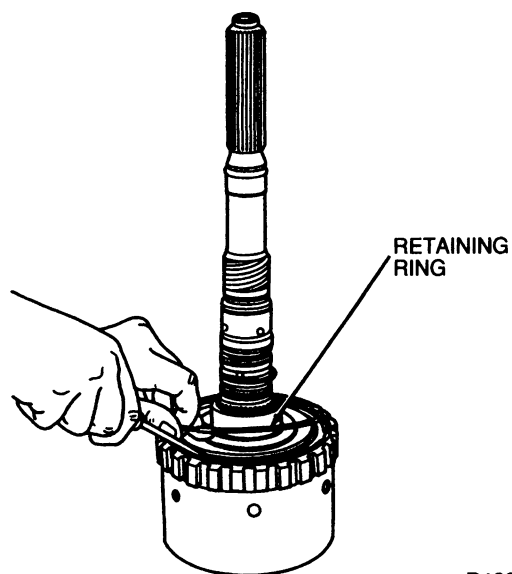
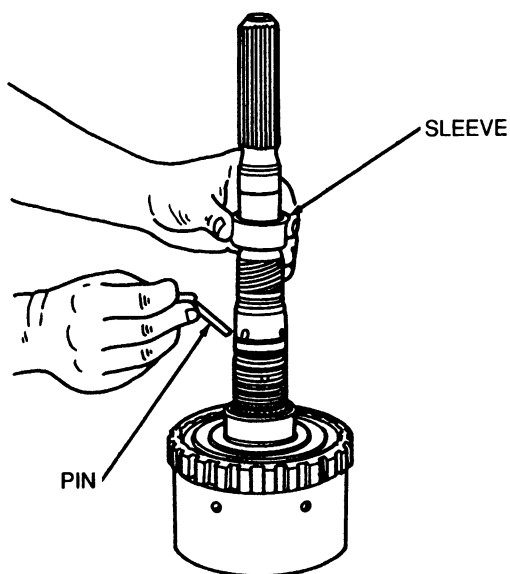
(Continued)

Item	Part Number	Description
8	391231-S	Pin
9	87054-S96	Seal
10	97713-S	Snap Ring
11	7060	Output Shaft Assy
12	7F273	Seals
13	7D164	Output Shaft Hub
14	7C122	Snap Ring
15	7B176	Output Shaft Sleeve

Disassembly

1. Remove ring retaining the output shaft hub to ring gear.

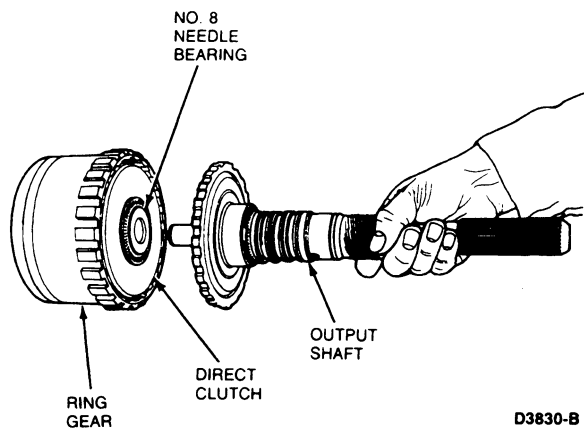
NOTE: Governor sleeve and block pin need only be removed when major component failure requires transmission cleaning and overhaul.



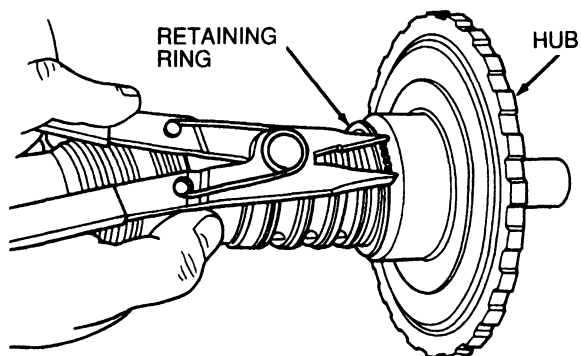
D10207-B

DISASSEMBLY AND ASSEMBLY (Continued)

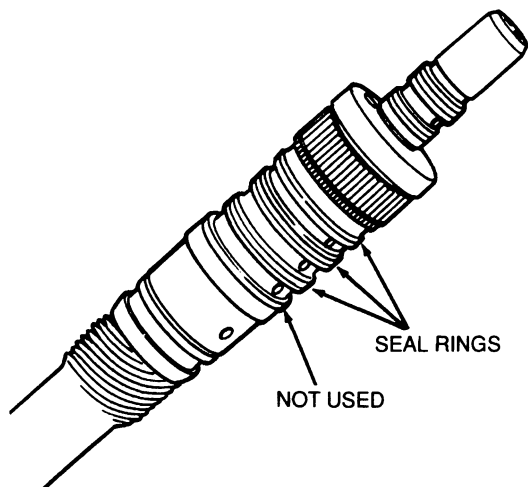
2. Separate output shaft from ring gear.



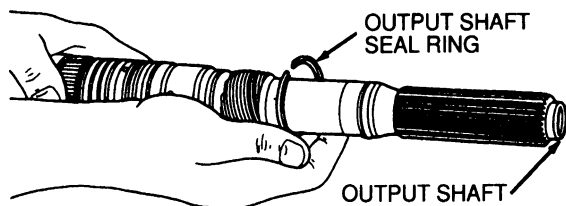
3. Remove snap ring retaining output shaft hub. Slide hub off rear of shaft.



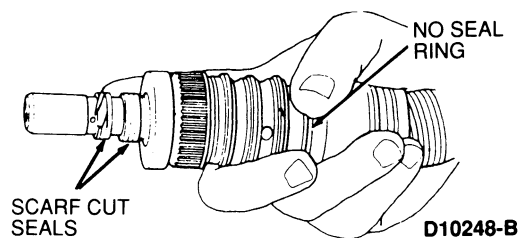
CAUTION: The output shaft has four grooves but only three are used. The illustration shows the correct locations.

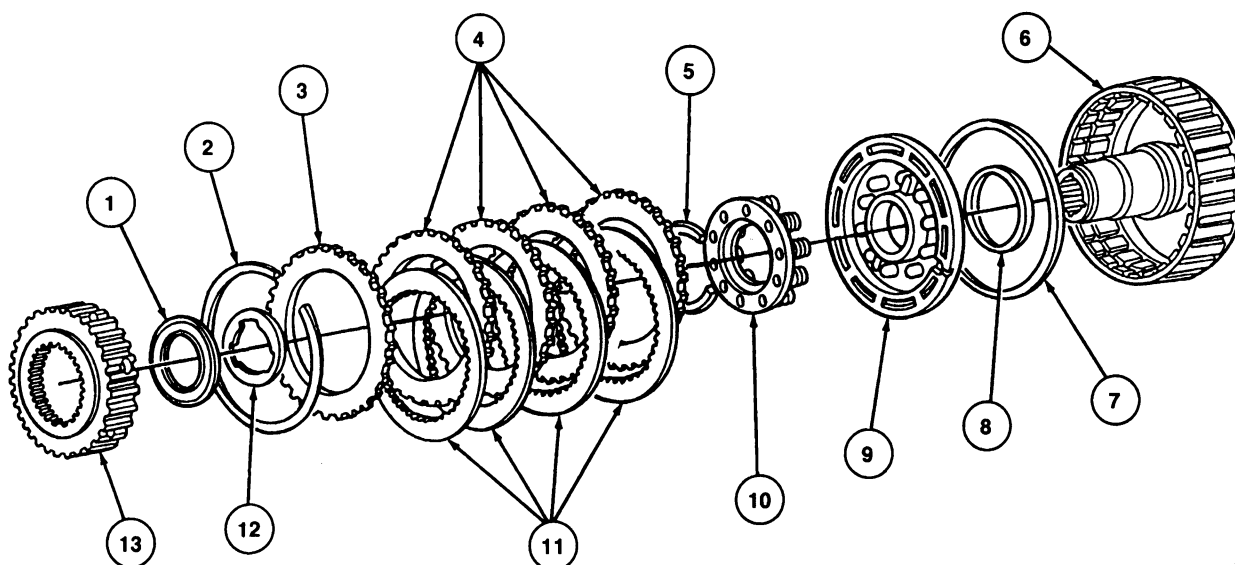


4. Remove three output shaft seal rings and output shaft O-ring.



5. Remove two direct clutch seal rings from the output shaft. Note the direction of the scarf-cut seals.



DISASSEMBLY AND ASSEMBLY (Continued)**Direct Clutch****Disassembled View****D10216-B**

Item	Part Number	Description
1	7F243	Inner Bearing
2	391234-S	Select Fit Retaining Ring
3	7B066	Direct Clutch Pressure Plate
4	7B442	Direct Clutch External Spline (Steel) Plates
5	388104-S	Retaining Ring
6	7F283	Direct Clutch Cylinder Assy
7	7A548	Outer Seal

(Continued)

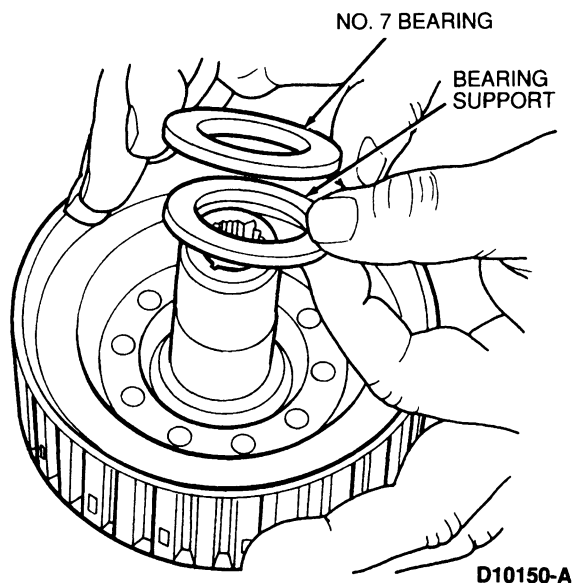
Item	Part Number	Description
8	7E099	Inner Seal
9	7F254	Direct Clutch Piston Assy
10	7F235	Direct Clutch Retainer and Spring Assy
11	7B164	Direct Clutch Internal Spline (Friction) Plates
12	7F237	Inner Bearing Support Washer
13	7B067	Direct Clutch Hub

Tools Required:

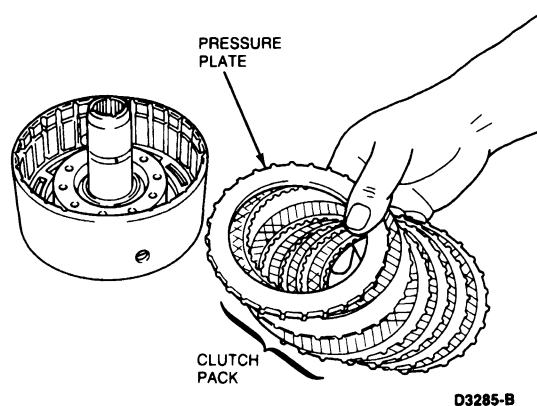
- Spring Compressor T65L-77515-A
- Direct Clutch Lip Seal Protector T80L-77234-A
- Lip Seal Protector T80L-77254-A

DISASSEMBLY AND ASSEMBLY (Continued)**Disassembly**

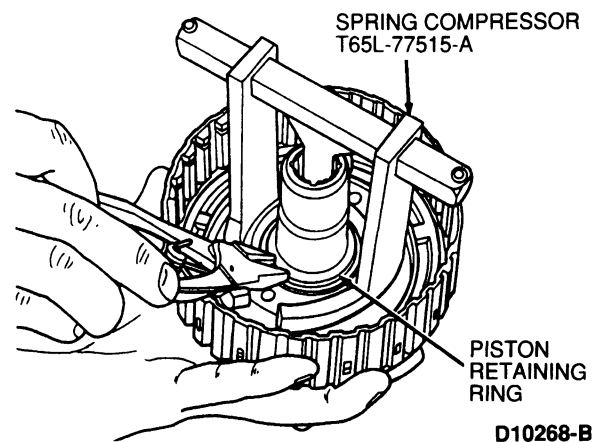
1. After removing direct clutch hub, remove No. 7 bearing and bearing support.



2. With snap ring removed, remove and inspect clutch pack. Note the relation of clutch plates for assembly.

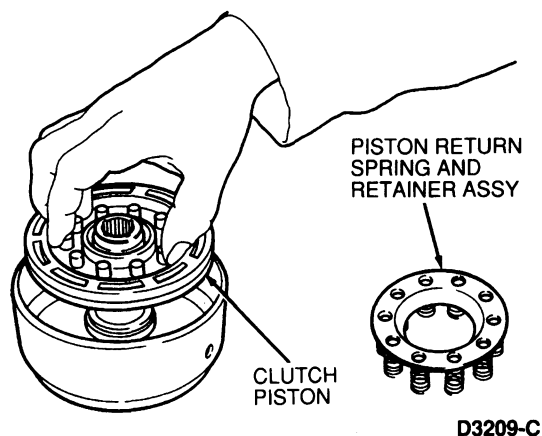


3. Using Spring Compressor T65L-77515-A compress the piston return spring. Remove piston retaining ring using expanding-type snap-ring pliers.



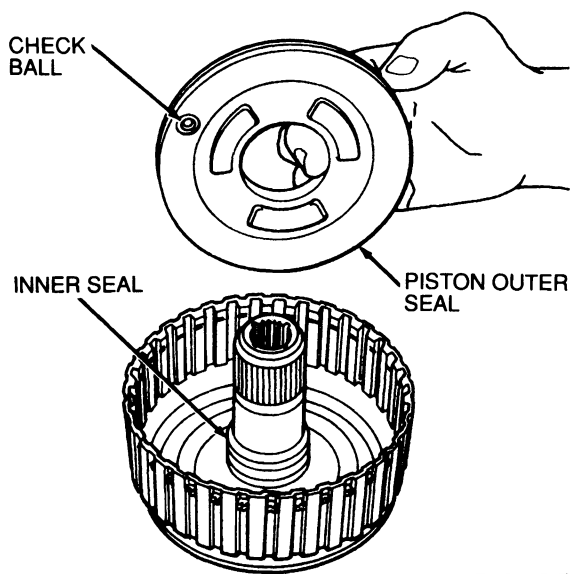
NOTE: Use air pressure if necessary to remove clutch piston.

4. Remove spring retainer assembly and piston from cylinder.



DISASSEMBLY AND ASSEMBLY (Continued)

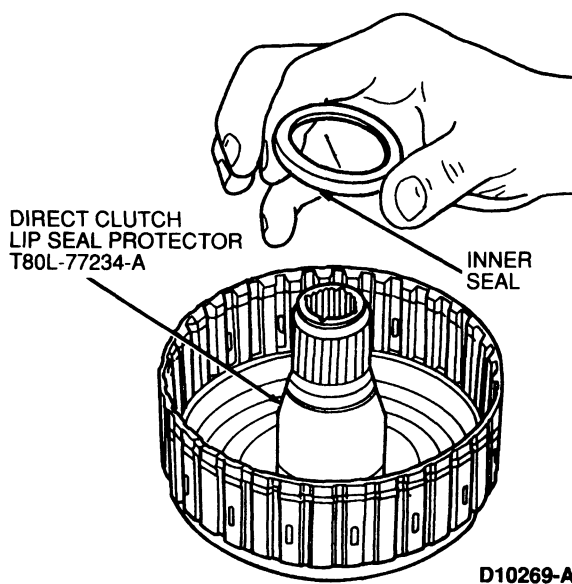
Remove inner seal from cylinder hub and outer seal from piston. Verify presence of check ball and that it moves freely.

**Assembly**

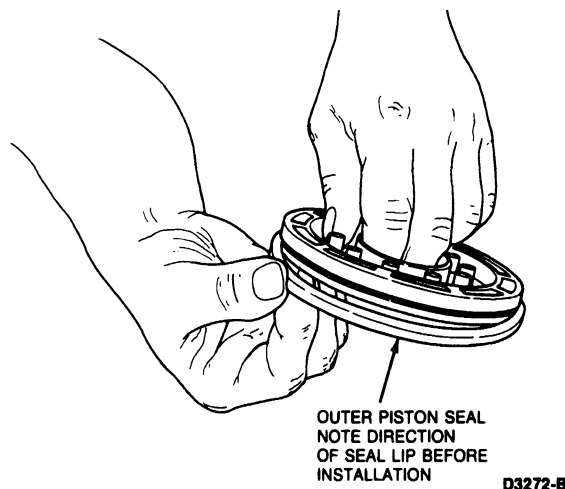
1. Install inner piston seal on clutch cylinder hub as follows:

NOTE: Lubricate seal and seal protector with petroleum jelly.

- a. Position Direct Clutch Lip Seal Protector T80L-77234-A over clutch cylinder hub.
- b. Position seal over installer tool with the sealing lip facing down.



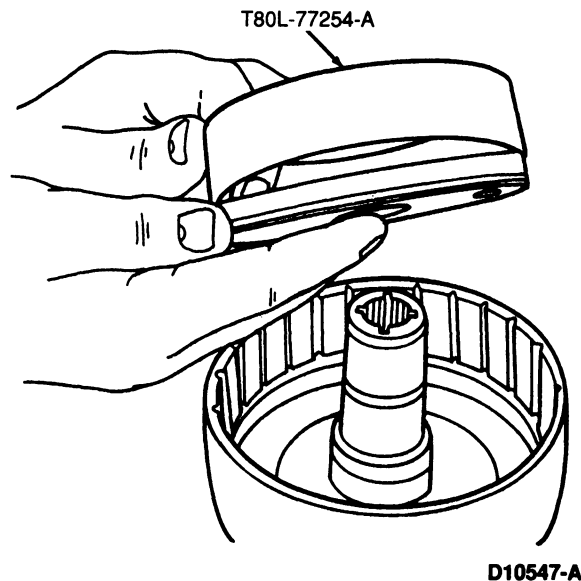
2. Install clutch piston outer seal. Note direction of sealing lip before installation. The lip should point toward bottom of cylinder.



3. Install clutch piston as follows:

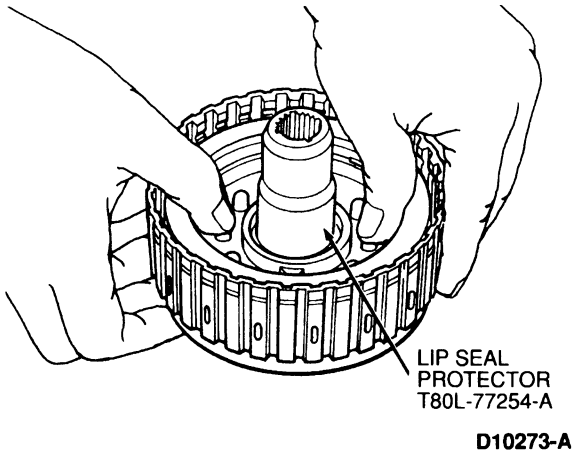
NOTE: Coat inner and outer piston seals, clutch cylinder sealing area and piston inner sealing area with petroleum jelly.

- a. Install piston in Lip Seal Protector T80L-77254-A.

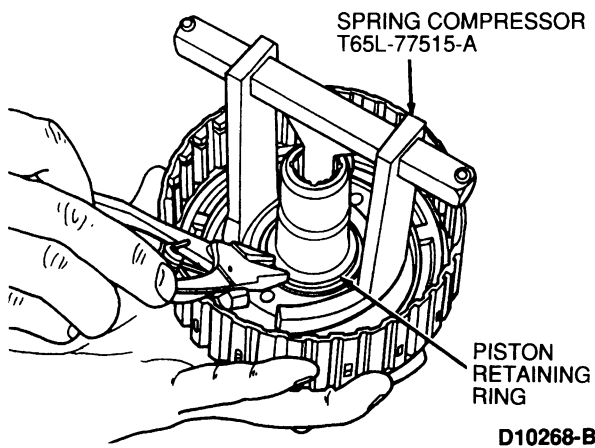


DISASSEMBLY AND ASSEMBLY (Continued)

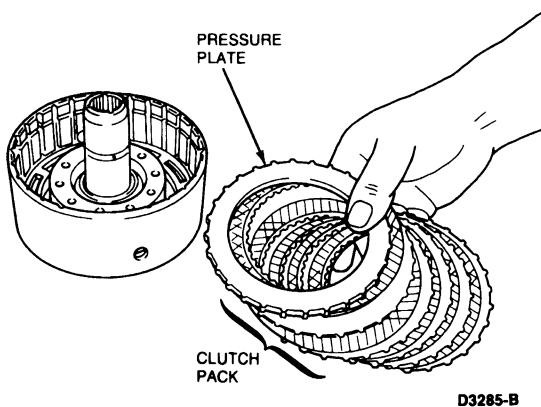
- b. Position tool in the clutch drum and push the piston to the bottom of the drum using even thumb pressure.



4. Install piston spring, retainer assembly and retaining ring using Spring Compressor T65L-77515-A.

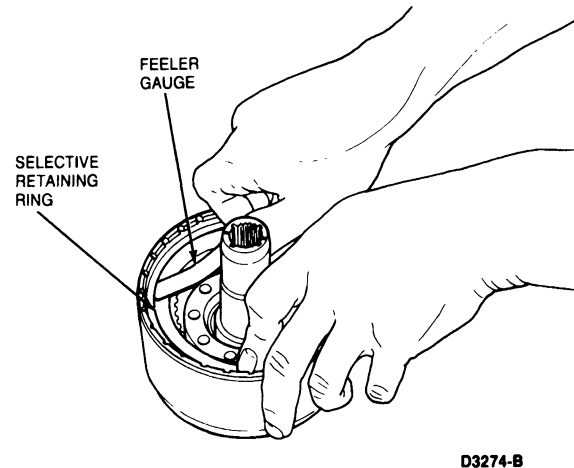


5. Install clutch pack.



6. With retaining ring installed, check clearance between ring and pressure plate using a feeler gauge.

Pressure plate should be held downward as the clearance is checked.



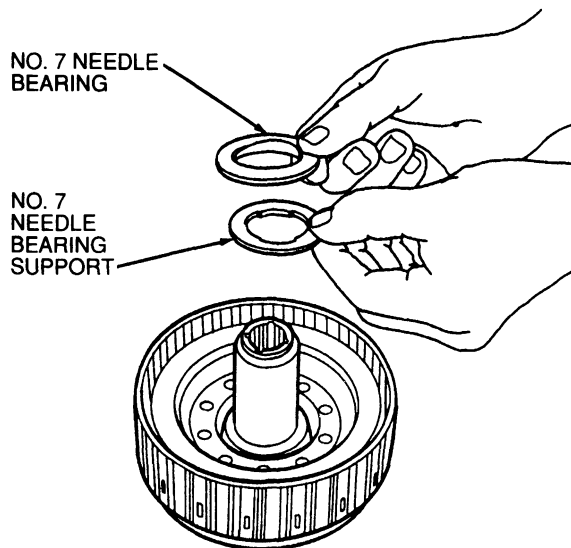
7. The clearance should be:

- Six Plate 1.52-2.33mm (0.060-0.091 inch).
- If the clearance is not within limits, install the correct size snap ring and check the clearance. Selective snap rings are available in the following thicknesses:

Selective Snap Rings
1.27-1.37mm (0.050-0.054 inch)
1.62-1.72mm (0.064-0.068 inch)
1.98-2.08mm (0.078-0.082 inch)
2.33-2.43mm (0.092-0.096 inch)

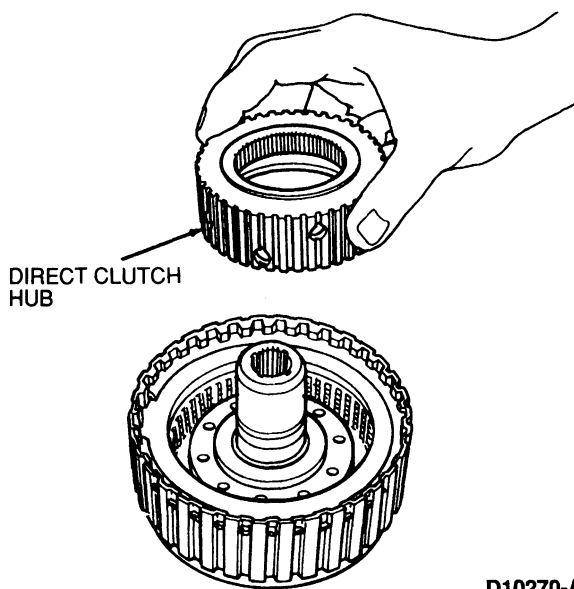
DISASSEMBLY AND ASSEMBLY (Continued)

8. Install No. 7 needle bearing support and No. 7 needle bearing (black side up toward direct clutch hub).



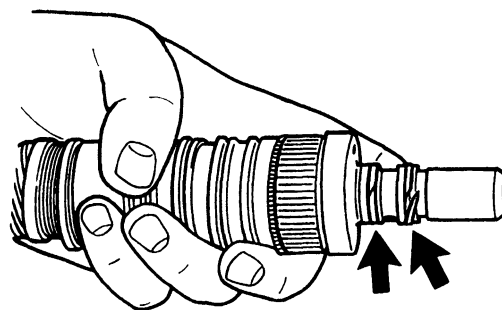
D10271-A

9. Install direct clutch hub.



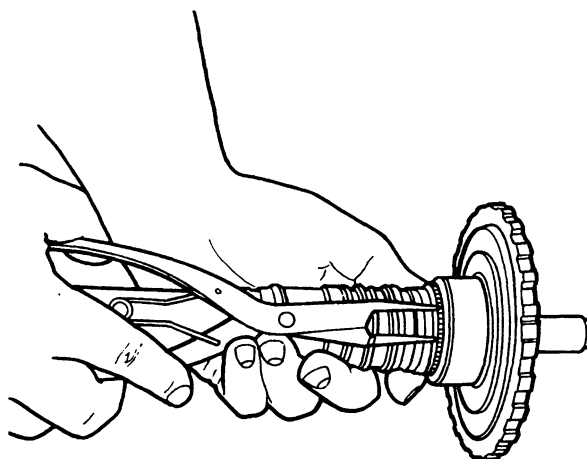
D10270-A

10. Install two direct clutch seal rings. Ensure seals are properly lapped.



D10548-A

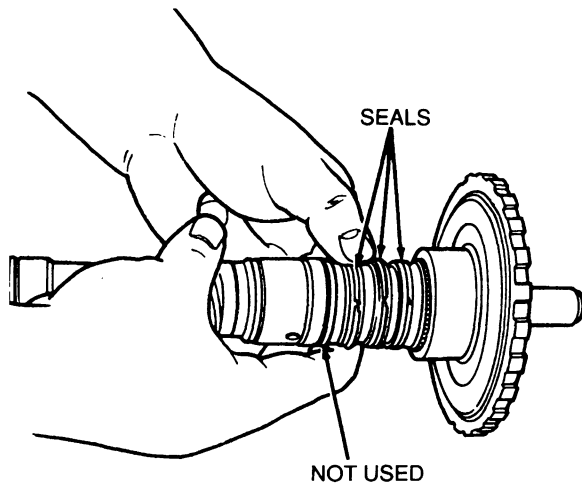
11. Install output shaft hub. Install retaining ring.



D10549-A

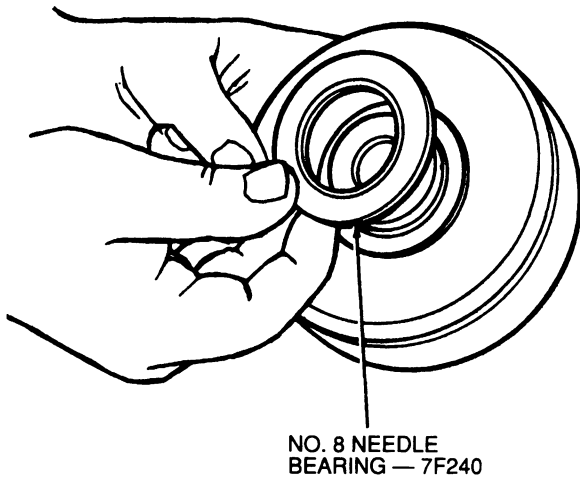
DISASSEMBLY AND ASSEMBLY (Continued)

12. Install three output shaft seal rings and output shaft O-ring.



D10550-A

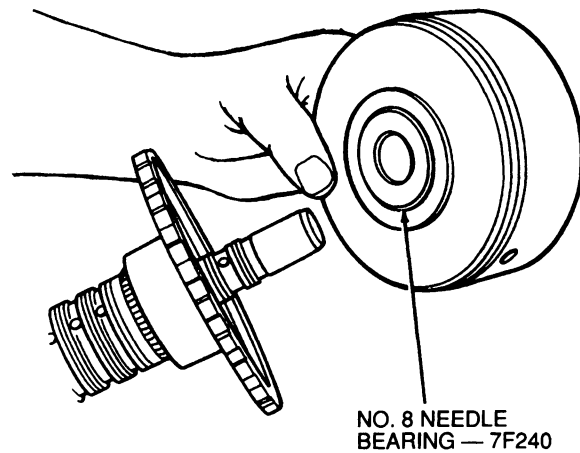
13. Install No. 8 needle bearing on direct clutch cylinder.



D10551-A

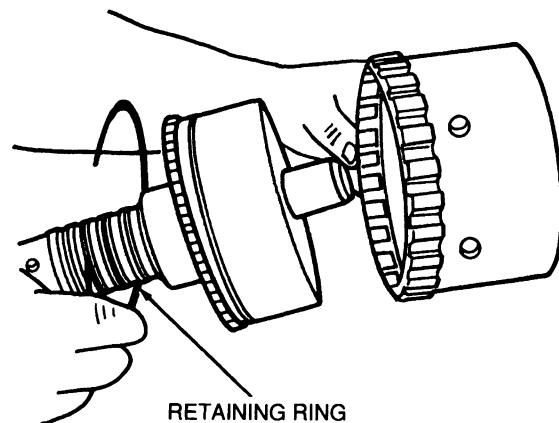
14. Install direct clutch on output shaft.

NOTE: Make sure seals are lapped properly.



D10552-A

15. Install ring gear and retaining ring on output shaft.

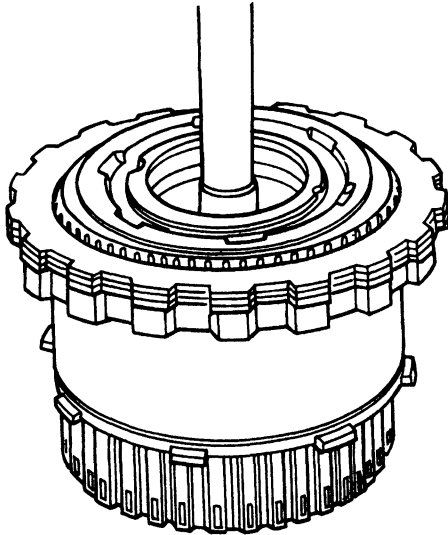


D10553-A

DISASSEMBLY AND ASSEMBLY (Continued)

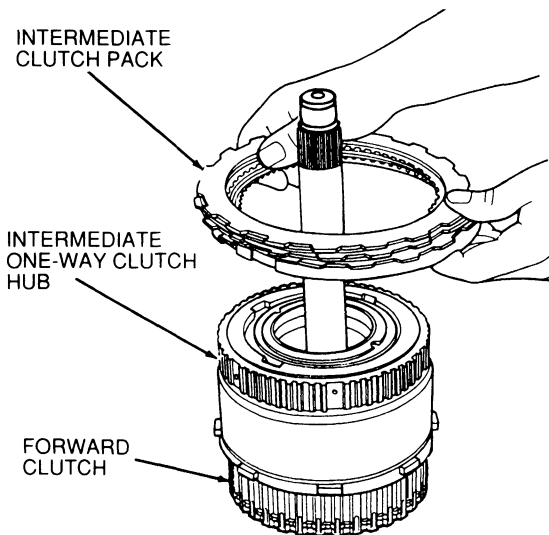
16. Install following components as an assembly:

- Intermediate clutch pack
- Intermediate one-way clutch
- Reverse clutch
- Forward clutch



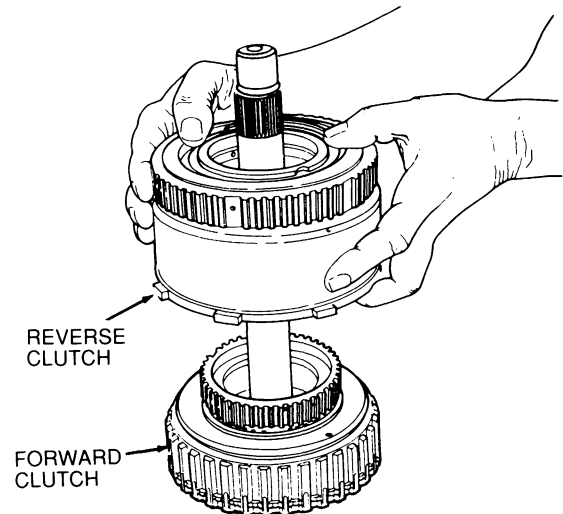
D10554-A

17. Install intermediate clutch pack on intermediate one-way clutch hub.



D11485-A

18. Install reverse clutch assembly on forward clutch assembly.



D11484-A

Transmission**Tools Required:**

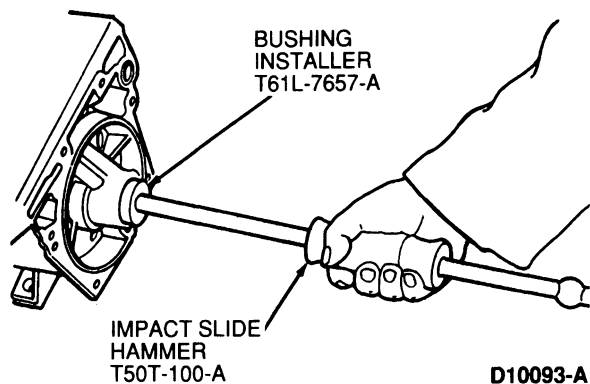
- Bushing Installer T61L-7657-A
- Impact Slide Hammer T50T-100-A
- Servo Piston Remover / Replacer Tool T92P-70023-A
- Depth Micrometer D80P-4201-A
- Gauge Bar T80L-77003-A
- Shift Lever Seal Replacer T74P-77498-A
- Servo Piston Remover / Replacer T92P-70023-A
- Gear Piston Sensor Adjuster T91P-70010-A

Assembly

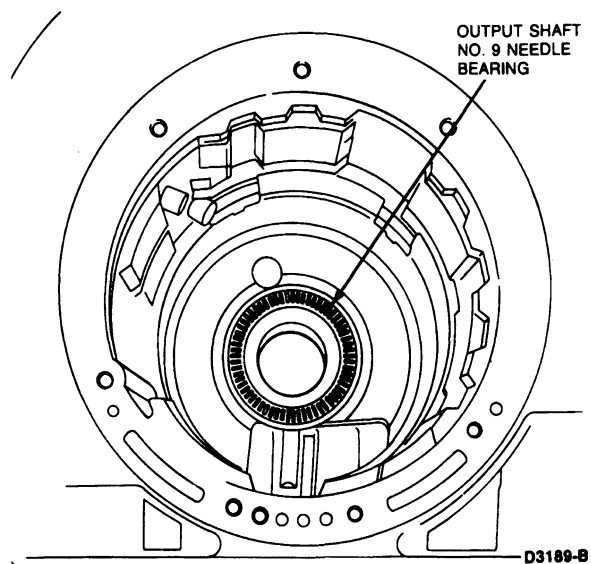
1. If output shaft bushing was removed, position replacement bushing on Bushing Installer T61L-7657-A and install in bushing bore through the front of the case.

DISASSEMBLY AND ASSEMBLY (Continued)

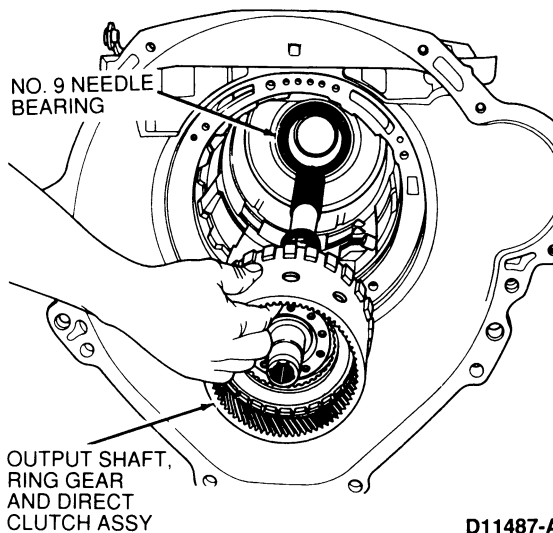
2. Thread Impact Slide Hammer T50T-100-A into bushing installer through the back of the case. Install the bushing.



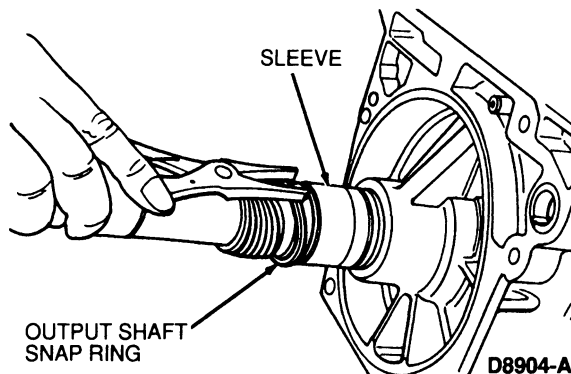
3. With transmission in the vertical position, coat bearing with petroleum jelly and install the No. 9 needle bearing on the transmission case boss.



4. Install output shaft, ring gear and direct clutch as an assembly.

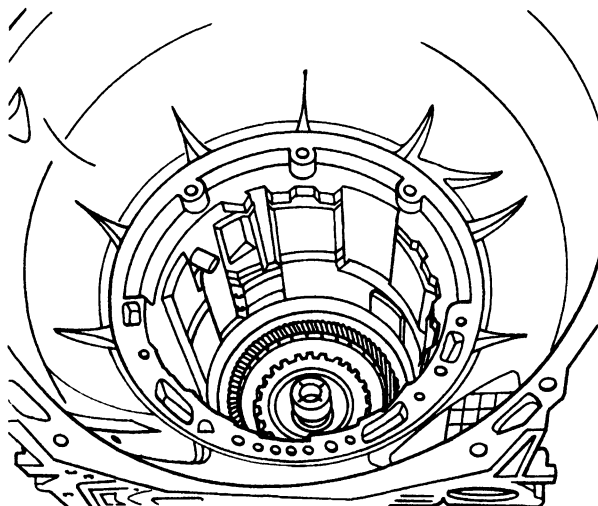


5. Install output shaft retaining snap ring.



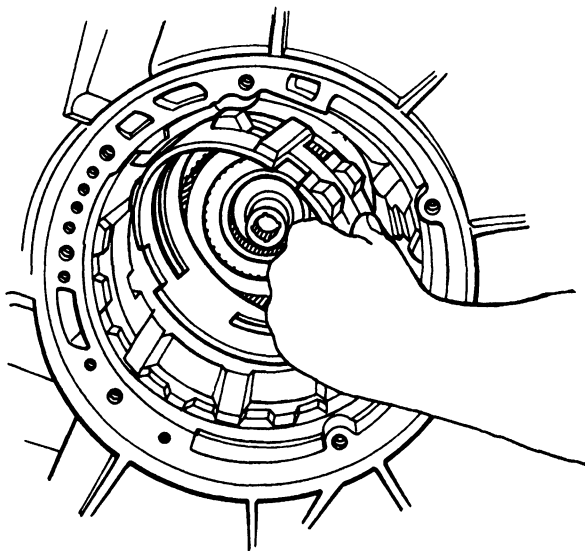
DISASSEMBLY AND ASSEMBLY (Continued)

6. Install retaining ring that supports low / reverse band.



D10562-A

7. Install the low / reverse band. Ensure band is seated on anchor pins.



D10162-A

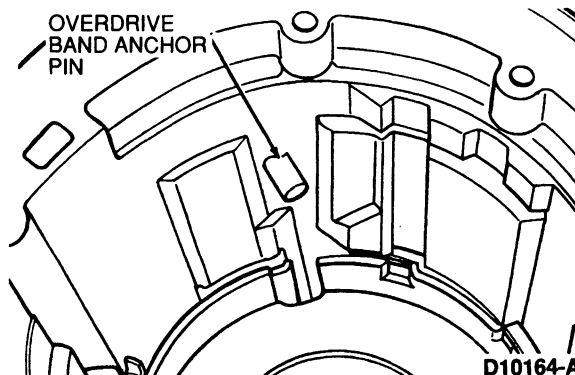
NOTE: Planet carrier and center support assembly cannot be installed unless the notch cut in the center support is aligned with the overdrive band anchor pin. Top of center support should be below snap ring groove.

8. Install planetary assembly and center support as a unit.

Align notch in center support with overdrive band anchor pin.

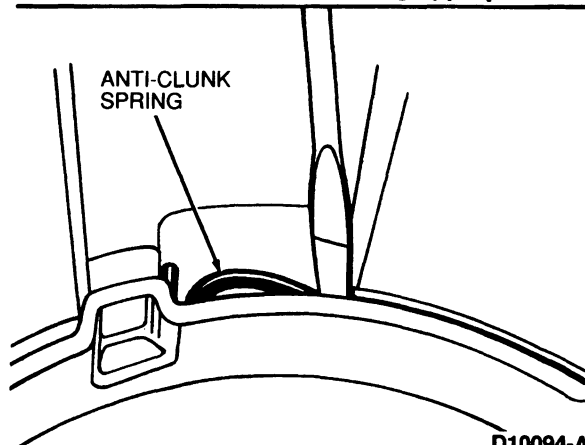
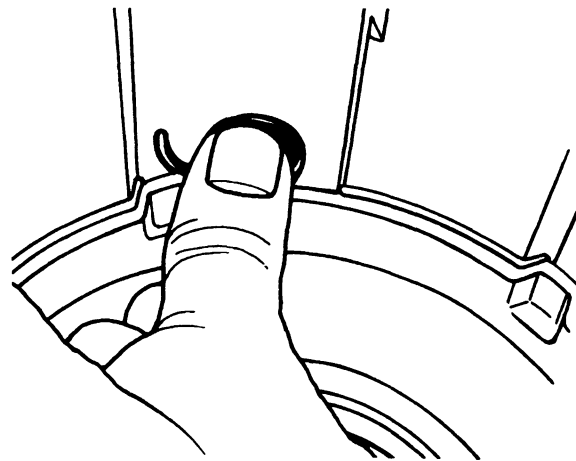
Rotate the output shaft, if necessary, to align the planet carrier splines with the direct clutch hub splines.

NOTE: Planet carrier and center support cannot be installed unless notch cut in center support is aligned with overdrive band anchor pin.



D10164-A

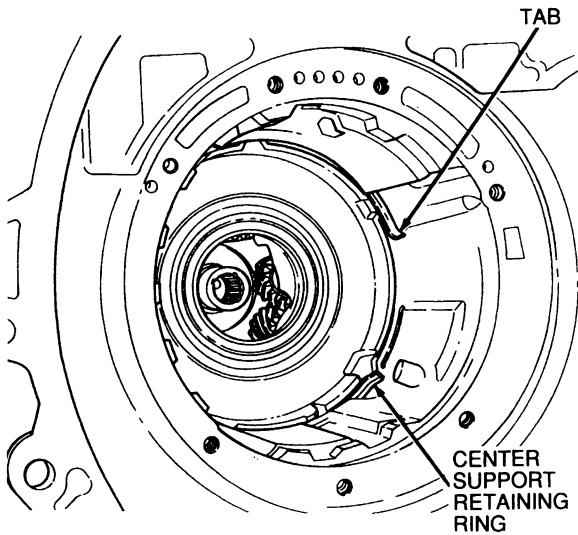
9. Install the center support anti-clunk spring using a screwdriver to position spring.



D10094-A

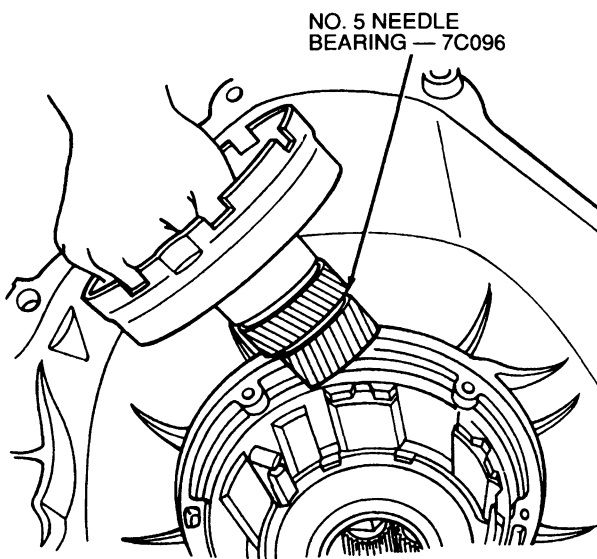
DISASSEMBLY AND ASSEMBLY (Continued)

10. Install center support retaining ring. Reference snap ring end tab to anchor pin location.



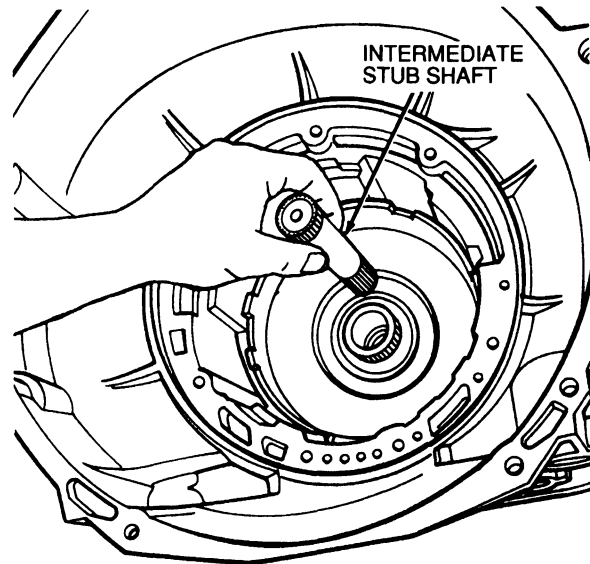
D3180-C

11. Install forward sun gear, No. 5 needle bearing drive shell and No. 4 needle bearing.



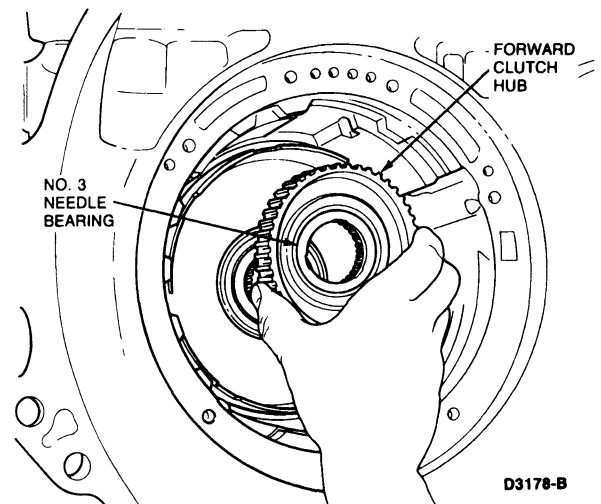
D10563-A

12. Install intermediate stub shaft.



D10259-A

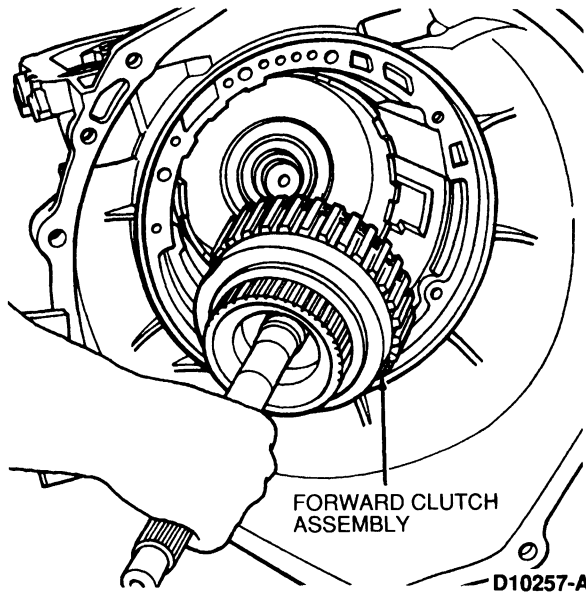
13. Install forward clutch hub and No. 3 needle bearing.



D3178-B

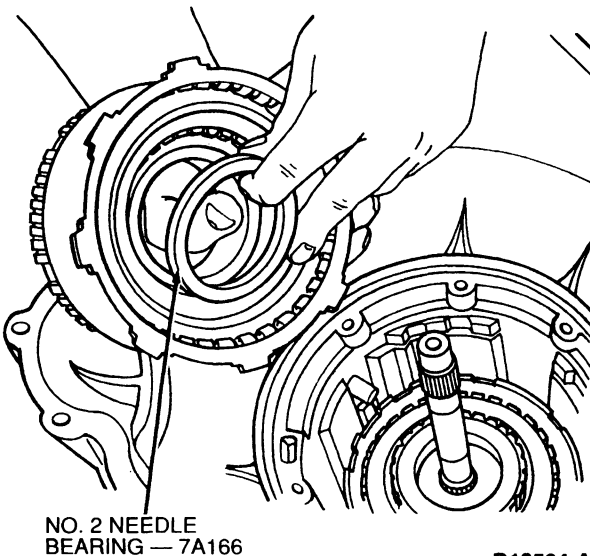
DISASSEMBLY AND ASSEMBLY (Continued)

14. Install forward clutch assembly.



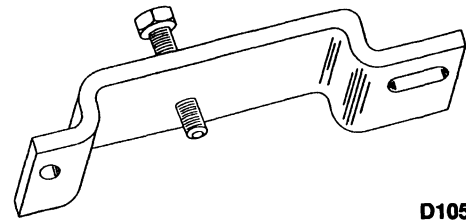
15. Install reverse clutch cylinder assembly.

NOTE: Wiggle the input shaft while engaging the reverse clutch splines. Make sure the reverse clutch cylinder lugs are completely seated in the notches of the reverse sun gear and drive shell.

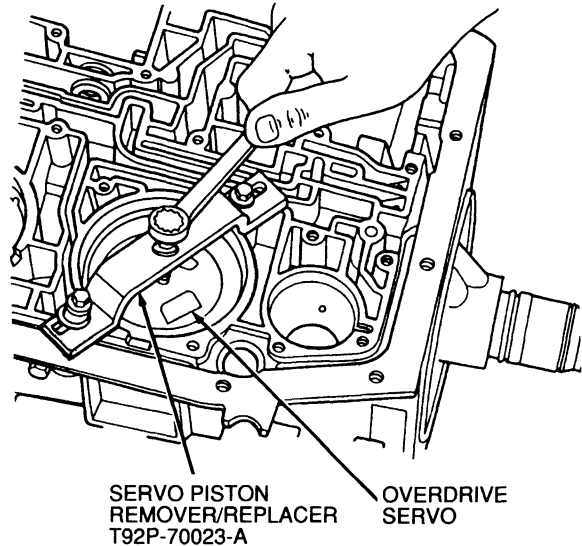


NO. 2 NEEDLE BEARING — 7A166

16. Install overdrive band over reverse clutch assembly and position the pocket of the band against anchor pin. Install overdrive servo return spring and overdrive servo piston assembly. Verify tip of piston assembly engages the pocket of overdrive band. Using Servo Piston Remover / Replacer Tool T92P-70023-A. Install piston assembly into the case and compress return spring.

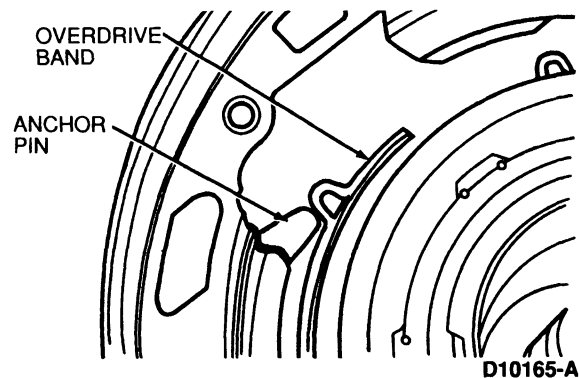


D10507-A



D10258-A

17. Make sure band anchor and tip of the piston assembly are properly positioned against band pockets. Tighten tool forcing screw until piston is below snap ring groove and install snap ring, remove tool.



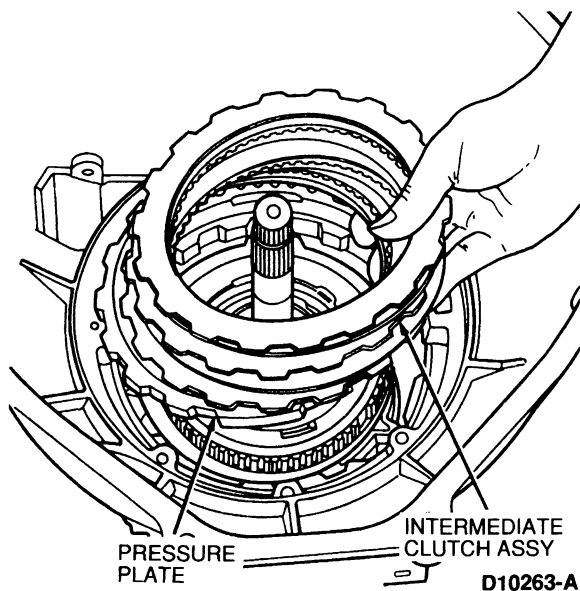
D10165-A

18. Install intermediate clutch as follows:

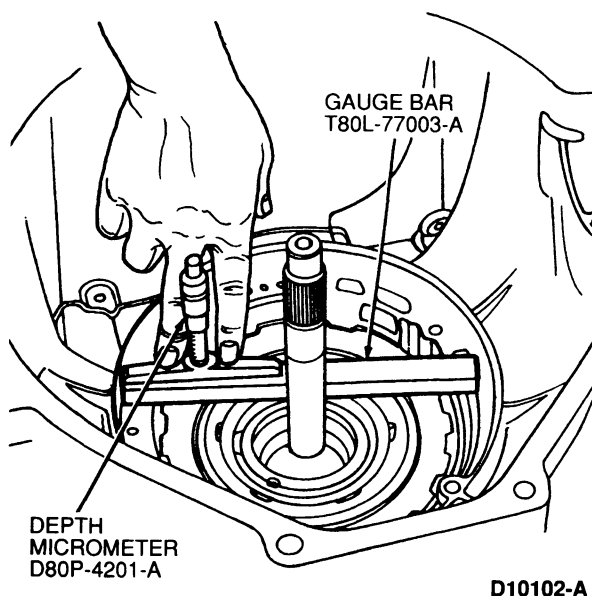
- Pressure plate is the thickest. Install this first with chamfer side down.
- Clutch plates.

DISASSEMBLY AND ASSEMBLY (Continued)

- c. Perform Intermediate Clutch Selective Steel intermediate clutch plate procedure.

**Intermediate Clutch Selective Steel Plate Procedure**

19. With proper intermediate plates selected and installed, perform end clearance check for No. 7 thrust washer using the same tools.



NOTE: Maintain downward pressure on clutch pack while measuring depth.

20. Measure the intermediate clutch clearance using Depth Micrometer D80P-4201-A or equivalent and Gauge Bar T80L-77003-A.

Set the gauge bar across the pump case mounting surfaces. The depth at the intermediate clutch separator plate is:

- 41.5-41.8mm (1.634-1.636 inch)

Check the clearance again 180 degrees opposite to ensure the average depth is within tolerance.

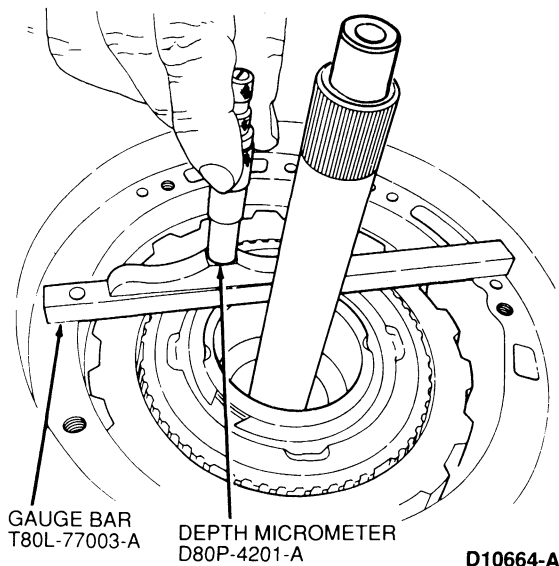
If the depth is not within tolerance, the following size selective steel plates are available:

- 1.80-1.7mm (0.071-0.067 inch)
- 2.05-1.95mm (0.081-0.077 inch)
- 2.31-2.20mm (0.091-0.087 inch)
- 2.56-2.46mm (0.101-0.097 inch)

Install correct plate and check clearance.

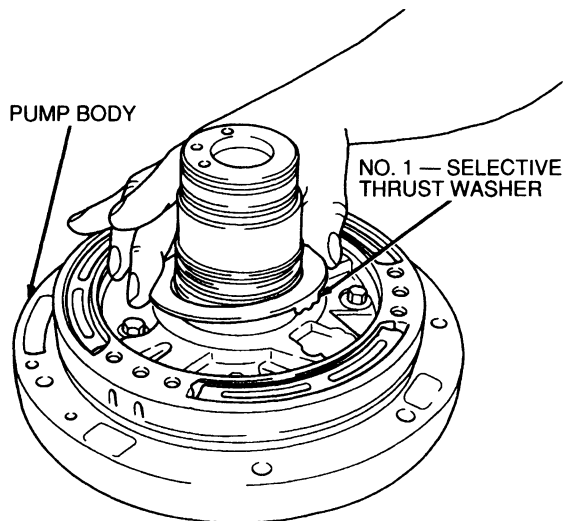
Transmission Selective Thrust Washer Procedure

21. Position the Depth Micrometer D80P-4201-A or equivalent on Gauge Bar T80L-77003-A so that the depth is measured at the reverse clutch drum thrust face. Check the end play 180 degrees opposite to determine the average depth.



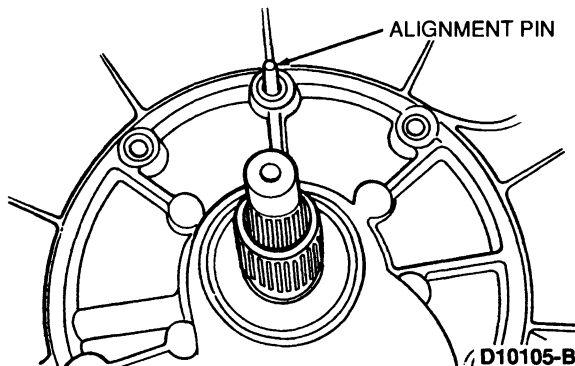
DISASSEMBLY AND ASSEMBLY (Continued)

22. Install No. 1 selected thrust washer on pump body using petroleum jelly to hold in place.

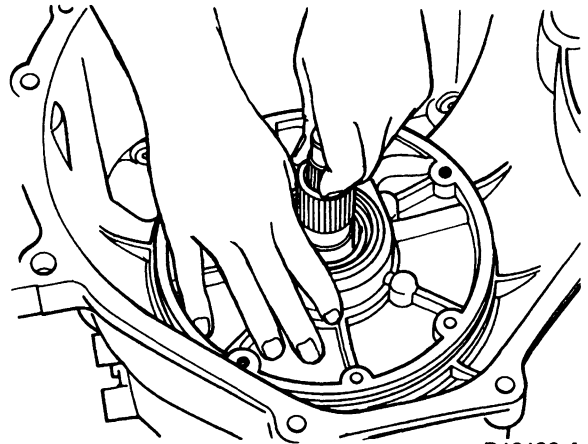


D3833-C

23. Install pump-to-case gasket. Make sure gasket is positioned and case passages are covered.
24. To maintain pump-to-case alignment, use a fabricated M8-1.25mm bolt (head removed) as a guide. Install in the 12 o'clock position using petroleum jelly on pump-to-case seal surfaces to aid pump installation.



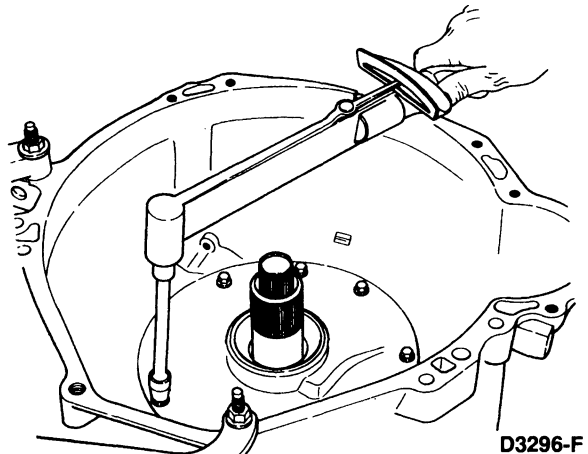
25. To aid assembly, grasp turbine shaft and wiggle shaft while pressing down on pump.



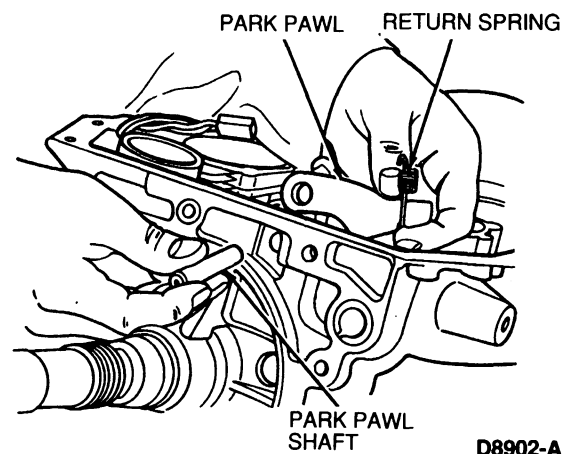
D10106-A

26. Remove alignment bolt and install pump-to-case bolts. Alternate bolt tightening to "draw" the pump fully into the case. Tighten to 20-26 N·m (15-19 lb-ft).

Place transmission in the horizontal position.



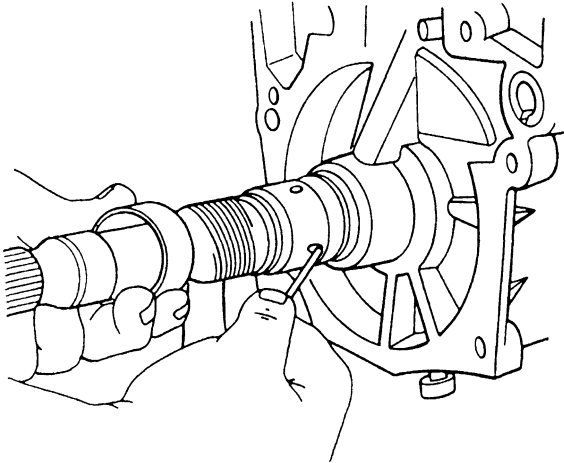
27. Install park pawl and return spring. Slide shaft into case through pawl.



DISASSEMBLY AND ASSEMBLY (Continued)

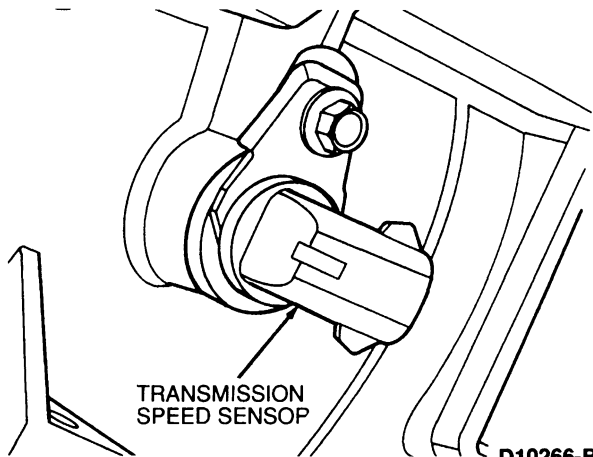
NOTE: Block pin must go in hole on the right when looking from the rear, with two holes up.

28. Install block pin and governor sleeve.



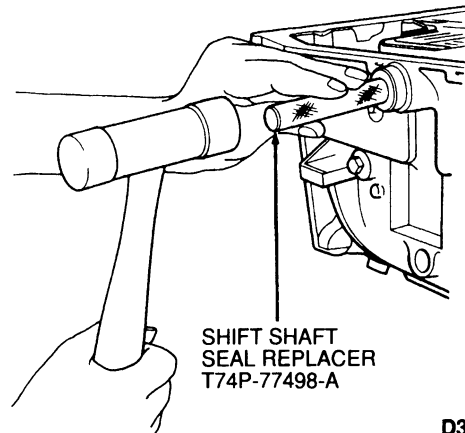
D10543-A

29. Install transmission speed sensor (TSS). Tighten bolt to 7-10 N·m (62-88 lb-in).



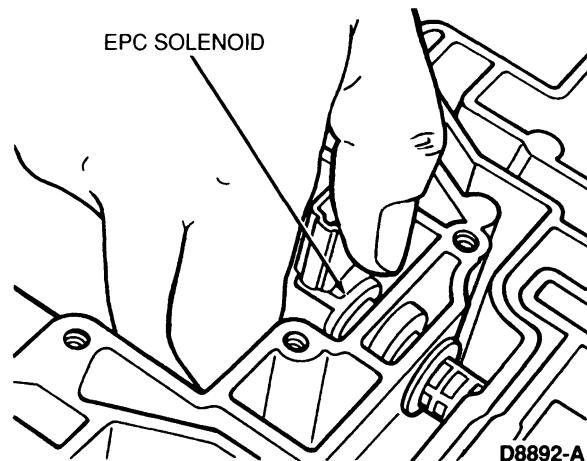
D10266-B

30. Install manual lever seal using Shift Lever Seal Replacer T74P-77498-A.



D3258-D

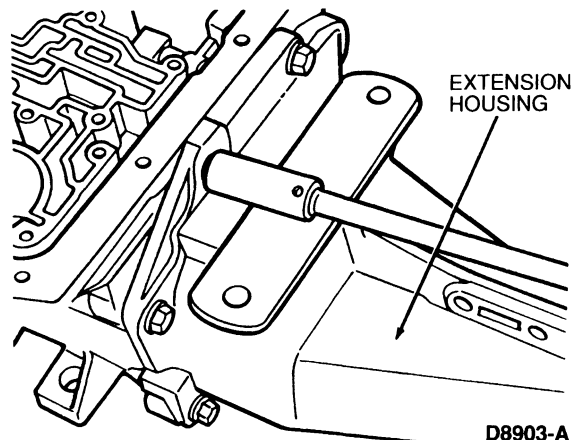
31. Install EPC.



D8892-A

32. Install new extension housing gasket and extension housing. Tighten bolts to 25-30 N·m (18-22 lb-ft).

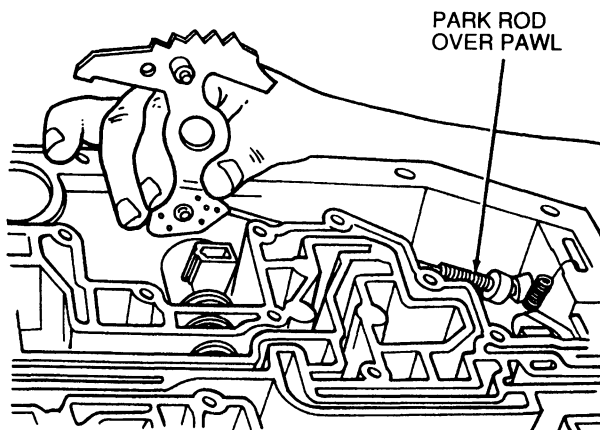
33. Install extension housing output shaft seal.



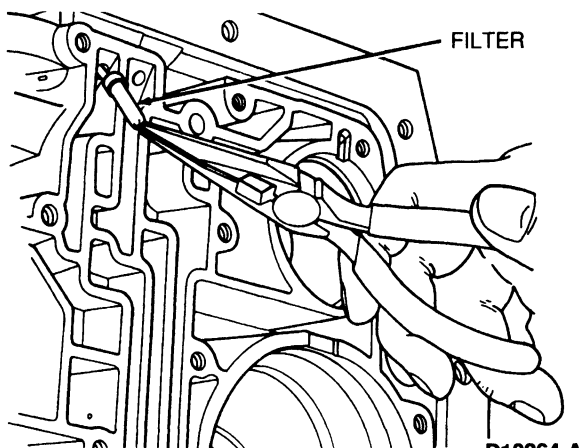
D8903-A

DISASSEMBLY AND ASSEMBLY (Continued)

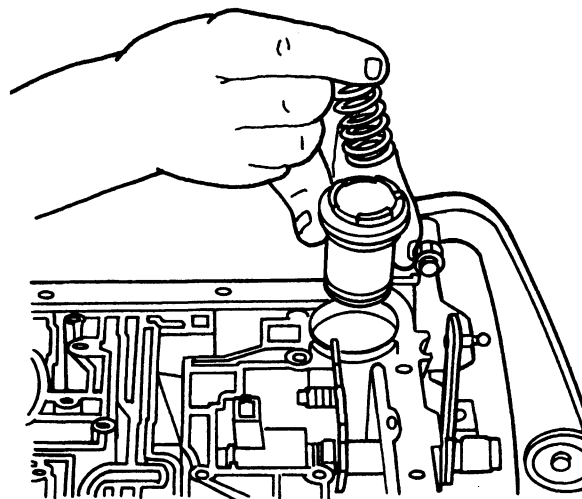
34. Position detent and park rod assembly into case. Park rod must be positioned over pawl.

**D10568-A**

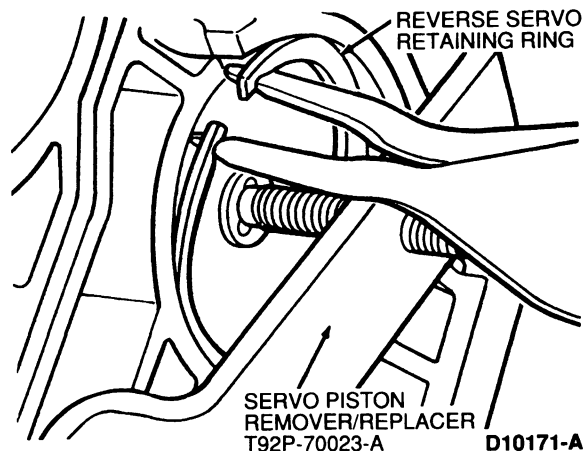
35. Slide manual lever into case and position through detent. Install nut and tighten to 26-37 N·m (20-27 lb·ft).
 36. Install tapered roll pin.
 37. Install filter into case (head first).

**D10264-A**

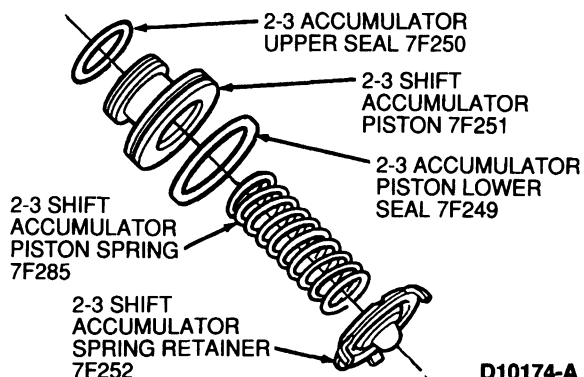
38. Install reverse band spring, piston and rod assembly, cover and snap ring.

**D10569-A**

39. Tighten screw on Servo Piston Remover/Replacer T92P-70023-A to allow enough clearance to install snap ring.

**D10171-A**

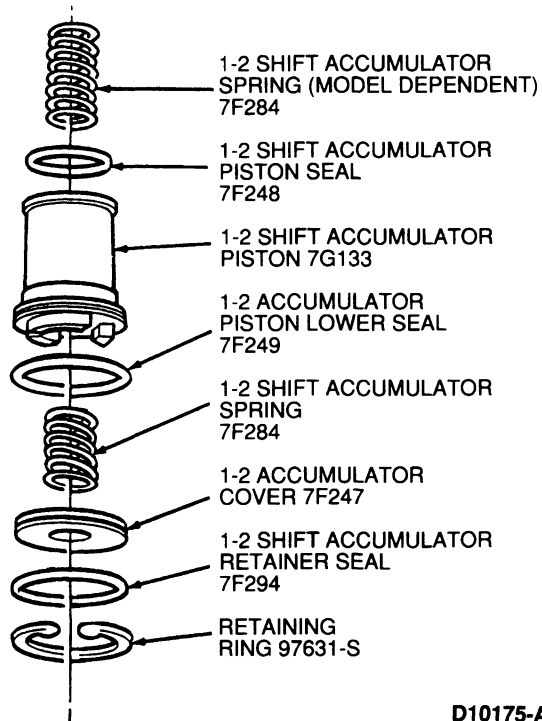
40. Install new piston O-ring seals on 2-3 accumulator and 1-2 accumulator. Install 2-3 accumulator.

**D10174-A**

DISASSEMBLY AND ASSEMBLY (Continued)

41. Install the following components:

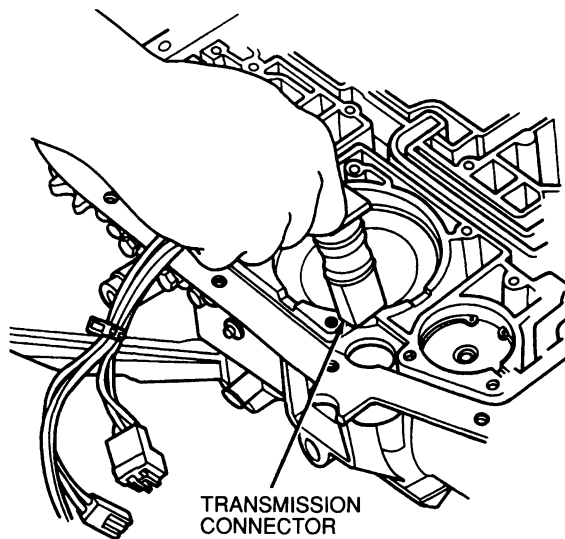
- Large spring
- New piston O-ring seals
- Piston
- Small spring
- Cover with new seals
- 1-2 accumulator



D10175-A

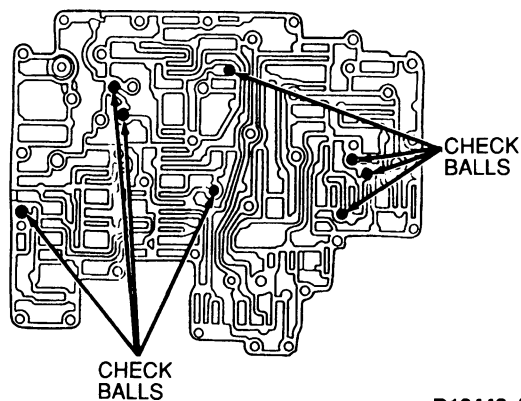
42. Align and install wire harness into case. Inspect O-ring and replace if required.

NOTE: Tab on connector is secured by main control.



D10261-A

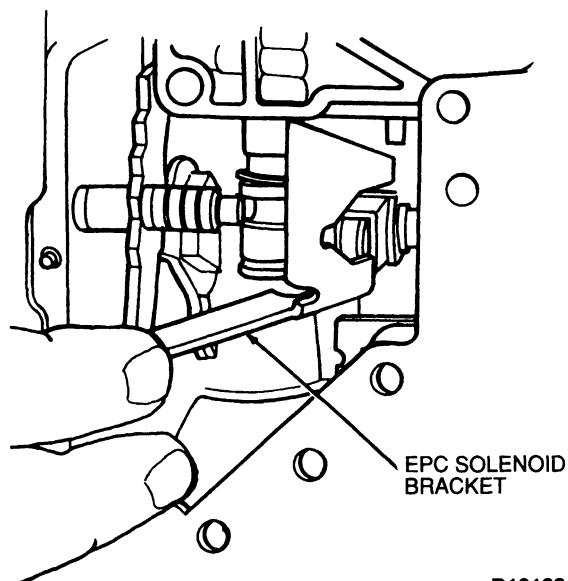
43. Position main control using the two alignment bolts as a guide. Ensure main control check balls are in the correct locations.



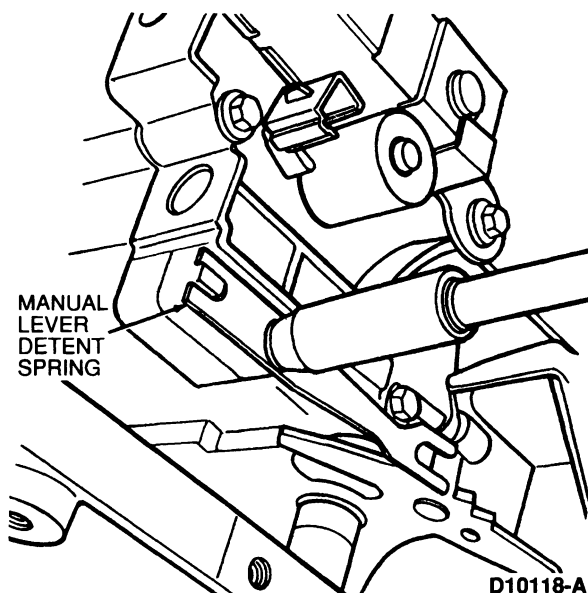
D10448-A

DISASSEMBLY AND ASSEMBLY (Continued)

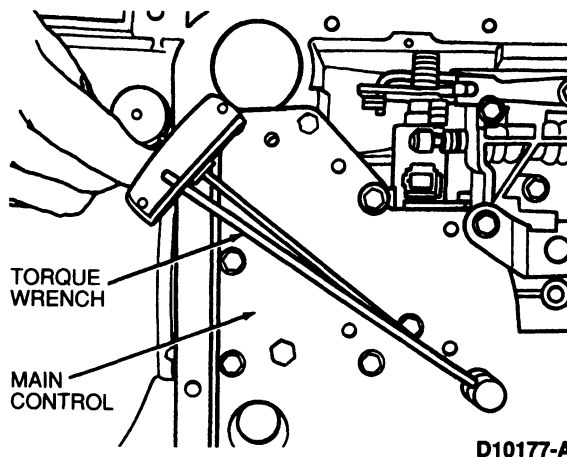
44. Install the EPC solenoid bracket. Loosely install one long 6mm bolt.



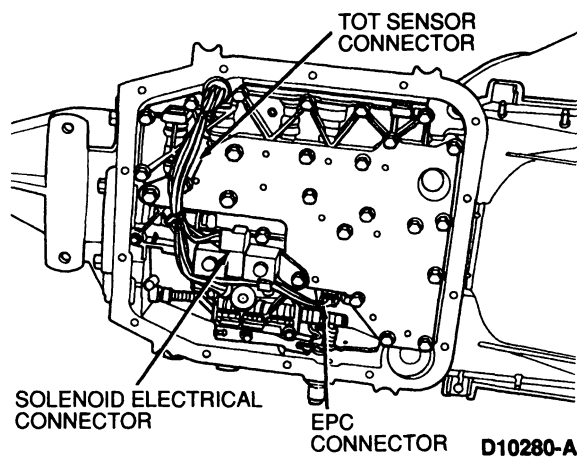
45. Loosely install 11 long and 12 short bolts.
46. Install detent spring and roller and one short 8mm bolt.



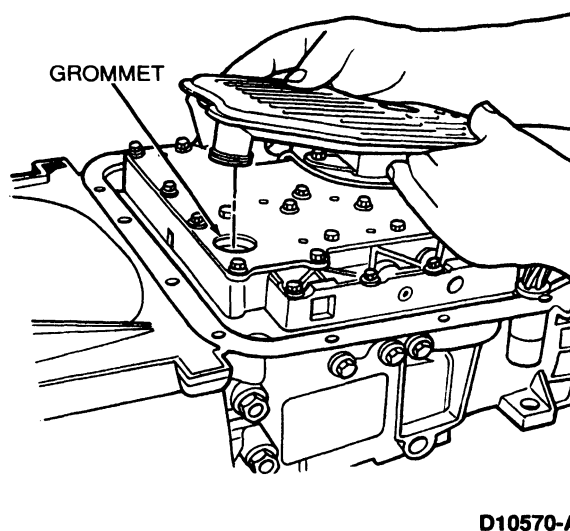
47. Tighten main control bolts to 9-11 N·m (80-100 lb-in).



48. Connect wiring harness.

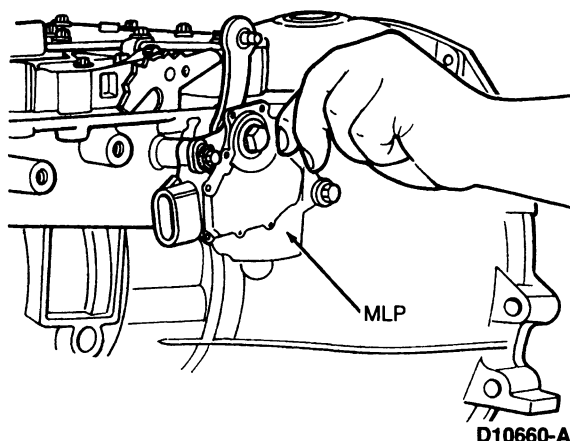


49. Install new filter and grommet.



DISASSEMBLY AND ASSEMBLY (Continued)

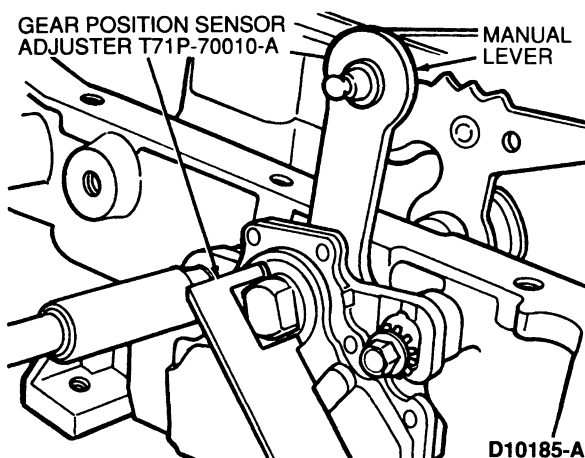
50. Install MLP sensor on manual lever and loosely install bolts.



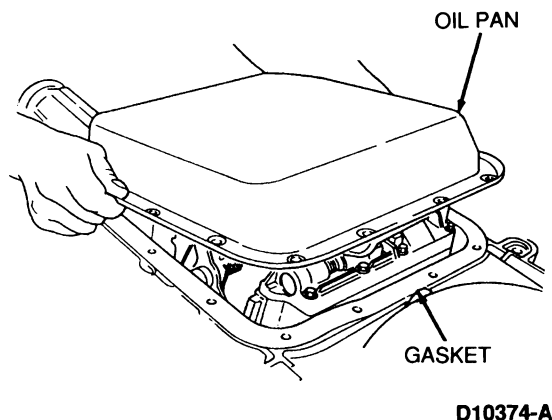
51. Position manual lever in NEUTRAL.

NOTE: PARK is the last detent when the manual lever is full forward. Return two detents toward output shaft for NEUTRAL.

Install MLP sensor adjustment tool. Insert Gear Position Sensor Adjuster T91P-70010-A into slots. Align all three slots on MLP sensor with three tabs on tool.



52. Tighten MLP sensor bolts to 9-11 N·m (80-100 lb-in).
53. Install new pan gasket and oil pan. Tighten all bolts to 9-11 N·m (80-100 lb-in).

**INSTALLATION****Transmission****Installation**

1. Tighten converter drain plug to 11-38 N·m (8-28 lb-ft).
 2. Position the converter on the transmission, making sure the converter drive flats are fully engaged in the pump gear by rotating the converter.
- NOTE:** Lube pilot with chassis grease.
3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with a chain.
 4. Rotate the converter until the studs and drain plug are in alignment with the holes in the flywheel.
 5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot. The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft.

6. Install and tighten the converter housing-to-engine attaching bolts to specification.

NOTE: Before installing the torque converter to flywheel nuts, check to make sure that the converter is properly seated. The converter should move freely with respect to the flywheel. Grasp the stud. Movement back and forth should result in a metallic clank noise if the converter is properly seated. If the converter will not move, the transmission must be removed and the converter repositioned so that the impeller hub is properly engaged in the pump gear.

7. Remove the safety chain from around the transmission.

INSTALLATION (Continued)

8. Install a new O-ring on the lower end of the transmission filler tube and lube the O-ring with transmission fluid. Insert the tube in the transmission case and secure the tube to the engine with the attaching bolt(s).
9. Connect the oil cooler lines to the right side of transmission case.
10. Secure the engine rear support to the extension housing and tighten the bolts to 82-108 N-m (60-80 lb-ft).
11. Position the crossmember on the side supports. Position the rear mount on the crossmember and install the attaching bolt and nut.
12. Lower the transmission and remove the jack.
13. Secure the crossmember to the side supports with the bolts and tighten them to specification.
14. Position the bellcrank to the converter housing and install the attaching bolt.
15. Connect the manual shift cable to the manual lever at the transmission.
16. Secure the converter-to-flywheel nuts and tighten them to specification.
17. Install the converter housing access cover.
18. Secure the starter motor in place with the bolts. Connect the cable to the terminal on the starter. Connect the park / neutral position switch wires at the plug connector.

NOTE: Lubricate the driveshaft yoke splines with Premium Long-Life Grease XG-1-C or -K or equivalent.
19. Install the driveshaft so the index marks on the companion flange and rear yoke made during removal are aligned.
20. Adjust the shift cable as required. Refer to Section 07-05.
21. Adjust throttle linkage per the procedure outlined in the beginning of this section.
22. Lower the vehicle.
23. Fill the transmission to the correct level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C166-H). Connect the battery negative cable. Start the engine and shift the transmission to all ranges, then check the fluid level.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the PCM relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

CLEANING AND INSPECTION**Transmission**

Clean all parts with suitable solvent and use moisture-free air to dry off all parts and clean out fluid passages.

NOTE: The composition clutch plates, bands and synthetic seals should not be cleaned in a vapor degreaser or with any type of detergent solution.

To clean these parts, wipe them off with a lint-free cloth. New clutch plates or bands should be soaked in the specified transmission fluid for 15 minutes before being assembled.

Valve Bodies

1. Clean all parts, except non-metallic check balls, thoroughly in clean solvent and blow dry with moisture-free compressed air.
2. Inspect all valve and plunger bores for scores. Check all fluid passages for obstructions. Inspect all mating surfaces for burrs and scores.

NOTE: If necessary, use crocus cloth to polish valves and plungers. Avoid rounding sharp edges of valves and plungers with crocus cloth.
3. Inspect all springs for distortion. Check all valves and plungers for free movement in their respective bores. Valves and plungers, when dry, must fall from their own weight in their respective bores.
4. Roll manual valve on a flat surface to check for bent condition.

Forward, Direct, Intermediate, Overdrive, Coast and Reverse Clutches

1. Inspect clutch cylinder thrust surfaces, piston bore and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace clutch cylinder if badly scored or damaged.
2. Check fluid passage in clutch cylinder for obstructions. Clean out all fluid passages. Inspect clutch piston for scores and replace if necessary. Inspect check balls for freedom of movement and proper seating.
3. Check clutch release spring for distortion and cracks. Replace spring (including wave spring) if distorted or cracked.
4. Inspect composition clutch plates, steel clutch plates and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored or burred.
5. Check clutch plates for flatness and fit on clutch hub serrations. Discard any plate that does not slide freely on serrations or that is not flat.
6. Check clutch hub thrust surfaces for scores and clutch hub splines for wear.

Output Shaft

1. Inspect output shaft bearing surfaces for scores. If excessive clearance or scores are found, replace shaft and inspect components.

CLEANING AND INSPECTION (Continued)

2. Check splines on output shaft for wear; replace shaft if splines are excessively worn. Inspect all bushings.

Electrical Connectors

Anytime an electrical connector is disconnected, inspect the connector for terminal condition, corrosion and contamination. Also inspect the connector seal for damage. Clean, service or replace as required.

One-Way Clutches

1. Inspect outer and inner races for scores or damaged surface areas where rollers or sprags contact races.
2. Inspect rollers, sprags and springs for excessive wear or damage.
3. Inspect spring and cage for bent or damaged spring retainers.

Case

Inspect case for cracks and stripped threads. Inspect gasket surfaces and mating surfaces for burrs. Check vent for obstruction, and check all fluid passages for obstructions and leakage.

Inspect case bushing for scores. Check all parking linkage parts for wear or damage.

Planet Assemblies

NOTE: Individual parts of the planet assemblies are not serviceable.

1. Pins and shafts in planet assemblies should be checked for loose fit and / or complete disengagement. Use new planet assembly if either condition exists.
2. Inspect pinion gears for damaged or excessively worn teeth.
3. Check for free rotation of pinion gears.

Thrust Bearings

Wash thrust bearings thoroughly in cleaning solvent. Blow bearings dry with compressed air.

Make certain bearings are clean and then lubricate with transmission fluid. Replace any bearings and races which show signs of pitting or roughness.

Oil Cooler Tube Leakage

When fluid leakage is found at the oil cooler, the cooler must be replaced.

When one or more of the fluid cooler steel tubes must be replaced, each replacement tube must be fabricated from the same size steel tubing as the original line.

Using the old tube as a guide, bend the new tube as required. Add the necessary fittings and install the tube.

After the fittings have been tightened, add fluid as necessary and check for fluid leaks.

Converter and Oil Cooler

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and must be removed from the system before the transmission is put back into service.

Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the converter and oil cooler must be cleaned by using a mechanically agitated cleaner, such as Rotunda Torque Converter and Oil Cooler Cleaner 014-00028 or equivalent.

Flush the converter of the remaining solvent using this procedure:

1. Thoroughly drain the remaining solvent through the drain plug.
2. Add 1.9L (2 qt) of clean transmission fluid to the converter. Agitate by hand.
3. Thoroughly drain the solution through the drain plug.

Transmission Fluid Drain and Refill

Normal maintenance and lubrication requirements do not necessitate periodic automatic transmission fluid changes. If a major service, such as a clutch, band, bearing, etc., is required in the transmission, it will have to be removed for service. At this time, the converter, transmission cooler and cooler lines must be thoroughly flushed to remove any dirt. When used under continuous or severe conditions, the transmission and torque converter should be drained and refilled with fluid as specified.

CAUTION: Use of a fluid other than specified could result in transmission malfunction and/or failure.

Refer to the Vehicle Certification Label affixed to the LH front door lock face panel or door pillar for the transmission code.

When filling a dry transmission and converter, refer to Specifications for capacity. Check the fluid level.

Procedures for partial drain and refill, due to in-vehicle service operation, are as follows:

1. Raise vehicle on a hoist or jackstands. Refer to Section 00-02.
2. Place drain pan under transmission.
3. Loosen oil pan retaining bolts and drain fluid from transmission.
4. When fluid has drained to level of pan flange, remove rest of pan bolts working from the RH side, and allow it to drop and drain slowly.
5. When all fluid has drained from transmission, remove and thoroughly clean pan. Discard gasket.
6. Place a new gasket on pan, and install pan on transmission.
7. Lower vehicle.

CLEANING AND INSPECTION (Continued)

8. Fill transmission to proper level with Motorcraft
MERCON ® Multi-Purpose Automatic
Transmission Fluid XT-2-QDX or DDX
E4AZ-19582-B ESP-M2C166-H
(ESR-M2C163-A2) or equivalent.

SPECIFICATIONS**CLUTCH SPECIFICATIONS**

Clutch	Steel	Friction	Clearance	Selective Snap Rings-Thickness
Forward Clutch	5 ³⁰	5	1.27-2.26mm (0.050-0.089 inch)	0.074-0.078 0.088-0.092 0.102-0.106
Reverse Clutch	3	4	1.02- 1.91mm (0.040-0.075 inch)	0.074-0.078 0.088-0.092 0.102-0.106
Direct Clutch	6	6 ³¹	1.5-2.3mm (0.060-0.092 inch)	0.050-0.054 0.064-0.068 0.078-0.082 0.092-0.096
Intermediate Clutch	3	3	41.504-41.808mm (1.634- 1.646 inch)	0.067-0.071 0.077-0.081 0.087-0.091

LOW-REVERSE SERVO PISTON TRAVEL — 2.845-6.020mm (0.112-0.237 inch)

NOTE: Piston travel can be adjusted using one of the selective servo pistons available for service.

SELECTIVE SERVO PISTONS— ALL MODELS

Rod Length ³²	I.D.
2.936	1 Groove
2.989	2 Groove
3.043	3 Groove

TRANSMISSION END PLAY

NOTE: Transmission end play can be adjusted using one of the selective thrust washers available for service. After measuring the depth, install the required thrust washer.

SELECTIVE THRUST WASHER³³ — ALL MODELS

Depth	Thickness	Color Code	Depth	Thickness	Color Code
36.7342-38.1838mm (1.4856-1.5033 inch)	1.217-1.371mm (0.050-0.054 inch)	Green	39.0754-39.5046mm (1.5384-1.5553 inch)	2.590-2.692mm (0.102-0.106 inch)	Red
38.1864-38.641mm (1.5034-1.5213 inch)	1.727-1.828mm (0.068-0.072 inch)	Yellow	39.5072-40.1396mm 1.5554-1.5803 inch)	3.022-3.124mm (0.119-0.123 inch)	Blue
38.6436-39.0728mm (1.5214-1.5383 inch)	2.159-2.260mm (0.085-0.089 inch)	Natural			

³⁰ Plus a waved plate (installed next to piston).

³¹ Plate only.

³² Measured from the piston surface to the end of the rod.

³³ The thrust washer is located on the stator support which is attached to the back of the pump housing.

SPECIFICATIONS (Continued)

OVERDRIVE SERVO

Dia.	Code	Stroke
2.7 Inch	A	1.676-5.332mm (0.066-0.210 Inch)

CLUTCH AND BAND APPLICATION

	Interim Friction Clutch	Interim One-Way Clutch	Overdrive Band	Reverse Clutch	Forward Clutch	Planetary One-Way Clutch	Low-Reverse Band	Direct Clutch
1st Gear Manual Low					Applied	Holding	Applied	
2nd Gear Manual Low	Applied	Holding	Applied		Applied			
1st Gear — Ⓔ(OVERDRIVE)					Applied	Holding		
2nd Gear — Ⓔ(OVERDRIVE)	Applied	Holding			Applied			
3rd Gear — Ⓔ(OVERDRIVE)	Applied				Applied			Applied
4th Gear — Ⓔ(OVERDRIVE)	Applied		Applied				Applied	
Reverse (R)				Applied			Applied	

CONVERTER END PLAY

Transmission	New or Rebuilt	Used
All	0.58mm (0.023 inch)	1.27mm (0.050 inch)

FLUID CAPACITY

Liters	Imperial Quarts	Quarts
12.9	11.3	13.6

SERVICE REPLACEMENT
COOLER LINE FITTING TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
1/4 x 18 Straight or Elbow Fitting	24-31	18-23

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
Manual Lever Position Sensor Retaining Bolts	7-10	62-88 (Lb-In)
Extension Housing Bolts	25-30	18-22
Oil Pan Retaining Bolts	12-15	107-132 (Lb-In)
Stator Support-to-Pump Body	20-26	15-19
Main Control Bolts	9-11	80-100 (Lb-In)
Crossmember-to-Side Support Bolts	95-136	70-100
Crossmember-to-Transmission	87-110	64-81
Converter-to-Flywheel Nuts	27-46	20-34
Converter Housing Access Cover	16-22	12-16

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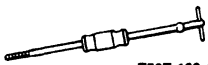
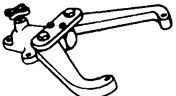

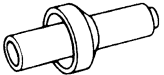
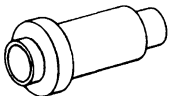
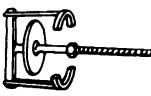

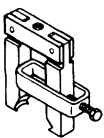
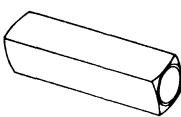
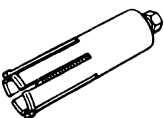
TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Converter Drain Plug	28-30	21-23
Converter Housing-to-Engine Bolts	55-68	40-50
Oil Cooler Lines-to-Case	20-26	15-19
Front Pump-to-Case	20-26	15-19
TCC Solenoid-to-Main Control	9-11	80-100 (Lb-In)
Reinforcement Plates-to-Drain Control	9-11	80-100 (Lb-In)
Cover Plate-to-Main Control	9-11	80-100 (Lb-In)
Separator Plate-to-Main Control	9-11	80-100 (Lb-In)
Pressure Top Plugs	8-16	6-12
Transmission Speed Sensor	7-10	5-7
Manual Lever-to-Case	26-37	20-27
Extension Housing Speedo Plug	5-8	4-6


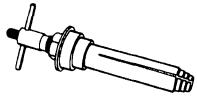
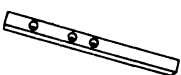
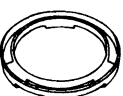

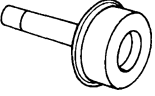

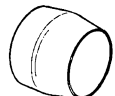
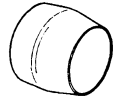

SPECIAL SERVICE TOOLS

Tool Number	Description
D80P-4201-A	Depth Micrometer
TOOL-1175-AC	Front Pump Seal Remover
TOOL-4201-C	Dial Indicator with Bracketry
TOOL-7000-DE	Air Nozzle

SPECIAL SERVICE TOOLS (Continued)

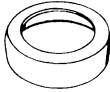


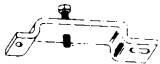
Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T57L-500-B Bench Mounted Holding Fixture	 T57L-500-B
T59L-100-B Impact Slide Hammer	 T59L-100-B
T61L-7657-A Bushing Installer	 T61L-7657-A
T63L-77837-A Front Pump Seal Replacer	 T63L-77837-A
T65L-77515-A Direct Clutch Spring Compressor	 T65L-77515-A
T68P-7D158-A Forward Clutch Lip Seal Protector (Outer)	 T68P-7D158-A
T74P-77248-A Seal Remover	 T74P-77248-A
T76L-7902-C Converter Clutch Torquing Tool	 T76L-7902-C
T77L-7697-A Extension Housing Bushing Remover	 T77L-7697-A

(Continued)

Tool Number / Description	Illustration
T77L-7902-R Converter Clutch Holding Tool	 T77L-7902-R
T80L-7902-A End Play Checking Tool	 T80L-7902-A
T80L-77003-A End Play Gauge Bar	 T80L-77003-A
T80L-77005-A Seal Replacer	 T80L-77005-A
T80L-77140-A Forward Clutch Lip Seal Protector (Inner)	 T80L-77140-A
T80L-77268-A Bushing Installer	 T80L-77268-A
T80L-77268-B Bushing Remover	 T80L-77268-B
T80L-77234-A Direct Clutch Lip Seal Protector	 T80L-77234-A
T80L-77254-A Lip Seal Protector	 T80L-77234-A
T80L-77403-A Reverse Clutch Seal Protector (Outer)	 T80L-77403-A

(Continued)

SPECIAL SERVICE TOOLS (Continued)

Tool Number / Description	Illustration
T80L-77403-B Reverse Clutch Seal Protector (Inner)	 T80L-77403-B
T89T-70010-A Adapters	 T89T-70010-A
T91P-70010-A Gear Position Sensor Adjuster	 T91P-70010-A
T92P-70023-A Servo Piston Remover / Replacer	 T92P-70023-A

ROTUNDA EQUIPMENT

Tool Number	Description
007-0041A	SUPER STAR II Tester
007-00085	Transmission Tester
014-00028	Torque Converter and Oil Cooler Cleaner
014-00407	Digital Volt Ohmmeter
021-00054	Torque Converter Leak Test Kit

SECTION 07-03A Transmission, Manual, M50D

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION.....	07-03A-1	DISASSEMBLY AND ASSEMBLY (Cont'd.)	
DIAGNOSIS AND TESTING.....	07-03A-2	Transmission Disassembly	07-03A-4
DISASSEMBLY AND ASSEMBLY		IDENTIFICATION.....	07-03A-2
Cleaning and Inspection	07-03A-19	REMOVAL AND INSTALLATION	
Countershaft.....	07-03A-15	Crossmember.....	07-03A-3
Input Shaft	07-03A-10	Transmission (4x2).....	07-03A-2
Output Shaft.....	07-03A-11	Transmission (4x4).....	07-03A-2
Reverse Idler Gear Assembly	07-03A-16	SPECIAL SERVICE TOOLS.....	07-03A-32
Top Cover	07-03A-16	SPECIFICATIONS.....	07-03A-31
Transmission Assembly	07-03A-22	VEHICLE APPLICATION	07-03A-1

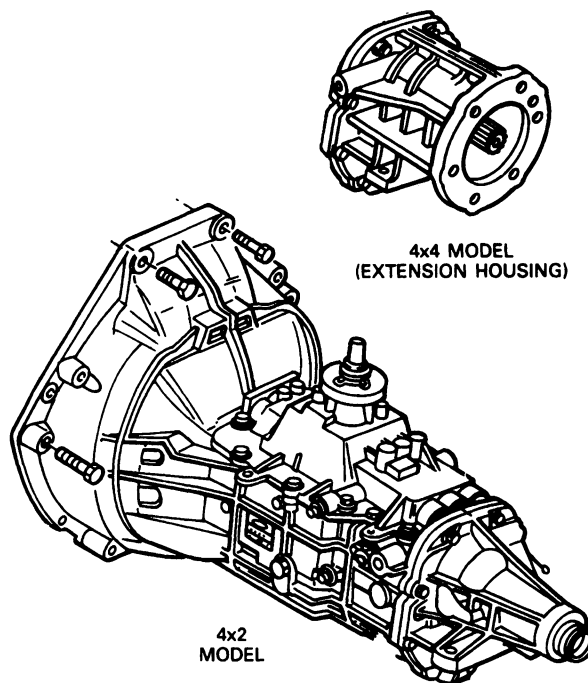
VEHICLE APPLICATION

F-Series and Bronco (under 8500 lbs GVW) with 4.9L and 5.0L Engines

DESCRIPTION

The M50D is a top shift, fully synchronized, five-speed manual transmission, equipped with an overdrive fifth gear ratio. All gear changes including reverse are accomplished with synchronizer sleeves.

The transmission main case, top cover, and extension housing are constructed of aluminum alloy. Steel bearing race inserts provide durability in appropriate areas.



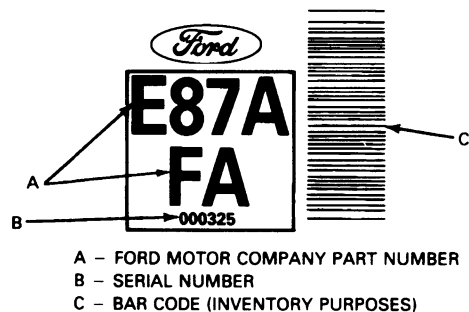
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The extension housing contains a bronze alloy bushing. This bushing cannot be serviced. The extension housing must be replaced as a unit if the bushing requires service (4x2 vehicles only).

IDENTIFICATION

The Vehicle Safety Compliance Certification Label (located on the driver's door lock pillar) lists applicable transmission identification codes. For identification of the label codes, refer to Section 00-01.

Manual transmissions are equipped with service identification tags. The M50D transmission service tag is located on the driver's side of the transmission.



C8663-B

DIAGNOSIS AND TESTING

For diagnosis and testing procedures, refer to Section 07-00B.

REMOVAL AND INSTALLATION

Transmission (4x2)

Removal

- Shift the transmission into neutral.
- Open hood and disconnect negative battery cable from battery terminal.
- Remove the shifter boot retainer screws and slide the boot up the shift lever shaft.
- Remove the shift lever retaining bolt locknut.
- Remove the shift lever retaining bolt by placing locknut on opposite end of bolt and tightening to loosen the bolt. Remove the shift lever boot assembly.
- Raise the vehicle on a hoist and position safety stands under the vehicle.
- Disconnect the back-up lamp switch connector located at the top left hand side of the transmission.
- Place drain pan under transmission. Remove the drain plug and drain the oil from the transmission.
NOTE: Drain transmission only if transmission disassembly is required.
- Position a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent under the transmission.
- Remove the driveshaft from the transmission. Refer to Section 05-01.

- Disconnect the clutch slave cylinder hydraulic line. Refer to Section 08-02.
- Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in crossmember removal and installation in this section.
- Remove the bolts that retain the transmission to the engine block.
- Move the transmission to the rear until the input shaft clears the clutch. Lower the transmission from the vehicle.

Installation

- Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent. Install guide studs in the engine block and raise the transmission until the input shaft splines are aligned with the clutch disc splines.
- Slide the transmission forward on the guide studs until it is in position. Install the attaching bolts and tighten to 54-67 N·m (40-50 ft·lb). Remove the guide studs and install the remaining bolts. Tighten the two bolts for the lower plate to 12-16 N·m (9-12 ft·lb).
- Install the crossmember as described under Crossmember Removal and Installation in this section. Position the insulator and retainer between the transmission and crossmember. Install bolts and tighten to 81-108 N·m (60-80 ft·lb). Install the nut retaining the insulator and retainer to crossmember. Tighten to 81-108 N·m (60-80 ft·lb). Remove the transmission jack.
- Connect the clutch hydraulic line.
- Connect the backup lamp switch.
- Connect the driveshaft. Refer to Section 05-01.
- Check transmission fluid level. Fill transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C 166-H) or equivalent automatic transmission fluid.
- Remove safety stands and lower vehicle.
- Install the shift lever retaining bolt in the shift lever hole such that the flat aligns with the mating flat on the transmission stub shaft. Push bolt fully into position. Install nut and tighten to 16-24 N·m (12-18 ft·lb).
- Slide the shifter boot into position on the shifter shaft, and install the boot retaining screws.
- Install the isolator pad assembly. Install the floor pan cover and floor mat if previously removed.
- Connect battery negative cable.

Transmission (4x4)

Removal

- Shift the transmission into neutral and remove the shift knob from the transfer case shift lever.

REMOVAL AND INSTALLATION (Continued)

2. Remove the shifter boot retainer screws and slide the boot up the shift lever shaft.
3. Remove the shift lever retaining bolt by placing locknut on opposite end of bolt and tightening to loosen the bolt. Remove the shift lever boot assembly.
4. Open hood and disconnect battery negative cable from negative terminal.
5. Raise the vehicle on a hoist and position safety stands under the vehicle.
NOTE: Drain transmission only if transmission disassembly is required.
6. Place drain pan under transmission. Remove the drain plug and drain the transmission.
7. Remove the rear driveshaft from the transfer case. Refer to Section 05-01.
8. Remove the front driveshaft from the transfer case. Refer to Section 05-01.
9. Disconnect the backup lamp switch connector.
10. If equipped, remove the skid pad from beneath the transfer case.
11. Position a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent under the transfer case. Remove the six bolts holding the transfer case to the transmission and carefully lower the transfer case from the vehicle, using care to make sure that the transfer case shift lever clears the opening in the floor pan.
12. Place a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent under transmission. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in crossmember removal and installation in this section.
13. Remove the bolts that retain the transmission to the engine block.
14. Move the transmission to the rear until the input shaft clears the clutch. Lower the transmission from the vehicle.

Installation

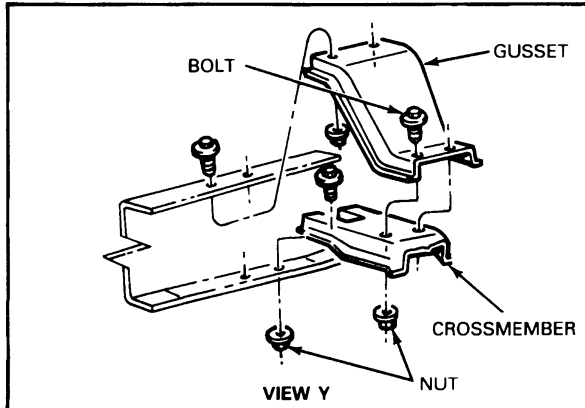
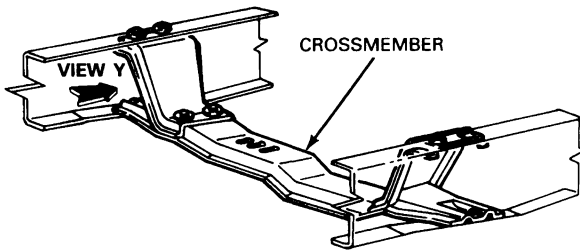
1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent and install two guide studs in the transmission front case top holes, to guide the transmission into position. Join together the transmission and engine block mating surfaces.
2. Install the two lower bolts and tighten to 54-67 N·m (40-50 ft·lb). Remove the guide studs and install the upper bolts.
3. Place the rear support bracket in position and install the retaining bolts. Refer to crossmember installation in this section. Tighten the bolts to 82-108 N·m (60-80 ft·lb).
4. Install the two bolts at the rear support insulator bracket. Remove the transmission jack.
5. Position the transfer case on the transmission jack. Position the transfer case on the transmission, using care to guide the transfer case shift lever through the opening in the floor pan. Install the gasket and six retaining bolts. Tighten the bolts to 34-58 N·m (25-43 ft·lb). If vehicle has a manual shift transfer case, install the transfer case shift mechanism.
6. Install the front driveshaft to the transfer case yoke or flange. Refer to Section 05-01.
7. Install the rear driveshaft to the transfer case yoke or flange. Refer to Section 05-01.
8. Check transmission and transfer case fluid levels. Fill transfer case and transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C166-H) or equivalent automatic transmission fluid.
9. Connect the back-up lamp switch connector.
10. Remove safety stands and lower vehicle.
11. Install the shift lever retaining bolt in the shift lever bolt hole such that the flat aligns with the mating flat on the transmission stub shaft. Push bolt fully into position. Install nut and tighten to 16-24 N·m (12-18 ft·lb).
12. Slide the shifter boot into position on the shifter shaft, and install the boot retaining screws.

Crossmember**Removal**

1. Raise vehicle on a hoist and position safety stands under vehicle.
CAUTION: Use extreme caution when working in the area of the catalytic converter because of the extremely high temperatures generated by the converter.
2. Remove skid plate, if so equipped. Remove heat shield from catalytic converter.
3. Remove two nuts connecting upper gusset to frame on both sides of frame.
4. Remove nut and bolt assembly connecting gusset to crossmember. Remove gusset on left side.
5. Remove bolts holding transmission to transmission support plate on crossmember.
6. Raise transmission with a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent.
7. Remove the nut and bolt assemblies connecting the support plate to the crossmember. Remove support plate. Remove right gusset.
8. Remove nut and bolt assemblies connecting crossmember to frame. Remove crossmember.

REMOVAL AND INSTALLATION (Continued)

Crossmember Installation



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Installation

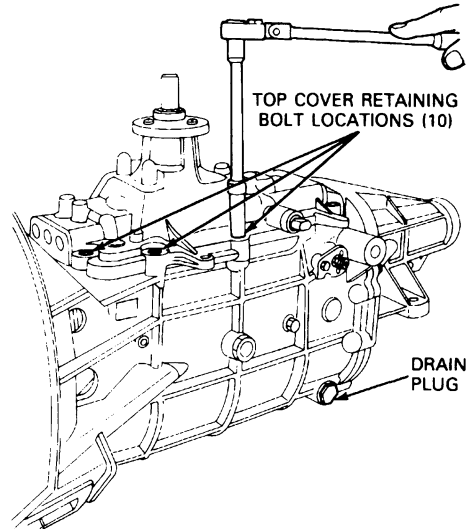
1. Install crossmember and transmission support plate, and position right and left gussets on bolt on frame. Install nuts on upper gusset to frame bolts and tighten to 53-72 N·m (39-53 ft-lb).
2. Install crossmember to frame nut and bolt assembly and tighten to 53-72 N·m (39-53 ft-lb).
3. Install nut and bolt assembly connecting gusset to crossmember and tighten to 53-72 N·m (39-53 ft-lb).
4. Lower the transmission.
5. Install skid plate, if so equipped. Install heat shield over catalytic converter. Tighten all nuts and bolts to specification.
6. Remove safety stands and lower vehicle.

DISASSEMBLY AND ASSEMBLY

Transmission Disassembly

CAUTION: Care must be taken when removing bearings from either shafts or the case. When possible, have the puller or press device resting on the press fit portion of the bearing being removed. Failure to do so will probably cause damage requiring replacement of the bearing. In many cases, essential tools called out in removal procedures will damage the component being removed. In these circumstances, the parts will have to be replaced.

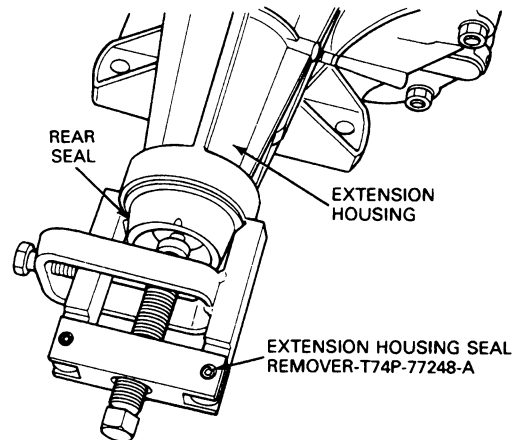
1. Remove transmission from vehicle as outlined. Secure transmission to an appropriate holding fixture.
2. Remove shift lever and dust boot if necessary.
3. Using a 12mm wrench, remove ten top cover retaining bolts. Remove top cover assembly.



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4. Using a 14mm socket, remove nine extension housing retaining bolts. Pry gently at locations provided on extension housing and transmission case. Remove extension housing from case.

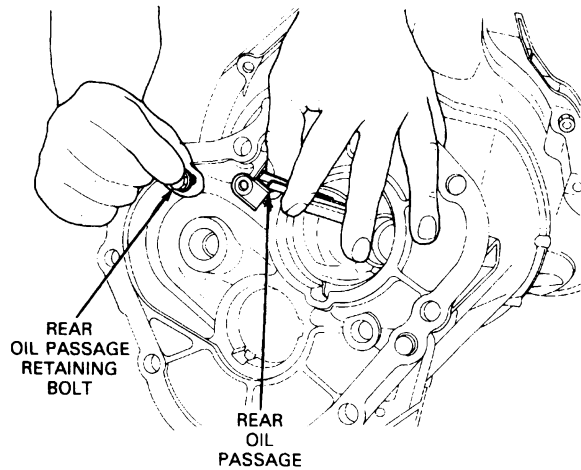
NOTE: On 4x2 models, if it is necessary to remove rear seal from extension housing, extension housing must be installed to transmission case. Remove extension housing rear seal using Seal Remover T74P-77248-A or equivalent.



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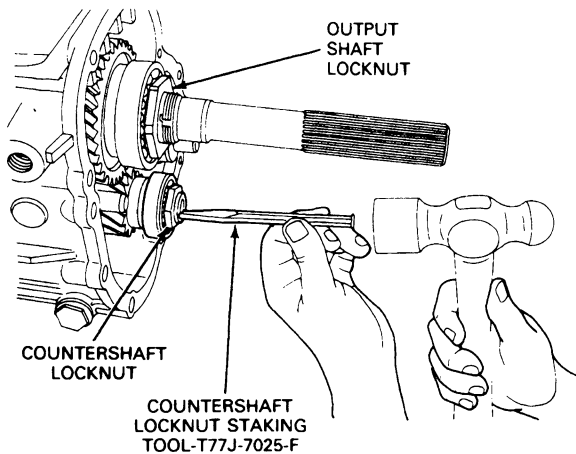
DISASSEMBLY AND ASSEMBLY (Continued)

5. If necessary, remove rear oil passage from extension housing using a 10mm socket (4x2 models only).

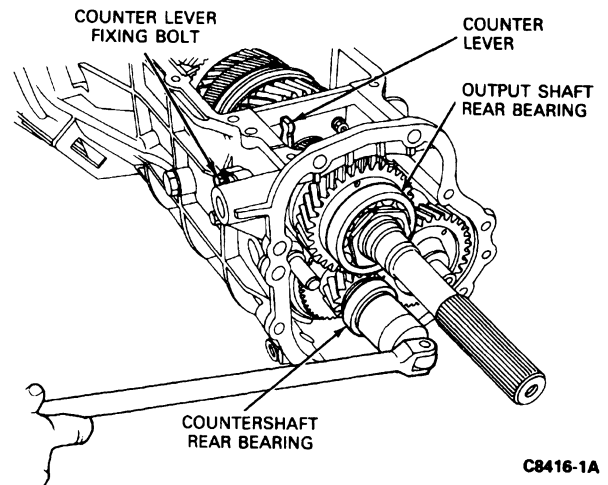


6. Remove and discard anti-spill oil seal from output shaft (4x2 models only).
 7. Lock transmission into first and third gears.
 8. Using Countershaft Locknut Staking Tool T77J-7025-F or equivalent, release the staked areas securing output shaft and countershaft locknuts.

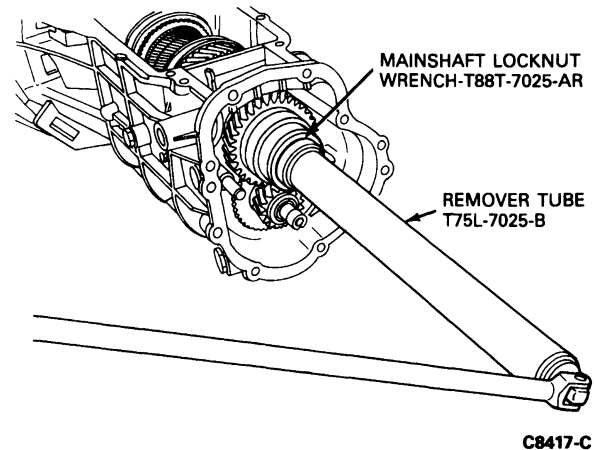
CAUTION: Staked areas of locknuts must be fully released or damage to shaft threads will result.



9. Using a 32mm socket, remove and discard the countershaft rear bearing locknut. Remove the countershaft bearing and thrust washer.

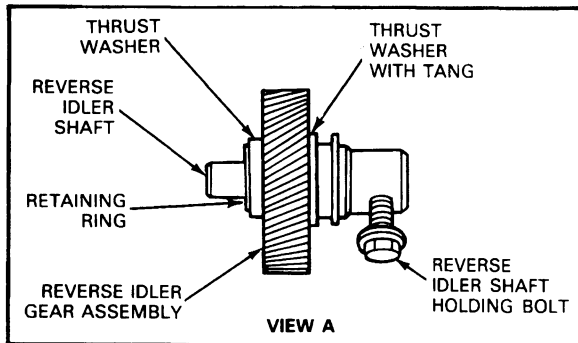
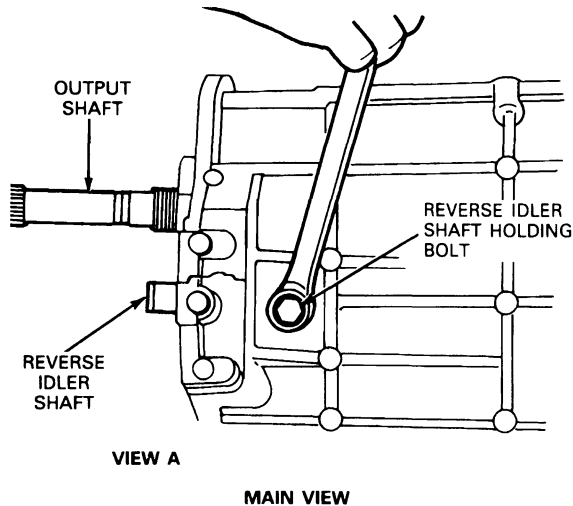


10. Using Mainshaft Locknut Wrench T88T-7025-AR and Remover Tube T75L-7025-B or equivalents, remove and discard output shaft locknut.



DISASSEMBLY AND ASSEMBLY (Continued)

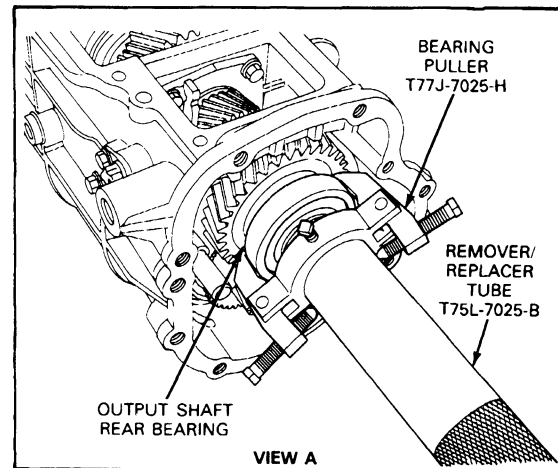
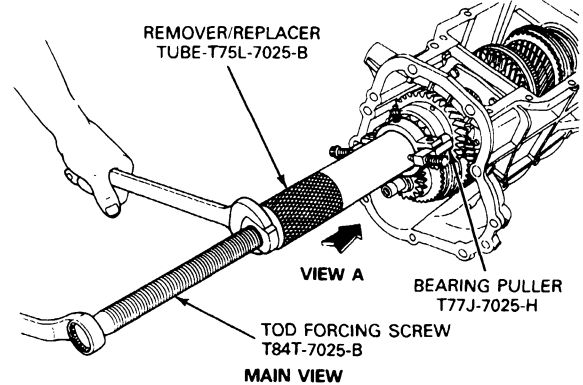
11. Using a 17mm wrench, remove reverse idler shaft holding bolt. Remove reverse idler gear assembly by grasping and pulling rearward.



C10279-C

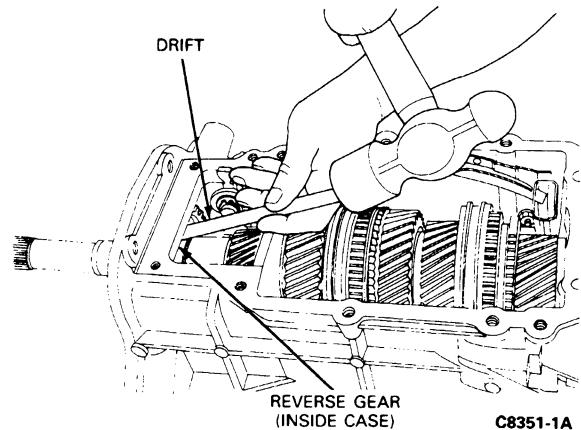
12. Remove output shaft rear bearing from output shaft using Remover / Replacer Tube T75L-7025-B, TOD Forcing Screw T84T-7025-B and Bearing Puller T77J-7025-H or equivalents.

CAUTION: Make sure special tools are properly positioned so as not to damage parts being removed.



C6725-1A

13. Using a brass drift and hammer, drive reverse gear from output shaft.

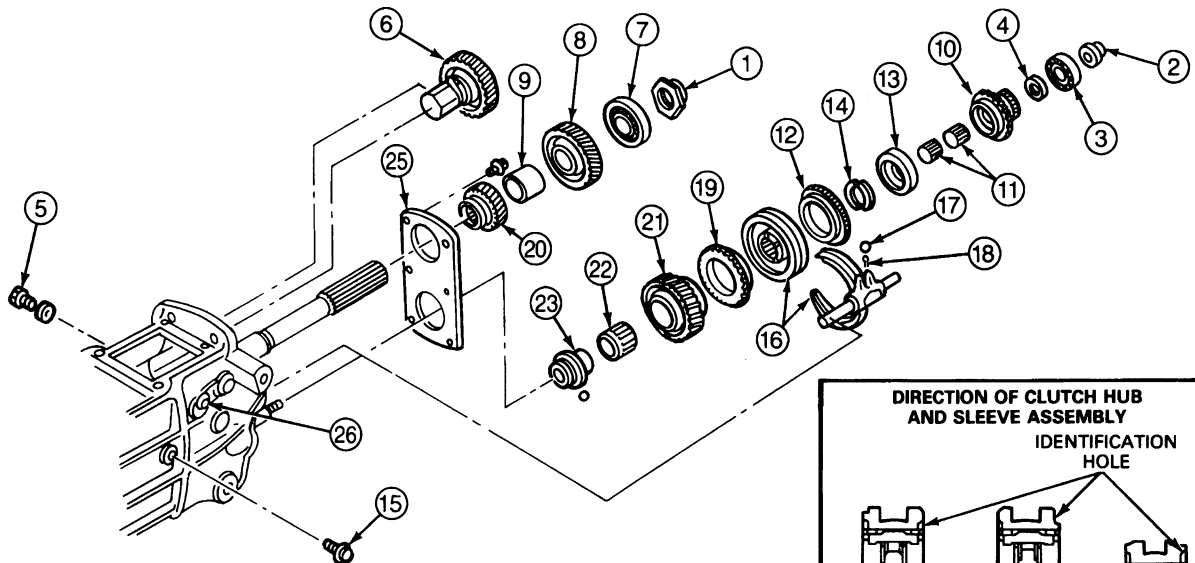


C8351-1A

14. Remove sleeve from output shaft.
15. Remove counter reverse gear with two needle bearings and reverse synchronizer ring.

DISASSEMBLY AND ASSEMBLY (Continued)

Transmission, Rear Housing



C8352-C

TRANSMISSION, REAR HOUSING (LEGEND)

Item No.	Description
1	Locknut — Output Shaft
2	Locknut — Countershaft
3	Countershaft Rear Bearing
4	Thrust Washer
5	Holding Bolt — Reverse Idler Gear
6	Reverse Idle Gear Assembly
7	Bearing — Output Shaft Rear
8	Reverse Gear — Output Shaft
9	Sleeve — Output Shaft
10	Countershaft Reverse Gear
11	Needle Bearings
12	Synchronizer Ring — Reverse
13	Thrust Washer

Item No.	Description
14	Split Washer (2 Pcs.)
15	Holding Bolt — Shift Rod
16	Shift Rail/Fork/Hub/Sleeve Assembly
17	Lock Ball (Steel) Shift Rail
18	Spring — Shift Rail
19	Synchronizer Ring — 5th Gear
20	5th Gear — Output Shaft
21	5th Gear — Countershaft
22	Needle Bearing — 5th Gear (Two Halves)
23	Sleeve — 5th Gear
24	Ball
25	Center Bearing Cover
26	5th/Reverse Counter Lever Lockplate Retaining Bolt

CC11128-A

16. Remove thrust washer and split washer from countershaft.
17. Using a 12mm wrench, remove fifth / reverse shift rod holding bolt.

18. Remove the fifth / reverse synchronizer hub and sleeve assembly and fifth / reverse shift fork and rod as an assembly without separating the steel ball and spring (removed from shift fork groove) unless necessary.

DISASSEMBLY AND ASSEMBLY (Continued)

19. Remove fifth gear synchronizer ring.
20. Remove the fifth / reverse counter lever lockplate retaining bolt and inner circlip. Remove counter lever assembly from transmission case.

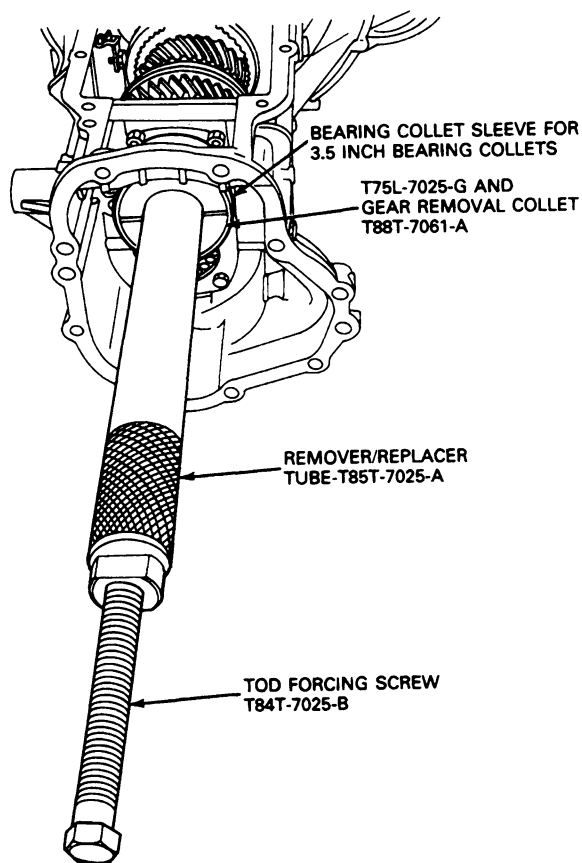
NOTE: Do not remove the Torx® nut retaining the counter lever pin at this time.

21. Remove fifth gear (counter) with needle bearing.

CAUTION: When installing special tools used to remove fifth gear as outlined in the next step, make sure special tools are properly positioned so as not to damage parts being removed. Refer to Cleaning and Inspection in this section for bearing inspection procedures.

22. Remove fifth gear from output shaft using Bearing Collet Sleeve for 3.5-inch Bearing Collets T75L-7025-G, Remover / Replacer Tube T85T-7025-A, TOD Forcing Screw T84T-7025-B and Gear Removal Collet T88T-7061-A or equivalents.

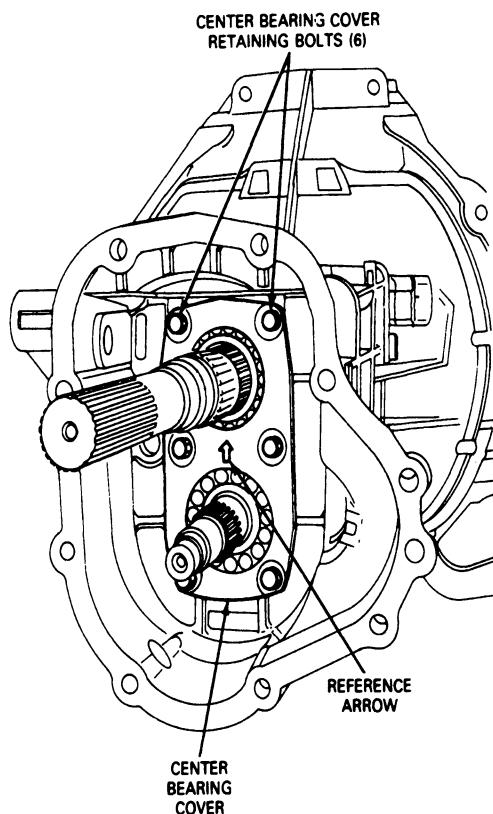
NOTE: For reference during assembly, observe that the longer of the two collars on fifth gear faces forward.



C8673-1A

23. Remove fifth gear sleeve and ball.
24. Using a 12mm socket, remove six center bearing cover retaining bolts. Remove center bearing cover.

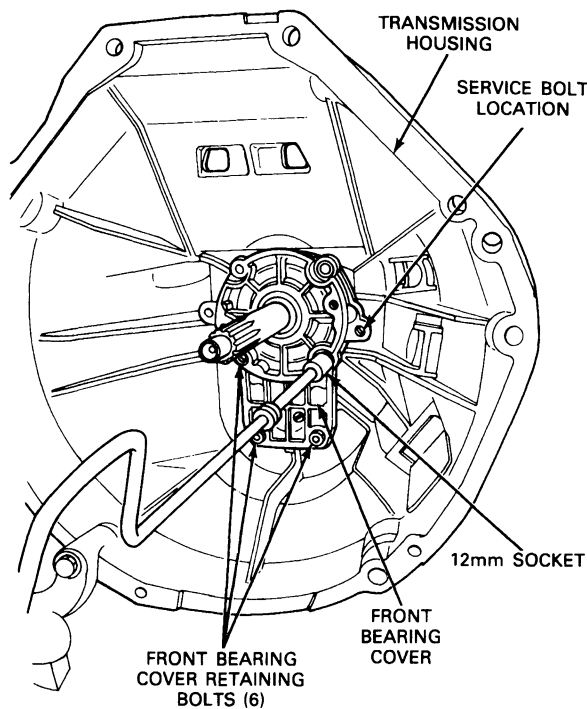
NOTE: For reference during assembly, observe that reference arrow in middle of center bearing cover points upward. Observe that flanged side of center bearing cover faces inward.



C8364-1B

DISASSEMBLY AND ASSEMBLY (Continued)

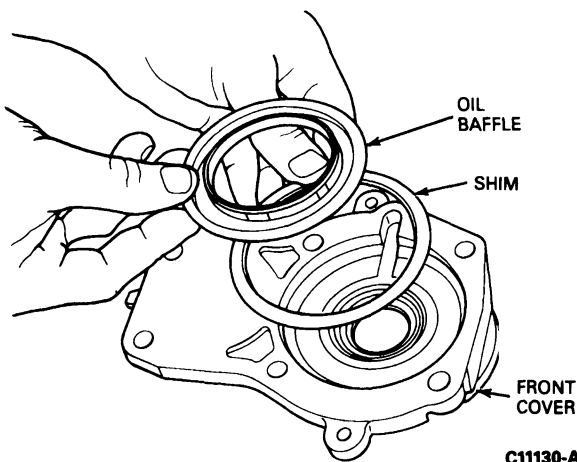
25. Using a 12mm socket, remove six front bearing cover attaching bolts.



C8355-B

26. Remove front bearing cover by threading two of the originally installed retaining bolts into the front bearing cover service bolt locations (nine o'clock and three o'clock). Alternately tighten bolts until front bearing cover can be lifted away by hand. Remove and discard front bearing cover oil baffle.

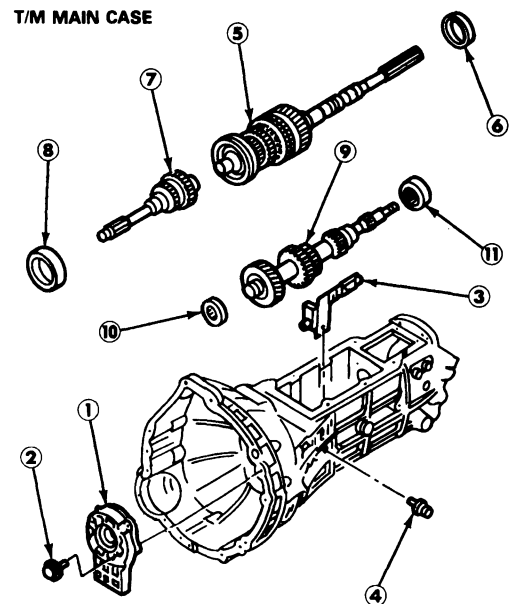
NOTE: Bolts threaded into service bolt locations will bottom against housing and lift front bearing cover away from transmission case.



C11130-A

NOTE: Do not remove plastic scoop ring from input shaft at this time.

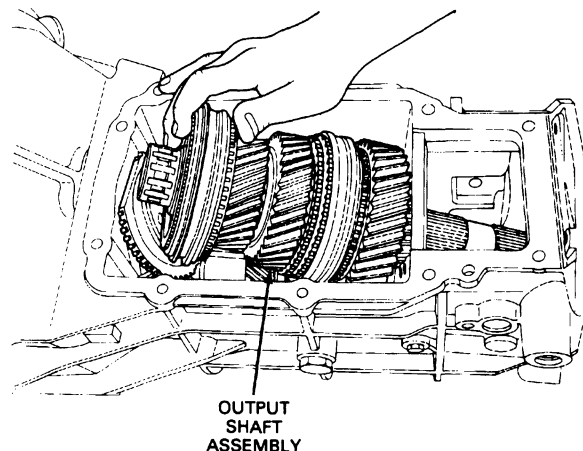
27. Using a 10mm socket, remove oil trough retaining bolt and oil trough from upper transmission case.



1. FRONT BEARING COVER
2. FRONT COVER RETAINING BOLT-(6)
3. OIL TROUGH
4. RETAINING BOLT - OIL TROUGH
5. OUTPUT SHAFT ASSEMBLY
6. OUTPUT SHAFT CENTER BEARING OUTER RACE
7. INPUT SHAFT ASSEMBLY
8. INPUT SHAFT BEARING OUTER RACE
9. COUNTER SHAFT ASSEMBLY
10. COUNTERSHAFT FRONT BEARING
11. COUNTERSHAFT REAR BEARING

C8357-C

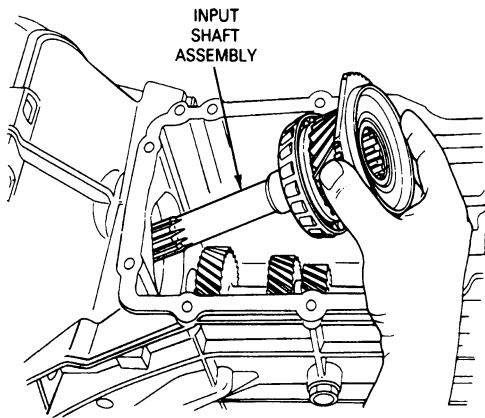
28. Pull input shaft forward and remove input bearing outer race. Pull output shaft rearward.
29. Pull input shaft forward and separate it from output shaft. Incline output shaft upward and lift it from transmission case.



C8358-1A

DISASSEMBLY AND ASSEMBLY (Continued)

30. Remove input shaft from transmission case.



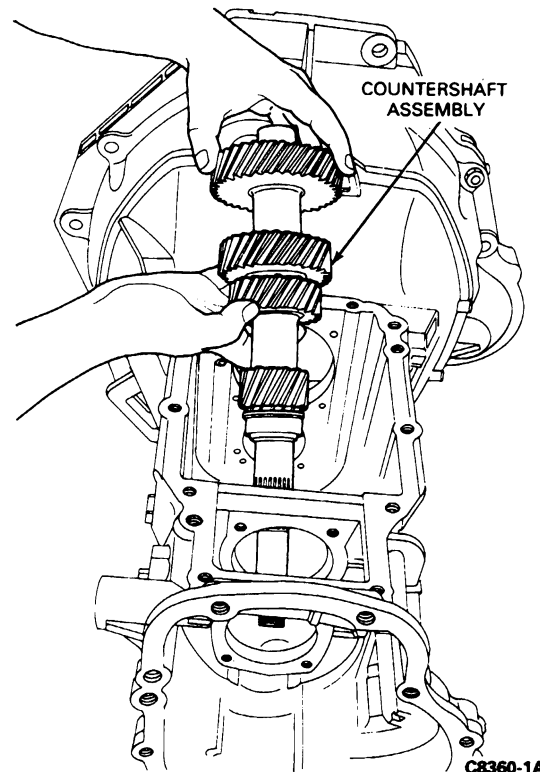
C8359-1A

31. Remove countershaft bearing outer races (front and center) by moving countershaft forward and rearward. Pull countershaft rearward far enough to permit tool clearance behind front countershaft bearing. Using Bearing Race Puller T88T-7 120-A and Slide Hammer T50T-100-A or equivalents, remove front countershaft bearing.

CAUTION: Tap gently during bearing removal. A forceful blow can cause damage to bearing or transmission case.

CAUTION: Make sure special tools are properly positioned so as not to damage parts being removed. Refer to Cleaning and Inspection in this section for inspection procedures.

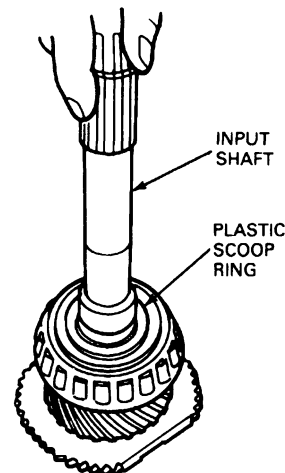
32. Remove countershaft through upper opening of transmission case.



C8360-1A

Input Shaft Disassembly

1. Remove and discard plastic scoop ring.

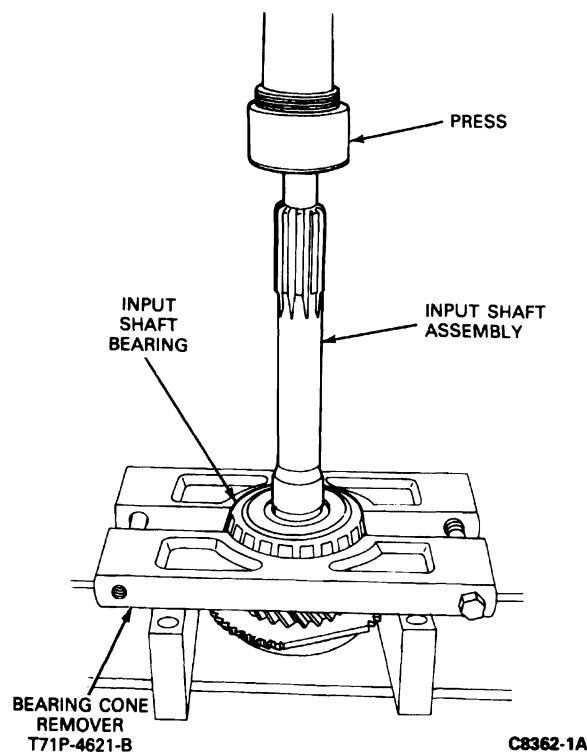


C8361-1A

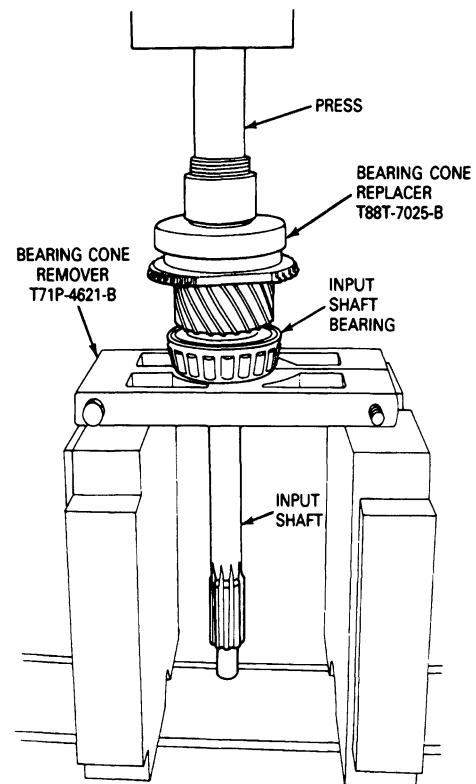
DISASSEMBLY AND ASSEMBLY (Continued)

2. Press tapered roller bearing from input shaft using Bearing Cone Remover T71P-4621-B or equivalent and arbor press.

CAUTION: Use of essential tools may cause damage to bearings being removed. Refer to **Cleaning and Inspection** procedures in this section to determine if parts need to be replaced.

**Assembly**

1. Install input shaft tapered roller bearing onto input shaft using a press and Bearing Cone Replacer T88T-7025-B or equivalent and Bearing Cone Remover T71P-4621-B or equivalent as a press plate.

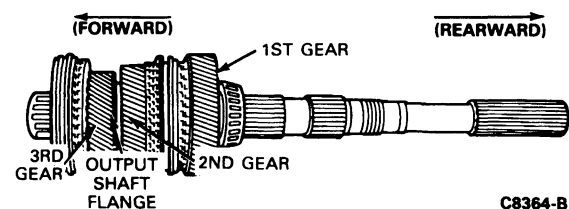


C8363-1B

2. Install plastic scoop ring onto input shaft. Manually rotate ring clockwise to make sure that input shaft oil holes properly engage scoop ring. A click should be heard as scoop ring notches align with input shaft oil holes.

Output Shaft**Disassembly**

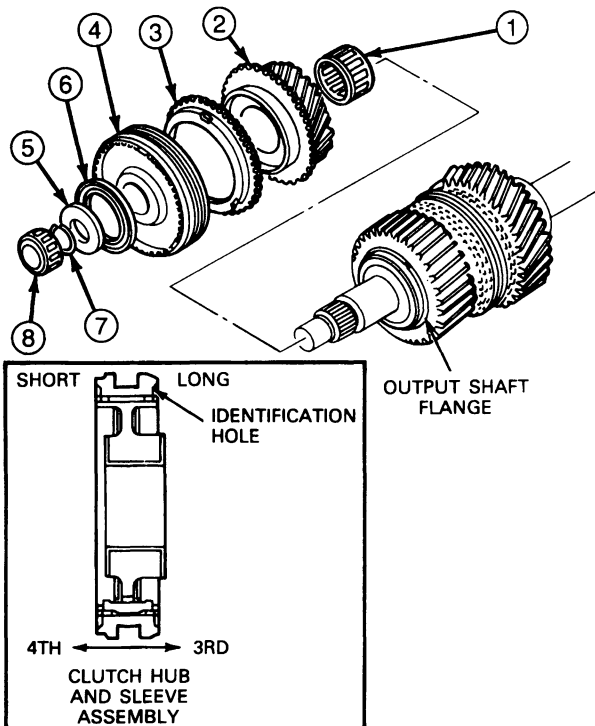
1. Position output shaft front flange as illustrated. Use this flange as a reference point and dividing line during assembly and disassembly procedures.



C8364-B

DISASSEMBLY AND ASSEMBLY (Continued)

2. Remove pilot bearing, retaining ring, needle bearing, and spacer from front (short side of flange) of output shaft.

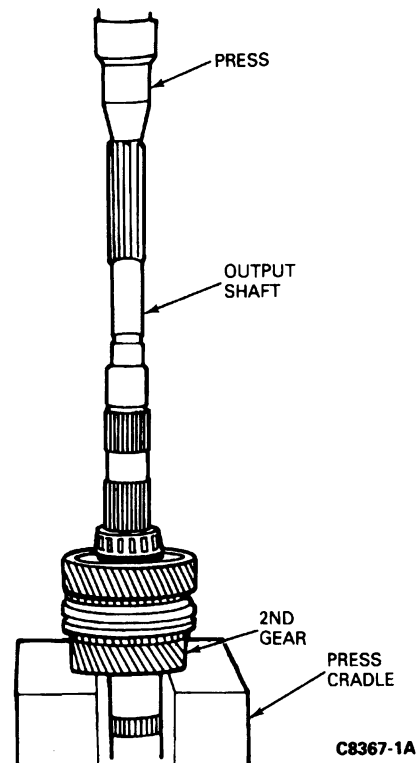


1. NEEDLE BEARING — 3RD GEAR
2. THIRD GEAR
3. SYNCHRONIZER RING — 3RD GEAR
4. CLUTCH HUB AND SLEEVE ASSEMBLY — 3RD/4TH
5. SPACER
6. NEEDLE BEARING (PLAIN)
7. RETAINING RING
8. ROLLER BEARING — PILOT BEARING

C10281-B

3. Position the front (short side of flange) of output shaft so that it faces upward. Lift off the following components as a unit:
- Clutch hub and sleeve assembly (third / fourth).
 - Synchronizer ring (third).
 - Third gear.
 - Needle bearing.
4. Position output shaft with rear end (long side of flange) facing upward. Position output shaft into press using T53T-4621-B as a press plate contacting the lower part of second gear and Bearing Cone Replacer T88T-7025-B to protect the inner race rollers.

CAUTION: Make sure that output shaft flange does not contact or ride up onto press cradle. Improper positioning of output shaft can cause component damage.



5. Press off the following components as a unit: center bearing, first gear sleeve, first gear, needle bearing, first / second clutch hub and sleeve assembly, first / second synchronizer rings, second gear and needle bearing using Bearing Replacer T53T-4621-B and Bearing Cone Replacer T88T-7025-B or equivalents.

Assembly

CAUTION: Pay close attention when installing synchronizer rings and sleeves. The 3rd gear synchronizer ring and sleeve are unique from the others. These must be installed as a set in the proper position. Failure to do so will result in the inability to shift the transmission into one of the gears. The synchronizer for the 3rd gear can be identified by the three extra teeth cut out from around its circumference. Directly adjacent to one side of the missing teeth, two teeth have been bridged together. This is to help eliminate any upshift "crunch" that may occur.

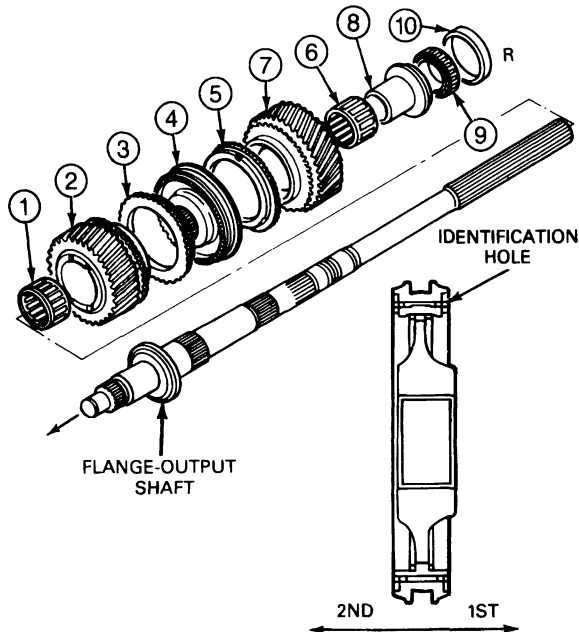
NOTE: During assembly, apply Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2QDX or -DDX, E4AZ-19582-B (ESP-M2C 166-H) or equivalent to all rotating or sliding parts.

1. Position output shaft so that the rear end (long side of flange) faces upward. Install the following parts in the order listed.
 - Second gear needle bearing
 - Second gear
 - Second gear synchronizer ring
 - First / second clutch hub and sleeve assembly
 - First gear synchronizer ring

DISASSEMBLY AND ASSEMBLY (Continued)

- First gear needle bearing
- First gear
- First gear sleeve
- Center bearing (inner)

NOTE: To install components onto output shaft, position components as shown. Press components into position using Bearing Replacer T53T-4621-B and Bearing Plate T75L-1165-B or equivalents.



1. NEEDLE BEARING - 2ND GEAR
2. 2ND GEAR
3. SYNCHRONIZER RING - 2ND GEAR
4. CLUTCH HUB AND SLEEVE ASSEMBLY - 1ST AND 2ND
5. SYNCHRONIZER RING - 1ST GEAR
6. NEEDLE BEARING - 1ST GEAR
7. 1ST GEAR
8. SLEEVE - 1ST GEAR
9. CENTER BEARING - INNER
10. CENTER BEARING - OUTER RACE

- CLUTCH HUB IS NONDIRECTIONAL
- HUB SLEEVE INSTALLATION IS DIRECTIONAL

C8366-B

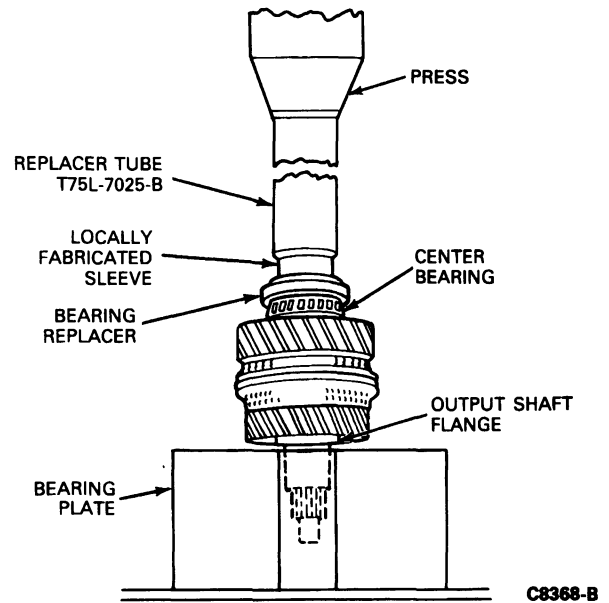
NOTE: Make sure that center bearing race is still positioned in transmission case.

NOTE: When installing first / second clutch hub and sleeve, make sure that narrow width of sleeve faces second gear (front) side. Make sure that reference marks face rear of transmission; they reference synchronizer key installation position.

2. Press the center bearing onto the output shaft using the following tools:

- Replacer Tube T75L-7025-B.
- Locally fabricated sleeve where the inside diameter is large enough to fit over the output shaft but small enough to engage the inner bearing race.

Position the output shaft on a press cradle as shown in the following illustration. Using the sleeve and replacer tube as a press ram, seat the center bearing.



3. Position output shaft so that front (short side) of output shaft flange faces upward. Install the following parts in the order listed.

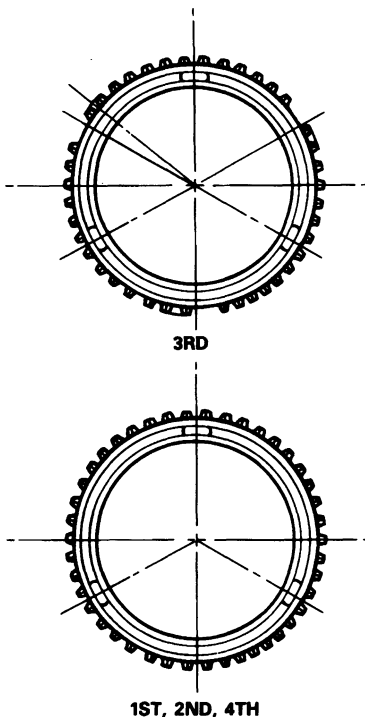
- Third gear needle bearing
- Third gear
- Third gear synchronizer ring

DISASSEMBLY AND ASSEMBLY (Continued)

4. Install third / fourth clutch hub and sleeve as follows:

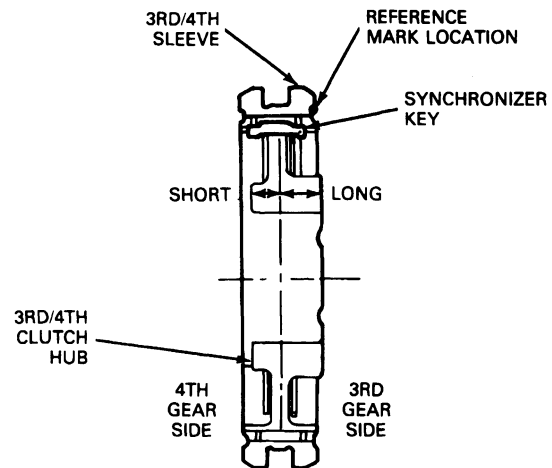
- Mate clutch hub synchronizer key groove with reference mark on the clutch hub sleeve. The mark should face rearward.
- Install longer flange on clutch hub sleeve toward third gear (rear) side.

NOTE: Make note of the differences between the 3rd gear synchronizer ring and the 1st, 2nd and 4th gear synchronizer rings. The 3rd gear synchronizer ring, or blocker ring, has three teeth cut out 120 degrees apart from each other. Directly adjacent to one side the missing teeth, two teeth have been bridged together. This is to help eliminate any upshift "crunch" that may occur.



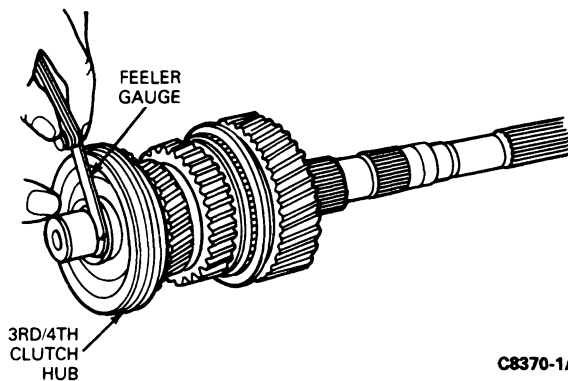
C11129-A

NOTE: The front and rear sides of the clutch hub may appear to be similar. Be sure to install it with the longer flange side (with reference mark) facing rearwards.



C8369-B

5. Install the spacer and retainer onto the output shaft.
6. With the original retainer ring installed, measure the clutch hub end play using a feeler gauge.



C8370-1A

7. If necessary, adjust third / fourth clutch hub end play to 0.00-0.05mm (0.00-0.0019 inch) by selecting required retaining ring according to the chart.

RETAINING RING SELECT CHART

Part Number	Thickness
E8TZ-7030-A	1.50mm (0.059 in)
E8TZ-7030-B	1.55mm (0.061 in)
E8TZ-7030-C	1.60mm (0.0629 in)
E8TZ-7030-D	1.65mm (0.0649 in)
E8TZ-7030-E	1.70mm (0.0669 in)
E8TZ-7030-F	1.75mm (0.0688 in)
E8TZ-7030-G	1.80mm (0.0708 in)

(Continued)

DISASSEMBLY AND ASSEMBLY (Continued)

RETAINING RING SELECT CHART (Cont'd)

Part Number	Thickness
E8TZ-7030-H	1.85mm (0.0728 in)
E8TZ-7030-J	1.90mm (0.0748 in)
E8TZ-7030-K	1.95mm (0.0767 in)

TC837 1A

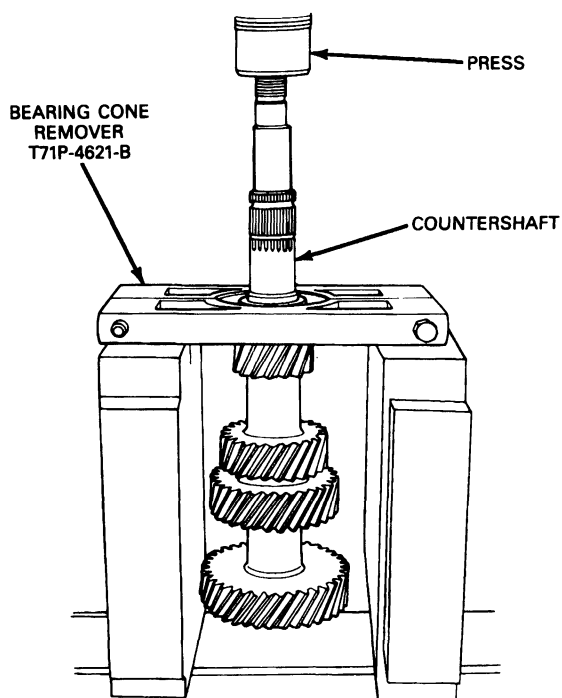
- After determining the correct retaining ring, install the needle bearing (with the rollers visible), retainer ring and pilot bearing.

Countershaft

Disassembly

- Using a press and Bearing Cone Remover T71P-4621-B or equivalent, remove the countershaft center bearing inner race.

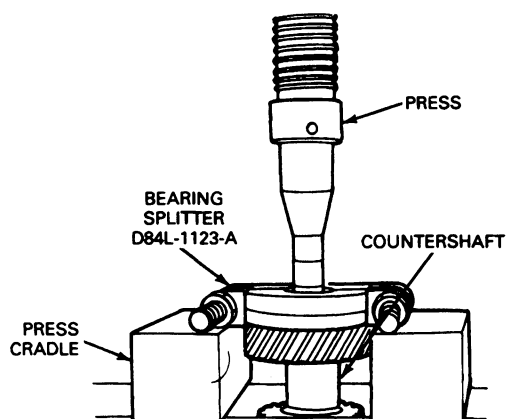
CAUTION: Use of the essential tools may cause damage to bearings being removed. Refer to Cleaning and Inspection procedures in this section to determine if parts need to be replaced.



C8372-C

- Using a press and Bearing Splitter D84L-1123-A or equivalent, remove the countershaft front bearing inner race.

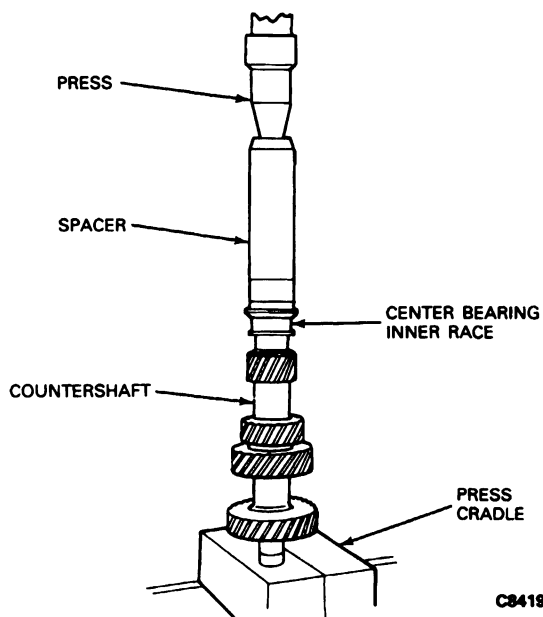
CAUTION: Use of the essential tools may cause damage to bearings being removed. Refer to Cleaning and Inspection procedures in this section to determine if parts need to be replaced.



C8373-1B

Assembly

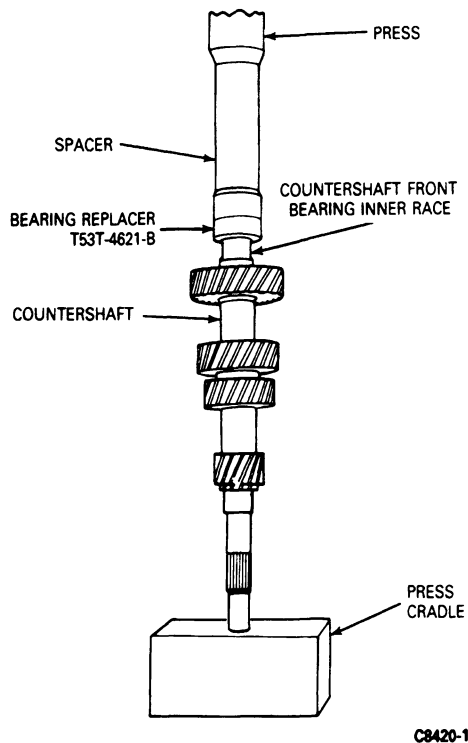
- Using a press, a suitable press plate and Bearing Replacer T53T-4621-B or equivalent, install center bearing inner race.



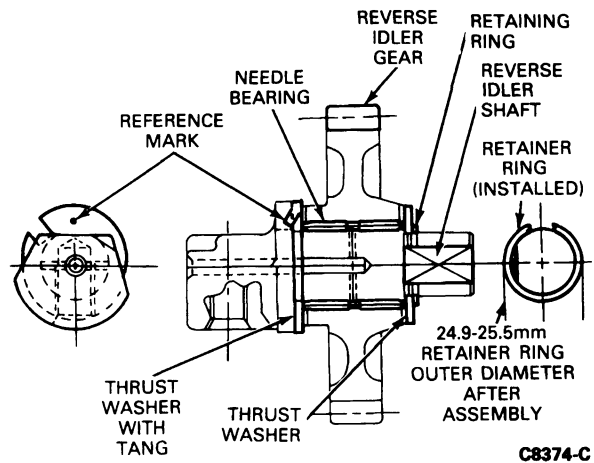
C8419-1A

DISASSEMBLY AND ASSEMBLY (Continued)

2. Using a press, a suitable press plate and Bearing Replacer T53T-4621-B or equivalent, install countershaft front bearing inner race.

**Reverse Idler Gear Assembly****Disassembly**

- Remove the following parts from reverse idler gear shaft:
 - Retaining ring
 - Spacer
 - Idler gear
 - Needle bearings
 - Thrust washer

**Assembly**

- Install thrust washer onto reverse idler gear shaft. Make sure that tab on thrust washer mates with groove on reverse idler shaft to prevent rotation of thrust washer.
- Install the following parts onto reverse idler gear shaft in the order listed.
 - Needle bearings
 - Idler gear
 - Spacer
- Install original retaining ring onto reverse idler gear shaft. Insert a feeler gauge between retaining ring and reverse idler gear to measure reverse idler gear end play. Using the chart, adjust reverse idler gear end play to 0.1-0.2mm (0.0039-0.0078 inch) by installing a retaining ring of necessary thickness.

REVERSE IDLER GEAR RETAINING RINGS

Part Number	Thickness
E8TZ-7156-F	1.5mm (0.059 in.)
E8TZ-7156-E	1.6mm (0.0629 in.)
E8TZ-7156-D	1.7mm (0.0669 in.)
E8TZ-7156-C	1.8mm (0.0708 in.)
E8TZ-7156-B	1.9mm (0.0748 in.)

TC8393A

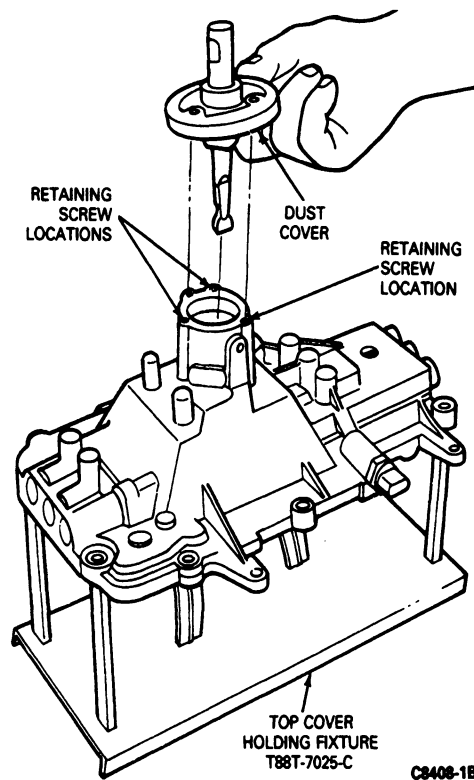
Top Cover**Disassembly**

- Position top cover assembly into Top Cover Holding Fixture T88T-7025-C or equivalent.

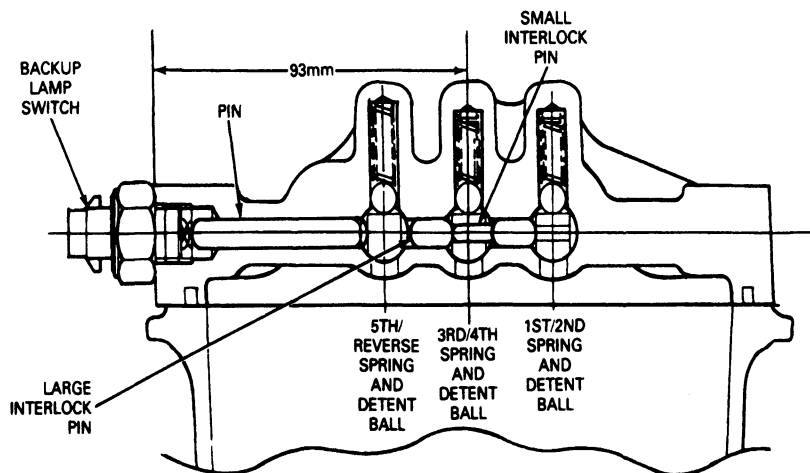
NOTE: For reference during assembly, notice that grooves in bushing align with slots in lower shift lever pivot ball. Notice that the notch in the lower shift lever faces toward front of transmission.

DISASSEMBLY AND ASSEMBLY (Continued)

2. If necessary, remove dust boot and shift lever from top cover, if not removed during transmission disassembly. Remove three dust cover retaining screws using a T30 Torx® wrench. Remove dust cover.



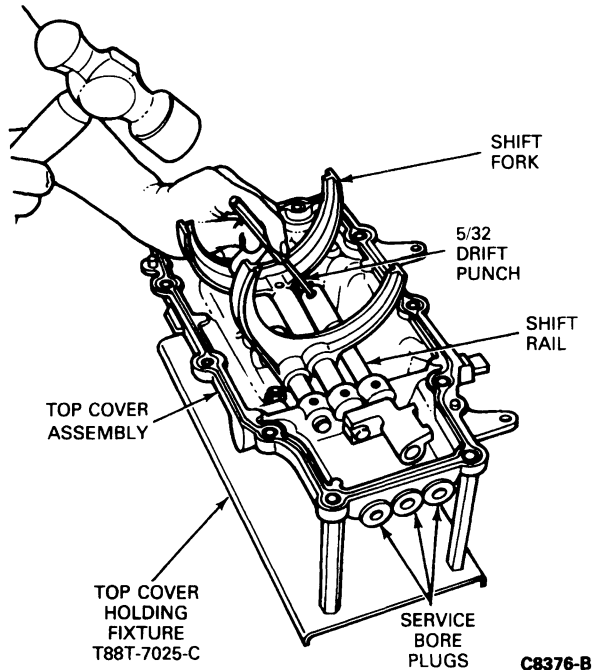
3. Remove backup lamp switch from top cover. Remove backup lamp switch pin from groove in top cover.

Spring and Detent Ball Assembly

DISASSEMBLY AND ASSEMBLY (Continued)

4. Invert top cover assembly on Top Cover Holding Fixture T88T-7025-C or equivalent. Using a 5/32-inch drift punch, remove spring pins retaining shift forks to the shift rail.

NOTE: Discard original spring pins.



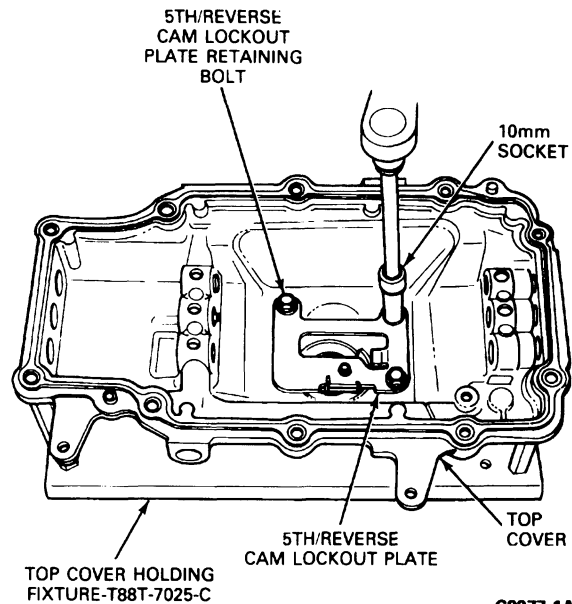
5. Make sure that fifth / reverse shift rail is in fully forward position. Remove spring pin from end of fifth / reverse rail.
6. Remove three rubber plugs sealing shift rod service bores.

CAUTION: Perform the following shift rail removal procedures with great care. Cover the lock ball bores and friction device and spring seats with a clean cloth held firmly in place during shift rail removal. Failure to firmly cover lock ball bores and friction device can result in component loss when the ball / friction device and spring forcefully leave their installed positions.

WARNING: WEAR SAFETY GLASSES WHILE PERFORMING SHIFT RAIL REMOVAL PROCEDURE.

7. Remove fifth / reverse shift rail from top cover through service bore. If necessary, insert a 5 / 16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.
8. Remove first / second shift rail from top cover through service bore. If necessary, insert a 5 / 16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.

9. Remove third / fourth shift rail from top cover through service bore. If necessary, insert a drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.
10. Remove fifth / reverse cam lockout plate retaining bolts using a 10mm socket. Remove fifth / reverse cam lockout plate.



C8377-1A

Assembly

NOTE: During assembly apply Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent to all rotating or sliding parts.

1. Position top cover into Top Cover Holding Fixture T88T-7025-C or equivalent.
2. Position fifth / reverse cam lockout plate to top cover. Install fifth / reverse cam lockout plate retaining bolts and tighten to 8-10 N·m (6-7 ft-lb).
3. Position third / fourth shift rail into top cover through service bore. If necessary, insert a 5 / 16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining forward pressure. Position detent ball and spring into top cover spring seats. Compress the detent ball and spring assembly using a suitable tool, and push shift rail into position over detent ball. Engage third / fourth shift fork with shift rail. Position friction device and spring into top cover spring seats. Compress friction device and spring assembly using a suitable tool, and push shift rail into position over friction device. Install spring pins retaining shift rail to top cover. Install spring retaining third / fourth shift fork to shift rail.

DISASSEMBLY AND ASSEMBLY (Continued)

4. Position first / second shift rail into top cover through service bore. If necessary, insert a 5 / 16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining forward pressure. Position detent ball and spring into top cover spring seats. Compress the detent ball and spring assembly using a suitable tool and push shift rail into position over detent ball. Engage first / second shift fork with shift rail. Position friction device and spring into top cover spring seats. Compress friction device and spring assembly using a suitable tool, and push shift rail into position over friction device. Install spring pins retaining shift rail to top cover. Install spring pin retaining first / second shift fork to shift rail.
5. Position fifth / reverse shift rail to top cover through service bore. If necessary, insert a 5 / 16-inch drift punch through spring pin bore and gently rock from side to side while maintaining forward pressure. Position detent ball and spring into spring seats. Compress the detent ball and spring using a suitable tool, and push shift rail into position over detent ball. Engage fifth / reverse shift fork with shift rail. Install spring pins retaining shift rail to top cover. Install spring pin retaining fifth / reverse shift fork to shift rail.
6. Install rubber plugs into service bores.
7. Install interlock pins into first / second and third / fourth shift rails. Make sure that large and small interlock pins are installed into their original positions.
CAUTION: Improper installation of interlock pins will prevent activation of neutral switch and/or backup lamp switch.
8. Apply sealant to backup lamp switch and neutral switch threads. Install switches to top cover and tighten to 25-35 N·m (18-26 ft-lb).
9. Position lower shift lever and dust cover assembly to top cover. Install three retaining screws and tighten to 8-11 N·m (6-8 ft-lb).

Cleaning and Inspection**Cleaning**

1. Wash all parts, except seals, in a suitable cleaning solvent. Brush or scrape all foreign matter from the parts. Be careful not to damage any parts with the scraper. Do not clean, wash, or soak transmission seals in cleaning solvent. Dry all parts with compressed air.
2. Rotate the bearings in a cleaning solvent until all lubricant is removed. Hold the bearing assembly to prevent it from rotating while drying it with compressed air.
3. Lubricate the bearings with approved transmission lubricant. Wrap them in a clean, lint-free cloth or paper, until ready for use.

Inspection

1. Inspect transmission case and housing for cracks, worn or damaged bores, damaged threads, or any other damage that could affect operation of the transmission. Inspect the machined mating surfaces for burrs, nicks or damage.
2. Inspect the front face of case for small nicks or burrs that could cause misalignment of transmission with flywheel housing. Remove all small nicks or burrs with a fine stone.
3. Inspect bell housing for cracks. Make sure the machined mating surfaces are free from burrs, nicks, or any other damage.
4. Check the condition of shift levers, forks, shift rails and shafts.
5. Inspect ball bearings. Refer to Bearing Inspection.

Bearing Raceways

NOTE: Bearings that have been removed using special service tools may have been damaged simply due to the tool design. Be sure the following checks are made to determine if the bearing can be put back into service.

1. Inner Ring Raceway — While holding outer ring stationary, rotate inner ring at least three revolutions. Examine raceway of inner ring for pits or spalling. If pits or spalling are unacceptable, replace the bearing assembly. Light particle indentation is acceptable.
2. Outer Ring Raceway — While holding inner ring stationary, rotate outer ring at least three revolutions. Examine raceway of the outer ring from the same side as the raceway of the inner ring. If raceway is spalled or pitted, similar to that shown, replace the bearing assembly. Light particle indentation is acceptable.

Bearing External Surfaces

The bearing must be replaced if damage is found in any of the following areas:

1. Radial cracks on front and rear faces of outer or inner rings.
2. Cracks on outside diameter or outer ring (particularly around snap ring groove).
3. Deformation or cracks in ball cage (particularly around rivets).

Spin Test

1. Lubricate bearing raceways with a slight amount of clean oil. Turn the bearing back and forth slowly until raceways and balls are coated with oil.

DISASSEMBLY AND ASSEMBLY (Continued)

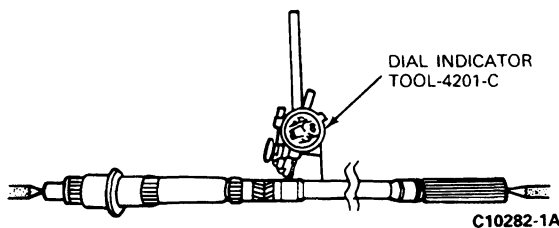
2. Hold bearing by inner ring in a vertical position. Vertical movement between the inner and outer rings is acceptable. Spin outer ring several times by hand (do not use compressed air). If roughness or vibration is noticeable or the outer ring stops abruptly, the bearing should be cleaned again and lubricated. Roughness in a bearing is usually caused by foreign particles in the bearing, which comes from inside the transmission case. If bearing is still rough after cleaning and relubricating three times, it must be replaced.
3. Hold bearing by the inner ring in a horizontal position. Spin outer ring several times by hand (do not use compressed air). If bearing is still rough after cleaning and re-lubricating three times (if not done in Step 2), it must be replaced. If bearing passes the visual inspection and spin tests, it can be re-installed in transmission.

Gear Inspection

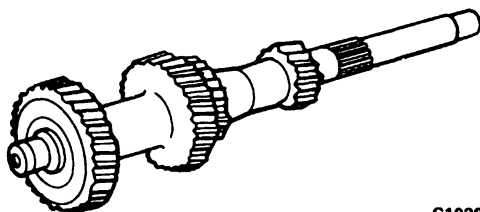
Inspect the teeth of each gear. If excessively worn, broken or chipped, replace the gear. Excessive wear increases backlash, which results in noise and unacceptable operating characteristics.

Shaft Inspection

1. Check output shaft for run-out by mounting the shaft between V-blocks and applying dial indicator TOOL-4201-C or equivalent to several places along shaft. The standard reading of the indicator for run-out should be less than 0.05mm (0.002 inch). If run-out exceeds 0.05mm (0.002 inch), replace shaft.



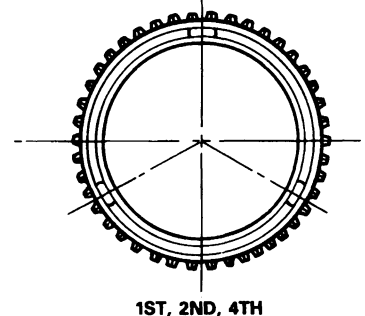
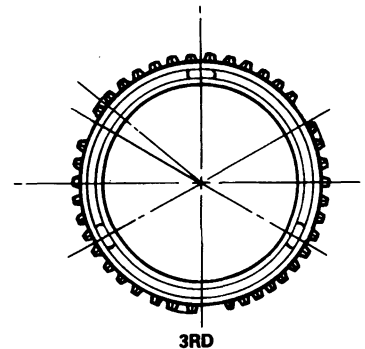
2. Replace input shaft if splines are damaged. If needle bearing contact surfaces are worn, rough, or other bearing contact surfaces are damaged, replace shaft.
3. Check countershaft gear teeth and countershaft splines for wear or damage. Replace countershaft if bent, scored, or worn.

**Synchronizer Mechanism**

1. Inspect gear teeth on synchronizer ring. If there is evidence of chipping or excessively worn teeth, replace with new parts.
2. Inspect synchronizer ring for wear. To check the wear of synchronizer ring, fit synchronizer ring evenly to gear cone. Measure clearance between side faces of synchronizer ring and gear with a feeler gauge. If clearance is less than 0.8mm (0.031 inch), replace synchronizer ring or gear.

NOTE: First / second, third / fourth and fifth / reverse synchronizer-to-gear clearance specifications are the same.

NOTE: Make note of the differences between the 3rd gear synchronizer ring and the 1st, 2nd and 4th gear synchronizer rings. The 3rd gear synchronizer ring or blocker ring, has three teeth cut out 120 degrees apart from each other. Directly adjacent to one side the missing teeth, two teeth have been bridged together. This is to help eliminate any upshift "crunch" that may occur.

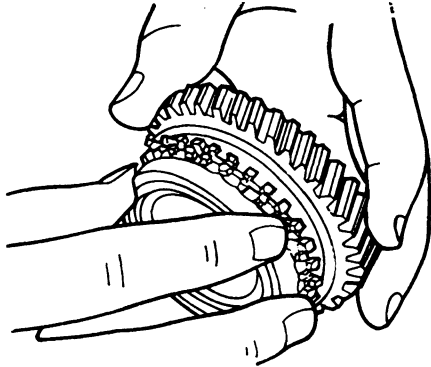


C11129-A

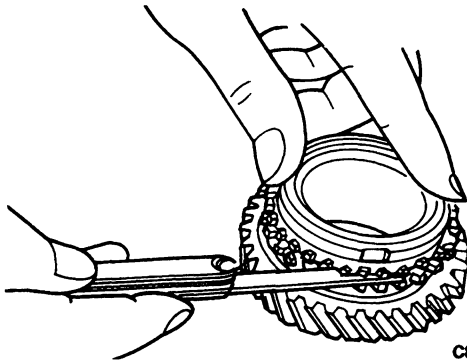
3. Inspect contact between inner surface of synchronizer ring and cone surface of gear. To inspect, apply a thin coat of Prussian Blue or equivalent on cone surface of gear and fit it into the ring. If the contact pattern is poor, correct this by applying compound and lapping surfaces together.
4. Make sure clutch sleeve slides easily onto clutch hub.

DISASSEMBLY AND ASSEMBLY (Continued)

5. Check synchronizer inserts (keys), inner surface of clutch sleeve, and insert groove on clutch hub for wear.
6. Check synchronizer insert spring for tension.



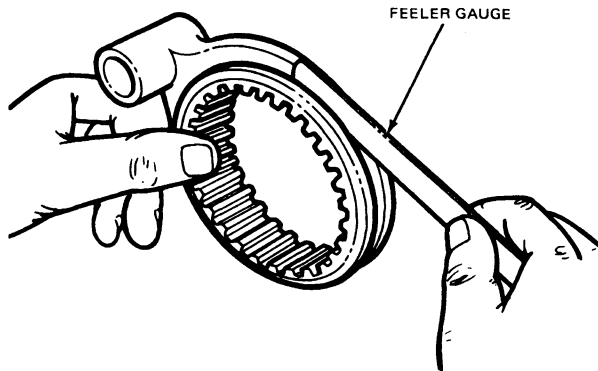
C8656-1A



C8657-1A

Shift Fork / Clutch Hub Sleeve

Check the contact surfaces of the shift fork and clutch hub sleeve for evidence of wear or damage. Measure from shift fork to the clutch hub sleeve. Clearance should not exceed 0.8mm (0.031 inch).



C3437-1A

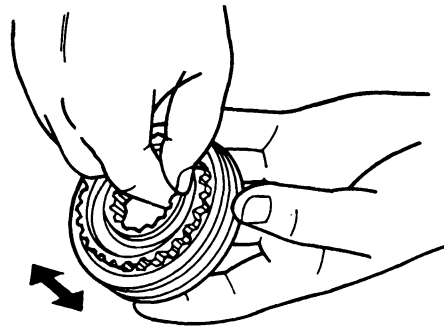
CLUTCH HUB SLEEVE-TO-SHIFT FORK CLEARANCE (R2)

Standard	Maximum
1st / 2nd 0.1-0.4mm (0.003-0.015)	0.8mm (0.314 in.)
3rd / 4th 0.1-0.4mm (0.003-0.015 in.)	0.8mm (0.314 in.)
5th / Rev 0.1-0.4mm (0.003-0.015 in.)	0.8mm (0.314 in.)

TC8662A

Clutch Hub

1. Check operation of clutch hub sleeve installed onto hub.
2. Position clutch hub and sleeve horizontally. Lift the hub approximately three-quarters of the way off the sleeve. Release the hub, and observe downward motion. Hub should slide downward into sleeve on its own. It should not be necessary to push hub into sleeve. Service as necessary.



C8658-1A

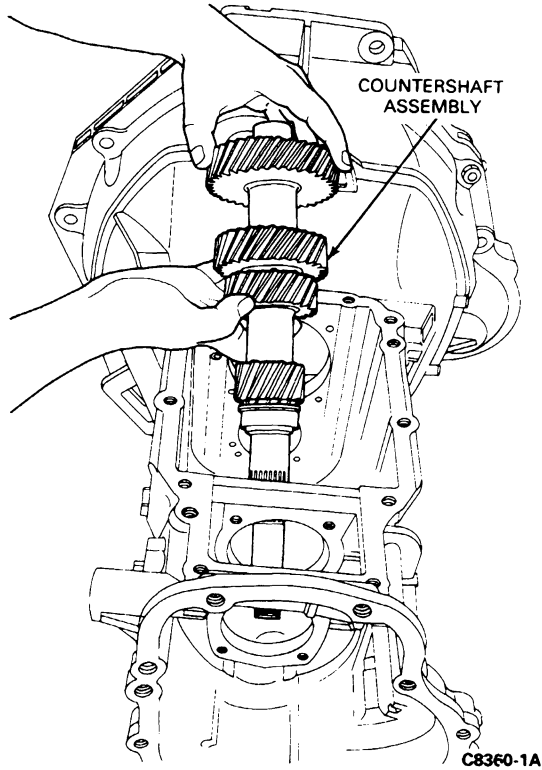
Extension Housing

Inspect the extension housing for cracks. Make sure that the machined mating surfaces are free from burrs, nicks or any other damage. If necessary, replace the oil seal after the extension housing has been installed onto the transmission.

NOTE: The extension housing rear bushing cannot be serviced. If it requires service, the extension housing must be replaced as a unit (4x2 models only).

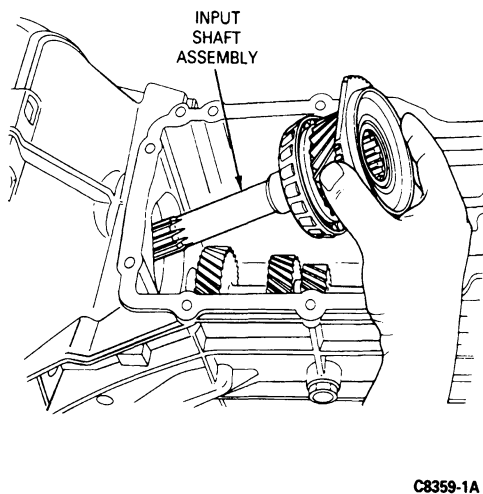
DISASSEMBLY AND ASSEMBLY (Continued)**Transmission Assembly**

1. Position countershaft into transmission case through top opening.



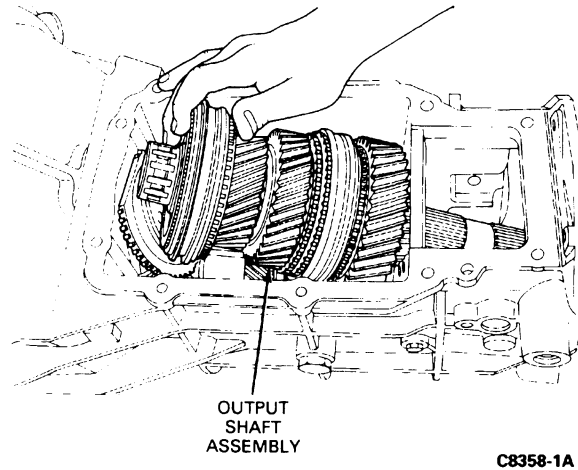
2. Position input shaft into transmission case through top opening.

NOTE: Make sure that needle roller bearing is installed into input shaft.

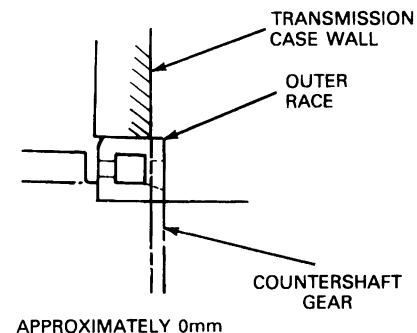
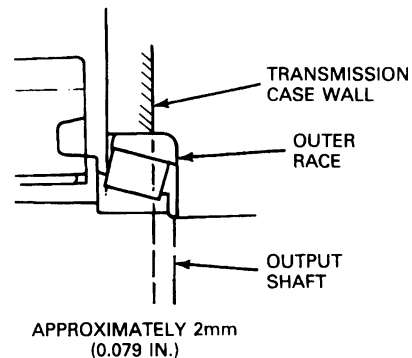


3. Position output shaft assembly into transmission case. Mate input and output shaft assemblies by positioning them at an upward angle and setting them together.

NOTE: Make sure that fourth gear synchronizer ring is installed at this time.

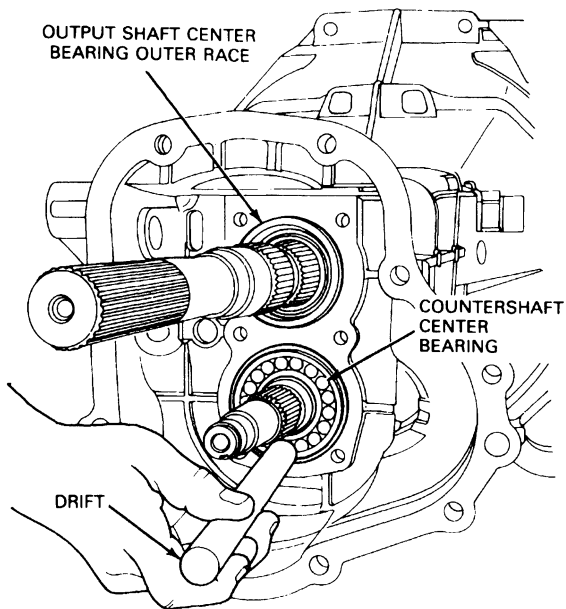


4. Install output shaft center bearing outer race using a brass drift. Seat center bearing outer races, maintaining bearing position illustrated.



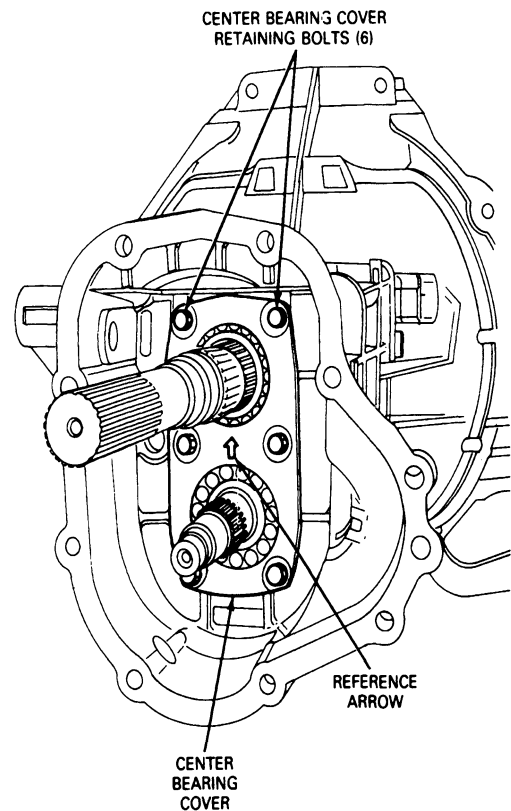
C8406-C

DISASSEMBLY AND ASSEMBLY (Continued)



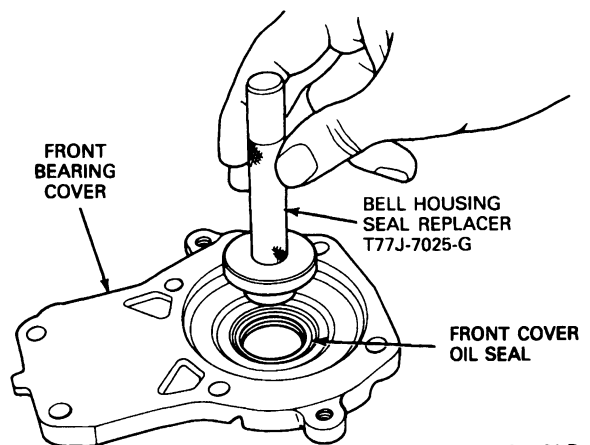
C8380-1A

5. Install countershaft center bearing.
NOTE: Make sure that center bearing outer races are squarely positioned in bores.
6. Position center bearing cover to transmission case with reference arrow pointing upward. Install and tighten center bearing cover retaining bolts to 18-26 N·m (14-19 ft-lb).
NOTE: Make sure that all center bearing cover retaining bolt heads are marked with an "8".
NOTE: For reference during assembly, observe that reference arrow in middle of center bearing cover points upward. Observe that flanged side of center bearing cover faces inward.



C8354-1B

7. Position transmission vertically (input shaft and clutch housing facing upward). Make sure that input shaft front bearing outer race is squarely positioned in bore. If removed, install front cover oil seal using Bell Housing Seal Replacer T77J-7025-G or equivalent.

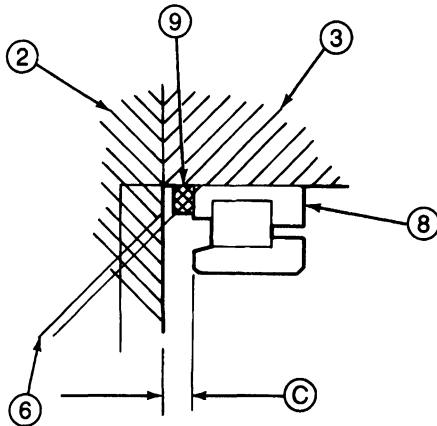
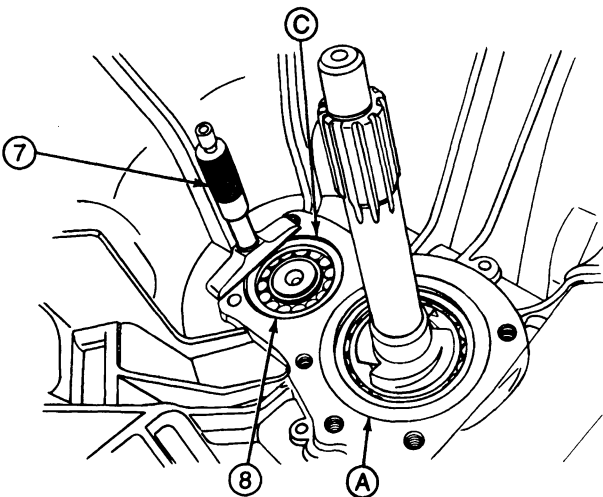
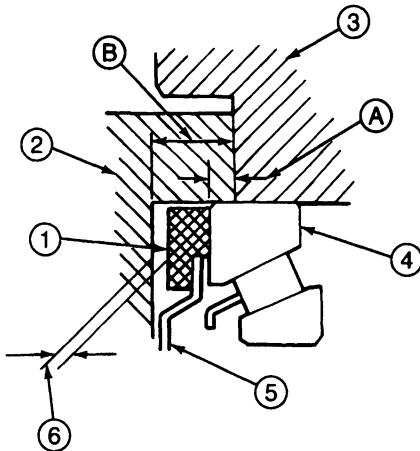
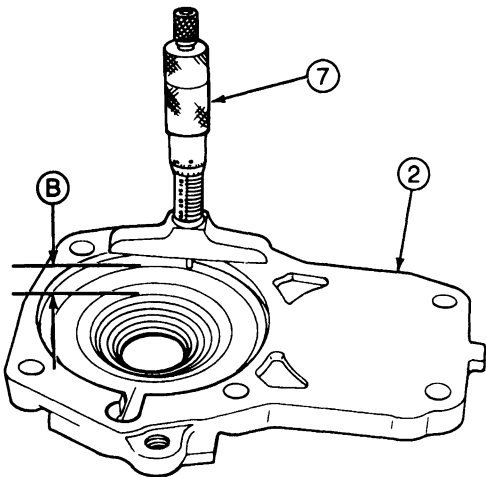


C11131-B

DISASSEMBLY AND ASSEMBLY (Continued)

8. Install countershaft front bearing by hand.
- NOTE: If any related parts (such as output shaft, bearing, etc.) have been replaced, measure dimensions A, B, C and D as illustrated. After measuring all dimensions, select bearing shim to maintain end play within specified limits.

Measuring to Select Shim Thickness



C11162-A

Item	Part Number	Description
1	—	Selective Shim (Input Shaft)
2	7050	Front Cover
3	7005	Transmission Case
4	7025	Input Gear Bearing Outer Race
5	7040	Oil Baffle
6	—	End Play Area

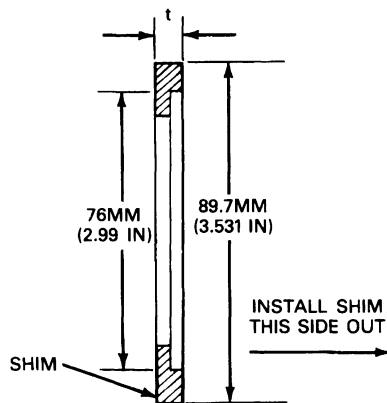
(Continued)

Item	Part Number	Description
7	D82L-4201-C	Depth Micrometer
8	7065	Countershaft Front Bearing Race
9	—	Selective Shim (Countershaft)
A	—	Dimension "A"
B	—	Dimension "B"
C	—	Dimension "C"

TC11162A

DISASSEMBLY AND ASSEMBLY (Continued)

- **Dimension A:** Height of input shaft bearing outer race above transmission front bearing cover mating surface.
- **Dimension B:** Depth of front cover outer race bore (input shaft).
- **Dimension C:** Depth of countershaft front bearing race (transmission case to front cover mating surface). bore (countershaft).
- Shim computation equations are as follows:
 Dimension B - (Dimension A + shim thickness) = 0.05 to 0.15mm (0.002 to 0.006 inch)
 Dimension C - (shim thickness) = 0.15 to 0.25mm (0.006 to 0.010 inch)

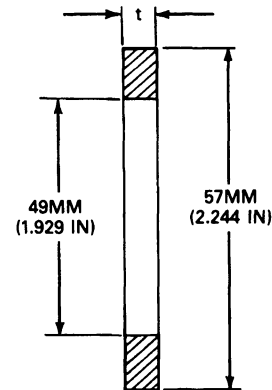


C10839-A

OUTPUT SHAFT SHIM SELECT CHART — M50D R2

Part Number	Thickness (t)
E8TZ-7029-FA	1.4mm (0.0551 in.)
E8TZ-7029-GA	1.5mm (0.0590 in.)
E8TZ-7029-HA	1.6mm (0.0629 in.)
E8TZ-7029-JA	1.7mm (0.0669 in.)
E8TZ-7029-S	1.8mm (0.0708 in.)
E8TZ-7029-T	1.9mm (0.0748 in.)
E8TZ-7029-U	2.0mm (0.0787 in.)
E8TZ-7029-V	2.1mm (0.0826 in.)
E8TZ-7029-W	2.2mm (0.0866 in.)
E8TZ-7029-X	2.3mm (0.0905 in.)
E8TZ-7029-Y	2.4mm (0.0944 in.)
E8TZ-7029-Z	2.5mm (0.0984 in.)
E8TZ-7029-AA	2.6mm (0.1023 in.)
E8TZ-7029-BA	2.7mm (0.1062 in.)
E8TZ-7029-CA	2.8mm (0.1102 in.)
E8TZ-7029-DA	2.9mm (0.1141 in.)
E8TZ-7029-EA	3.0mm (0.1181 in.)

TCC8395B



C10838-A

COUNTERSHAFT SPACER SELECT CHART — M50D-R2

Part Number	Thickness (t)
E8TZ-7C434-K	3.1mm (0.122 in.)
E8TZ-7C434-L	3.2mm (0.125 in.)
E8TZ-7C434-M	3.3mm (0.129 in.)
E8TZ-7C434-N	3.4mm (0.133 in.)
E8TZ-7C434-P	3.5mm (0.137 in.)
E8TZ-7C434-R	3.6mm (0.141 in.)
E8TZ-7C434-S	3.7mm (0.145 in.)
E8TZ-7C434-T	3.0mm (0.1181 in.)

TCC8396B

9. Remove any sealant residue remaining on mating surfaces of transmission and front cover.

NOTE: To prevent damage to oil seal lip during assembly, tape the input shaft splines along their entire length.

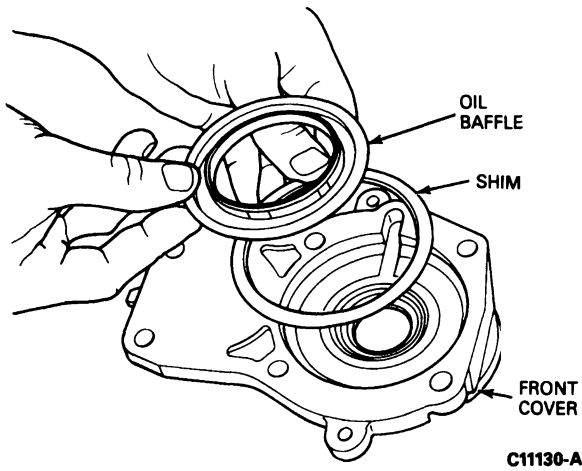
10. Apply a thin coat of oil to front cover oil seal lip. Position bearing shim and baffle plate into front cover (install shim with groove showing). Install spacer to transmission case countershaft front bearing bore.

NOTE: If necessary, apply a sufficient quantity of grease to shim, bearing cover and oil baffle to retain them in position during assembly.

DISASSEMBLY AND ASSEMBLY (Continued)

11. Apply a 1/8-inch bead of Silicone Rubber D6AZ-19562-BA (ESE-M4G195-A) or equivalent to front cover and front cover retaining bolt threads. Install front bearing cover to transmission case. Install and tighten front bearing cover retaining bolts to 16-22 N·m (12-16 ft·lb).

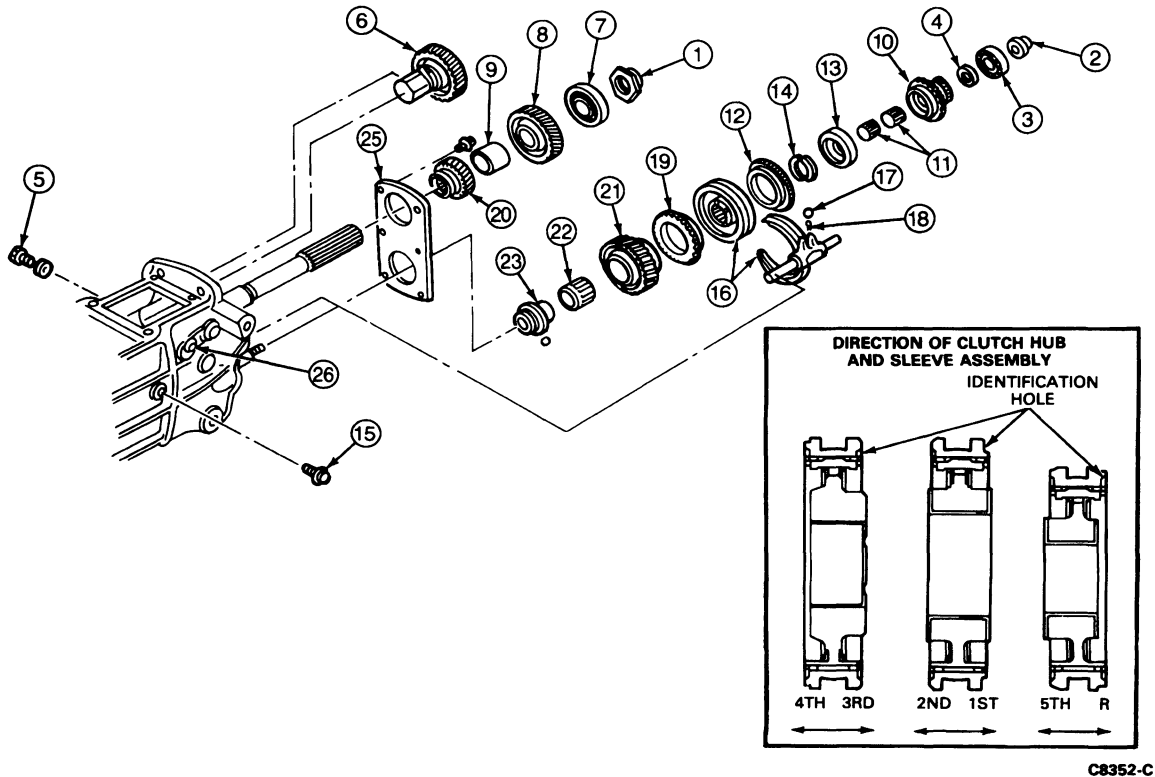
NOTE: Make sure that front bearing cover retaining bolt heads are marked with a "6".



12. Position transmission horizontally in holding fixture. Assemble the following parts in the order listed.

- Ball
- Fifth gear sleeve

NOTE: Install fifth gear sleeve using nut, Shaft Adapter Replacing T75L-7025-L, Adapter T88T-7025-J2 and Remover / Replacer Tube T75L-7025-B or equivalents.

Transmission, Rear Housing

DISASSEMBLY AND ASSEMBLY (Continued)

TRANSMISSION, REAR HOUSING (LEGEND)

Item No.	Description
1	Locknut — Output Shaft
2	Locknut — Countershaft
3	Countershaft Rear Bearing
4	Thrust Washer
5	Holding Bolt — Reverse Idler Gear
6	Reverse Idle Gear Assembly
7	Bearing — Output Shaft Rear
8	Reverse Gear — Output Shaft
9	Sleeve — Output Shaft
10	Countershaft Reverse Gear
11	Needle Bearings
12	Synchronizer Ring — Reverse
13	Thrust Washer

Item No.	Description
14	Split Washer (2 Pcs.)
15	Holding Bolt — Shift Rod
16	Shift Rail/Fork/Hub/Sleeve Assembly
17	Lock Ball (Steel) Shift Rail
18	Spring — Shift Rail
19	Synchronizer Ring — 5th Gear
20	5th Gear — Output Shaft
21	5th Gear — Countershaft
22	Needle Bearing — 5th Gear (Two Halves)
23	Sleeve — 5th Gear
24	Ball
25	Center Bearing Cover
26	5th/Reverse Counter Lever Lockplate Retaining Bolt

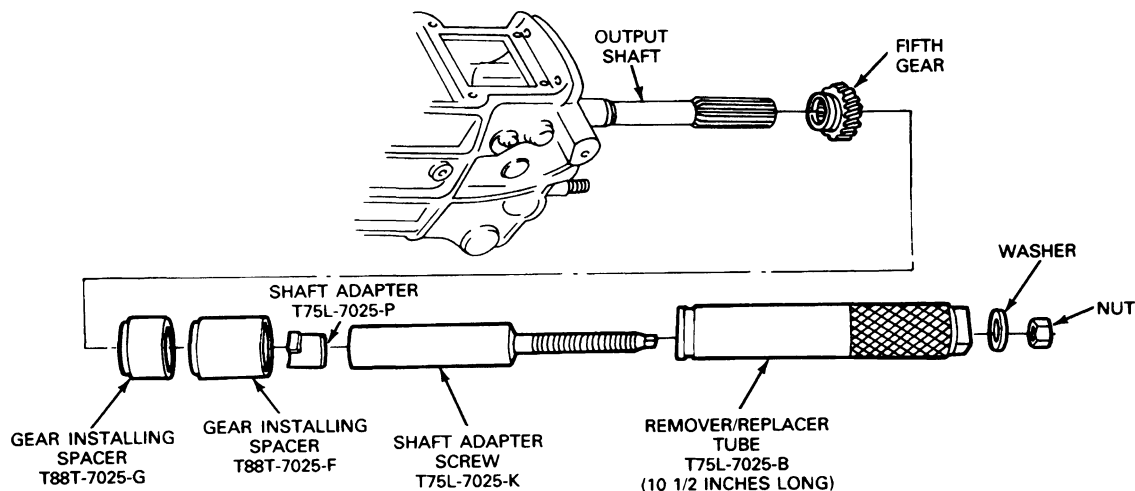
CC11128-A

13. Install fifth gear needle bearing onto fifth gear (countershaft).
14. Install fifth gear onto output shaft using Gear Installing Spacer T88T-7025-F, Gear Installing Spacer T88T-7025-G, Shaft Adapter T75L-7025-P, Shaft Adapter Screw T75L-7025-K, Remover / Replacer Tube T75L-7025-B (4x2 models only) or Remover / Replacer Tube T85T-7025-A (4x4 models only), nut and washer or equivalents. Make sure that long flange on fifth gear faces forward.

NOTE (4x2 models): To install fifth gear assembly, perform the process in two steps. First, install Gear Installing Spacer T88T-7025-F. When tool bottoms, add Gear Installing Spacer T88T-7025-G and press fifth gear assembly the rest of the way into position.

NOTE (4x4 models): Installation of fifth gear assembly is similar to 4x2 installation except that Remover / Replacer Tube T85T-7025-A and TOD Bearing Remover / Replacer Adapter T84T-7025-A are used.

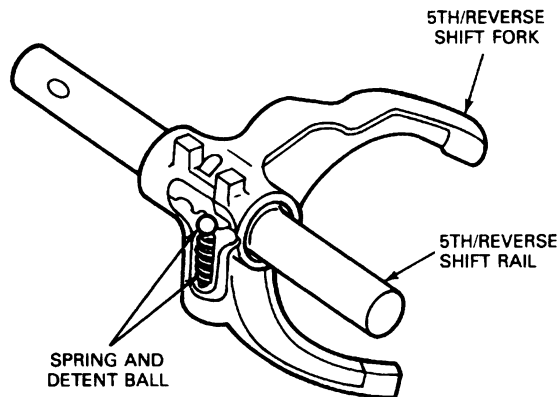
Output Shaft Rear Bearing Installation



C8665-2C

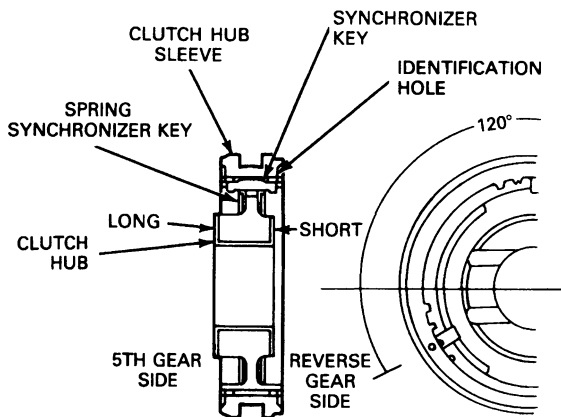
DISASSEMBLY AND ASSEMBLY (Continued)

15. Position counter lever assembly to transmission and install thrust washer and retaining ring. Apply sealant to counter lever fixing bolt threads. Install counter lever fixing bolt and tighten to 8-10 N·m (6-7 ft-lb).
16. If removed, position fifth / reverse shift fork and shift rail to top cover. Insert fifth / reverse shift rail through top cover bore and fifth / reverse shift fork. Install spring and detent ball to lower part of rod.



C8386-1A

17. Assemble the fifth / reverse synchronizer hub, sleeve, and fifth gear synchronizer ring to fifth / reverse shift fork and rod assembly. Make sure to install the longer flange (on the fifth / reverse hub, sleeve, and synchronizer assembly) toward the front of transmission. The identification hole on synchronizer sleeve must be installed toward reverse gear side.

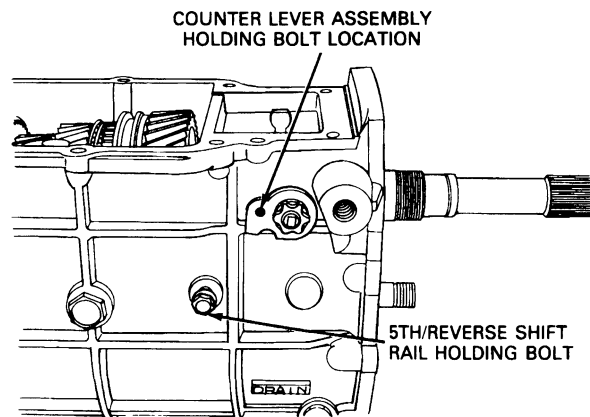


C8387-B

18. Install fifth / reverse shift fork and shift rail assembly (including fifth / reverse synchronizer hub, sleeve and fifth gear synchronizer ring) to countershaft. Mate shift fork gate to fifth / reverse counter lever end. Install fifth / reverse fork and shift rail assembly with threaded fixing bolt bores (in rail and transmission case) aligned with each other.

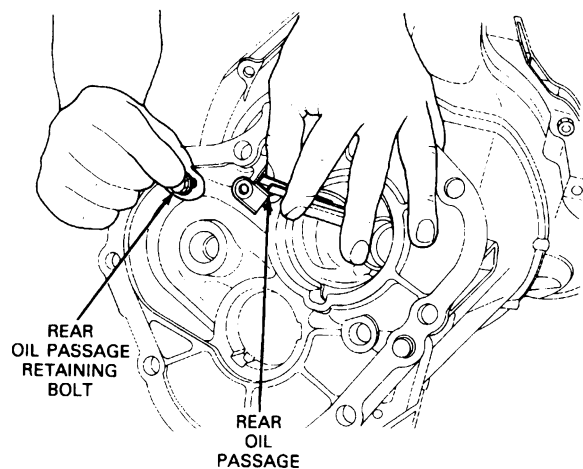
NOTE: To ease installation of the fork and rail assembly, position the fifth / reverse shift fork into the rearmost of the three detent positions (rearmost from threaded bore). Return shift fork to neutral gear position after installation.

- a. Apply sealant to fifth / reverse shift rail holding bolt threads. Install fifth / reverse shift rail fixing bolt to transmission case. Tighten fifth / reverse shift rail holding bolt to 21-30 N·m (16-22 ft-lb).



C8418-B

19. Apply sealant to oil passage retaining bolt. Position oil passage to transmission case and install retaining bolt. Tighten oil passage retaining bolt to 7-10 N·m (6-7 ft-lb).



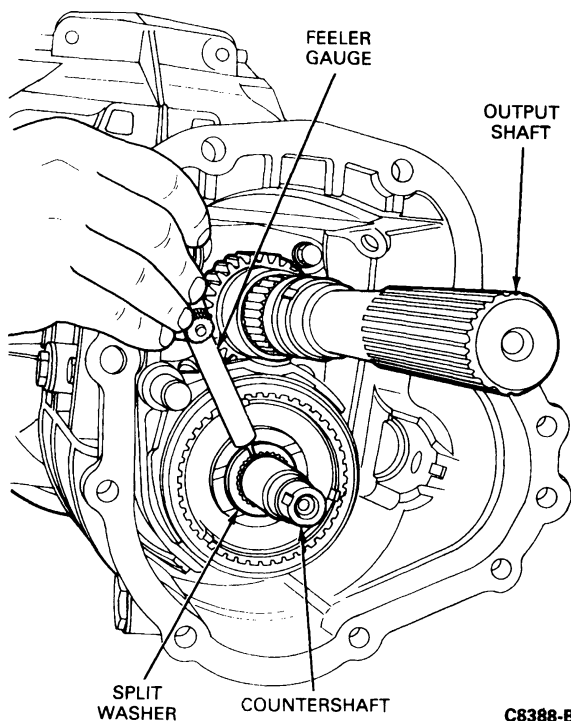
C6721-1A

20. If original clutch hub and / or counter reverse gear are being used, install original split and thrust washers, then proceed to Step 22.

DISASSEMBLY AND ASSEMBLY (Continued)

21. If clutch hub and/or counter reverse gear have been replaced, measure end play using a feeler gauge. Select replacement split washer using the following chart and install new washers onto countershaft.

NOTE: Make sure new split washers are matched, having identical thickness. Refer to Specifications for end play specifications.

**SPLIT WASHER SELECT CHART**

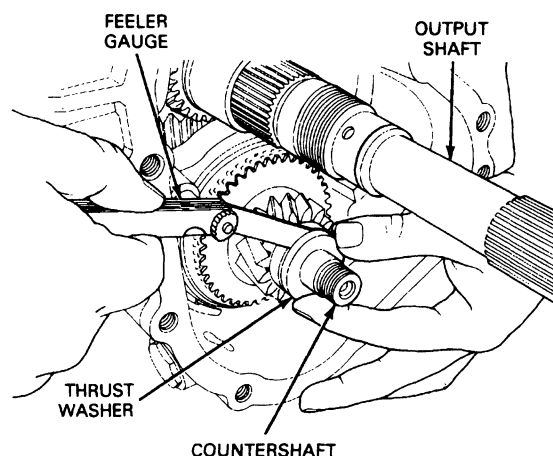
Part Number	Thickness
E8TZ-7R482-A	3.0mm (0.118 in.)
E8TZ-7R482-B	3.1mm (0.122 in.)
E8TZ-7R482-C	3.2mm (0.125 in.)
E8TZ-7R482-D	3.3mm (0.129 in.)
E8TZ-7R482-E	3.4mm (0.133 in.)
E8TZ-7R482-F	3.05mm (0.120 in.)
E8TZ-7R482-G	3.15mm (0.124 in.)
E8TZ-7R482-H	3.25mm (0.127 in.)
E8TZ-7R482-J	3.35mm (0.131 in.)
E8TZ-7R482-K	3.45mm (0.135 in.)
E8TZ-7R482-L	3.50mm (0.137 in.)

TC8389A

22. Install reverse synchronizer ring and needle bearings into counter reverse gear. Install counter reverse gear and needle bearings onto countershaft as an assembly. Install thrust washer to countershaft.

23. Press thrust washer forward (by hand) against shoulder on countershaft. Maintain forward pressure against thrust washer and insert feeler gauge between thrust washer and counter reverse gear. Using the chart, determine correct thrust washer to obtain specified end play. Counter reverse gear end play: 0.25-0.35mm (0.009-0.013 inch).

NOTE: If end play is not correct, the thrust washer that must be replaced is called out as item No. 13. Refer to the exploded view of the transmission rear housing.



C8390-1A

THRUST WASHER SELECT CHART

Part Number	Thickness
E8TZ-7C340-A	7.45mm (0.293 in.)
E8TZ-7C340-B	7.65mm (0.301 in.)
E8TZ-7C340-C	7.85mm (0.309 in.)
E8TZ-7C340-D	7.35mm (0.289 in.)
E8TZ-7C340-E	7.55mm (0.297 in.)
E8TZ-7C340-F	7.75mm (0.305 in.)

TC8397A

24. Temporarily install a suitable spacer (inner bore larger than 21mm, outer bore smaller than 36mm, 15-20mm overall length) in place of countershaft bearing. Loosely install countershaft locknut to retain components.

NOTE: Installation of a suitable spacer prevents thrust washer and split washers from slipping off shaft and avoids interference with reverse idler gears.

25. Install reverse idler gear assembly. Apply sealant to reverse idler gear fixing bolt threads. Install and tighten fixing bolt to 79-117 N·m (58-86 ft-lb).

NOTE: When installing the reverse gear, make sure the longer flange of the gear is facing rearward.

DISASSEMBLY AND ASSEMBLY (Continued)

26. Drive sleeve and reverse gear assembly onto output shaft using Gear Installing Spacer T88T-7025-G, Shaft Adapter T75L-7025-P, Shaft Adapter Screw T75L-7025-K, Remover / Replacer Tube T75L-7025-B (4x2 models only), Remover / Replacer Tube T85T-7025-A (4x4 models only), nut and washer or equivalents.

NOTE: Install reverse gear with longer flange facing rearward.

27. Install output shaft rear bearing using Gear Installing Spacer T88T-7025-G, Shaft Adapter T75L-7025-P, Shaft Adapter Screw T75L-7025-K, Remover / Replacer Tube T75L-7025-B (4x2 models only), or Remover / Replacer Tube T85T-7025-A (4x4 models only), nut and washer, or equivalents.

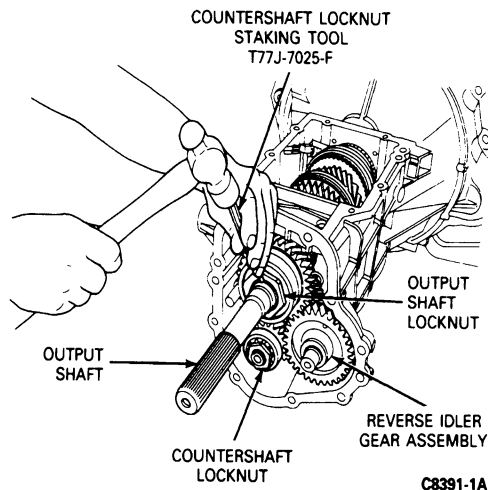
28. Remove temporary spacer from countershaft.

29. Install countershaft rear bearing by hand.

NOTE: Always install new output and countershaft locknuts when assembling transmission. Locknuts unstaked during disassembly cannot be reused.

NOTE: Tightening shaft locknuts without fully seating bearing can cause damage to output shaft threads.

30. Lock transmission into first and third gears. Install new output and countershaft locknuts hand tight. Tighten output shaft locknut to 216-274 N·m (160-202 ft·lb). Tighten countershaft locknut to 128-196 N·m (94-144 ft·lb).
31. Stake (secure) locknuts to bottom of shaft groove using Countershaft Locknut Staking Tool T77J-7025-F or equivalent.



C8391-1A

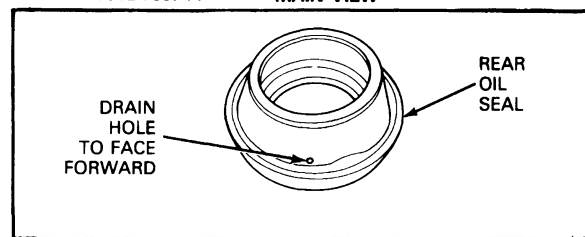
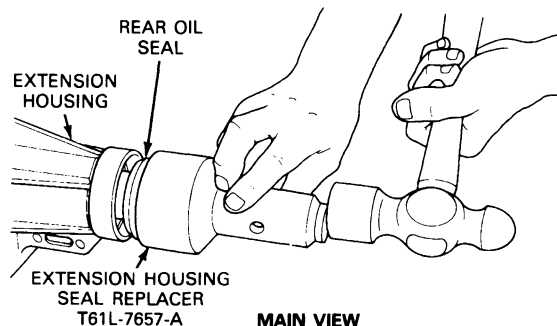
32. Remove any sealant residue from mating surfaces of transmission case and extension housing. Apply a 1/8-inch bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A or ESE-M4G195-A) or equivalent to transmission case.

NOTE: Extension housing bushing cannot be serviced. If bushing requires service, extension housing must be replaced as a unit.

33. Position extension housing to transmission to case, and install extension housing retaining bolts. Tighten bolts to 32-46 N·m (24-34 ft·lb).
34. Place synchronizers into neutral gear position. Make sure that shift forks on top cover assembly are in neutral gear position.

NOTE: Do not apply sealant to top cover or transmission case mating surfaces during top cover installation. If necessary, apply a small quantity of grease to sealing gasket to retain gasket in position during assembly.

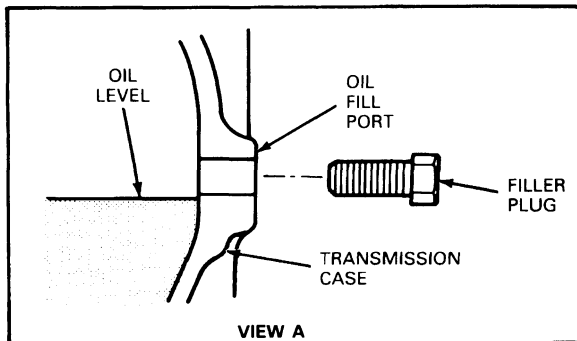
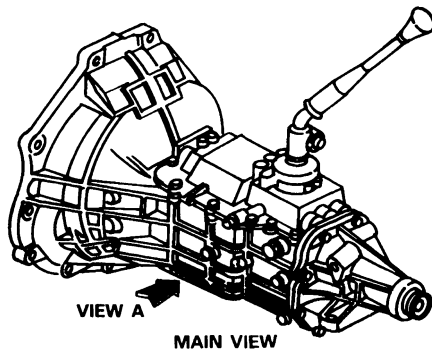
35. Position top cover to transmission case, and carefully engage shift forks with synchronizers. Apply sealant to the two rearmost top cover retaining bolts only, and install them into top cover rear retaining bolt locations. Install remaining top cover retaining bolts (no sealant). Tighten top cover retaining bolts to 16-22 N·m (12-16 ft·lb).
36. Install transmission drain plug and tighten to 40-58 N·m (29-43 ft·lb).
37. If removed, install rear oil seal into extension housing using Extension Housing Seal Replacer T61L-7657-A or equivalent. Make sure that oil seal drain hole faces downward.



C8392-B

DISASSEMBLY AND ASSEMBLY (Continued)

38. Fill transmission with specified quantity of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C 166-H) transmission fluid.



C8651-B

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Lb-Ft
Output Shaft Locknut	216-274	160-203
Countershaft Locknut	128-196	94-144
Extension Housing Retaining Bolts	32-46	24-34
Reverse Idler Shaft Fixing Bolt	79-117	58-86
Center Bearing Cover	18-26	14-19
Front Bearing Cover	16-22	12-17
Fifth / Reverse Cam Lockout Plate	8-10	6-7
Dust Cover	8-11	6-8
Top Cover	16-22	12-16
Filler Plug	40-58	29-43
Front Oil Passage	8-10	6-8
Counter Lever Shaft Fixing Bolt	8-10	6-7
Rock Plate	8-10	6-7
Drain Plug	40-58	29-43
Backup Lamp Switch	25-35	18-26
Neutral Switch (if Equipped)	25-35	18-26
Rear Oil Passage (Extension Housing)	7-10	6-7

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
5th / Reverse Shift Rail Fixing Bolt	21-30	16-22
Clutch Housing to Engine	54-67	40-50
Lower Plate	12-16	9-12
Transfer Case to Transmission	34-58	25-43
Shift Lever Retaining Bolt	16-24	12-18
Crossmember (all) (4x2)	81-108	60-80
Gusset to Frame (4x4)	53-72	39-53
Gusset to Crossmember (4x4)	53-72	39-53
Crossmember to Frame (4x4)	53-72	39-53

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION GEAR RATIOS

GEAR	RATIO
FIRST	3.90
SECOND	2.25
THIRD	1.50
FOURTH	1.00
FIFTH	.80
REVERSE	3.39

TC8403A

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION INSPECTION STANDARDS, TOLERANCE

Component	Inches	Millimeters
Mainshaft Runout Not to Exceed	0.002	0.05
Shift Fork to Clutch Sleeve Not to Exceed	0.031	0.8
Synchronizer Ring to Conical Face of Gear	0.059	1.5

TC8399A

APPROXIMATE LUBRICANT REFILL CAPACITY

Transmission	U.S. Pints	Liters
Five-Speed Manual Overdrive Transmission Motorcraft MERCON® (Ford Manual Transmission) Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX, E4AZ-19582-B (ESP-M2C 166-H) or equivalent.	7.6	3.55

TC8409A

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION ASSEMBLY STANDARDS

Component	Tolerance	
	Inches	Millimeters
3rd / 4th Clutch Hub Play	0.00-0.0019	0.00-0.05
Reverse Idler Gear End Play	0.0039-0.0078	0.1-0.2

(Continued)

SPECIFICATIONS (Continued)

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION
ASSEMBLY STANDARDS (Cont'd)

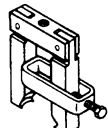

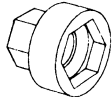
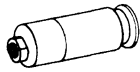
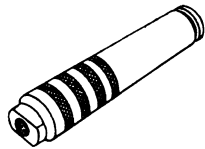

Component	Tolerance	
	Inches	Millimeters
5th / Rev. Hub End Play	0.00-0.0019	0.00-0.05
Counter Reverse Gear	0.0098-0.0138	0.25-0.35

TC8400A

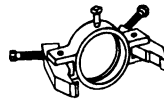


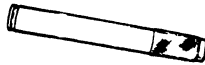

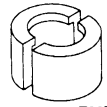
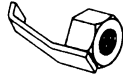



SPECIAL SERVICE TOOLS

NOTE: The following tools are included in Tool Kit Number T-1988-F-FLM-LT

SPECIAL SERVICE TOOLS




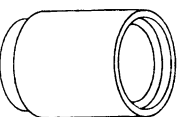
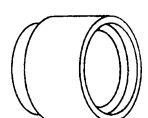

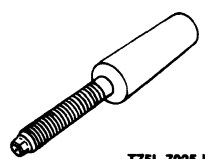
Tool Number / Description	Illustration
T74P-77248-A Extension Housing Seal Remover	 T74P-77248-A
T77J-7025-F Countershaft Locknut Staking Tool	 T77J-7025-F
T88T-7025-AR Mainshaft Locknut Wrench	 T88T-7025-AR
T77J-7025-B Remover / Replacer Tube	 T77J-7025-B
T75L-7025-B Remover / Replacer Tube	 T75L-7025-B
T84T-7025-B TOD Forcing Screw	 T84T-7025-B

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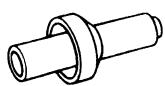

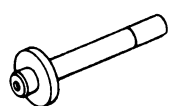

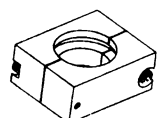
Tool Number / Description	Illustration
T77J-7025-H Bearing Puller	 T77J-7025-H
T77J-7025-J Puller Ring	 T77J-7025-J
T75L-7025-G Bearing Collet Sleeve for 3.5 Inch Bearing Collets	 T75L-7025-G
T85T-7025-A Remover / Replacer Tube	 T85T-7025-A
T84T-7025-A TOD Bearing Remover / Replacer Adapter	 T84T-7025-A
T88T-7061-A Gear Removal Collet	 T88T-7061-A
T88T-7120-A Bearing Race Puller	 T88T-7120-A
T50T-100-A Slide Hammer	 T50T-100-A
T53T-4621-B Bearing Replacer	 T53T-4621-B
T88T-7025-B Bearing Cone Replacer	 T88T-7025-B

(Continued)

SPECIAL SERVICE TOOLS (Continued)

Tool Number / Description	Illustration
T75L-1165-B Bearing Plate	 T75L-1165-B
T71P-4621-B Bearing Cone Remove	 T71P-4621-B
T88T-7025-C Top Cover Holding Fixture	 T88T-7025-C
T88T-7025-F Gear Installing Spacer	 T88T-7025-F
T88T-7025-G Gear Installing Spacer	 T88T-7025-G
T75L-7025-P Shaft Adapter	 T75L-7025-P
T75L-7025-K Shaft Adapter Screw	 T75L-7025-K

(Continued)

Tool Number / Description	Illustration
T61L-7657-A Extension Housing Seal Replacer	 T61L-7657-A
TOOL-4201-C Dial Indicator	 TOOL-4201-C
T77J-7025-G Bell Housing Seal Replacer	 T77J-7025-G
T75L-7025-L Shaft Adapter — Replacing	 T75L-7025-L
T88T-7025-J Countershaft Fifth Gear Sleeve Puller	 T88T-7025-J

ROTUNDA EQUIPMENT

Tool Number	Description
077-00008	Transmission Jack

SECTION 07-03B Transmission, Manual, Four-Speed

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION AND OPERATION	07-03B-1	REMOVAL AND INSTALLATION	
DIAGNOSIS AND TESTING.....	07-03B-1	Crossmember, F-150-250 and Bronco.....	07-03B-3
DISASSEMBLY AND ASSEMBLY		Shift Lever.....	07-03B-5
Countershaft Gear.....	07-03B-10	Transmission.....	07-03B-1
Gear Shift Housing.....	07-03B-10	F-150-250 4x2	07-03B-1
Output Shaft.....	07-03B-10	F-150-250 4x4 and Bronco	07-03B-2
Reverse Idler Gear.....	07-03B-10	SPECIAL SERVICE TOOLS/EQUIPMENT.....	07-03B-15
Transmission.....	07-03B-5	SPECIFICATIONS.....	07-03B-14
		VEHICLE APPLICATION	07-03B-1

VEHICLE APPLICATION

Applies to F-150-250 4x2 and 4x4, under 8500lbs.
GVW and Bronco Vehicles

DESCRIPTION AND OPERATION

The four-speed Model T-18 transmission is equipped with a center, floor-mounted gear shift lever.

The first and reverse gears are spur gears (not synchronized) and the second, third and fourth speed gears are helical cut and are synchronized for ease in shifting.

The input shaft is supported by the crankshaft pilot bearing and by a ball bearing, which is pressed onto the shaft and into the transmission case.

The front end of the output shaft is supported by a pilot bearing installed in the input shaft. The rear end of the output shaft is supported by a ball bearing which is pressed onto the shaft and into the transmission case. The bearing and shaft are retained in the case by a snap ring. The rear oil seal and rear bushing are contained in the extension housing, which is bolted to the rear of the case on F-150-250 4x2 only.

DIAGNOSIS AND TESTING

Refer to Section 07-00B for Diagnosis and Testing Procedures.

REMOVAL AND INSTALLATION

Transmission

F-150-250 4x2

Removal

1. Remove the upper gearshift lever, shift ball boot and vapor seal as an assembly. Remove the isolator pad.
2. Raise the vehicle and position safety stands. Position a transmission jack such as Rotunda 066-00017, or equivalent under the transmission.
3. Disconnect the back-up lamp switch wiring located at the rear of the gear shift housing cover.
4. Disconnect the driveshaft or coupling shaft and clutch actuator from the transmission and wire it to one side.

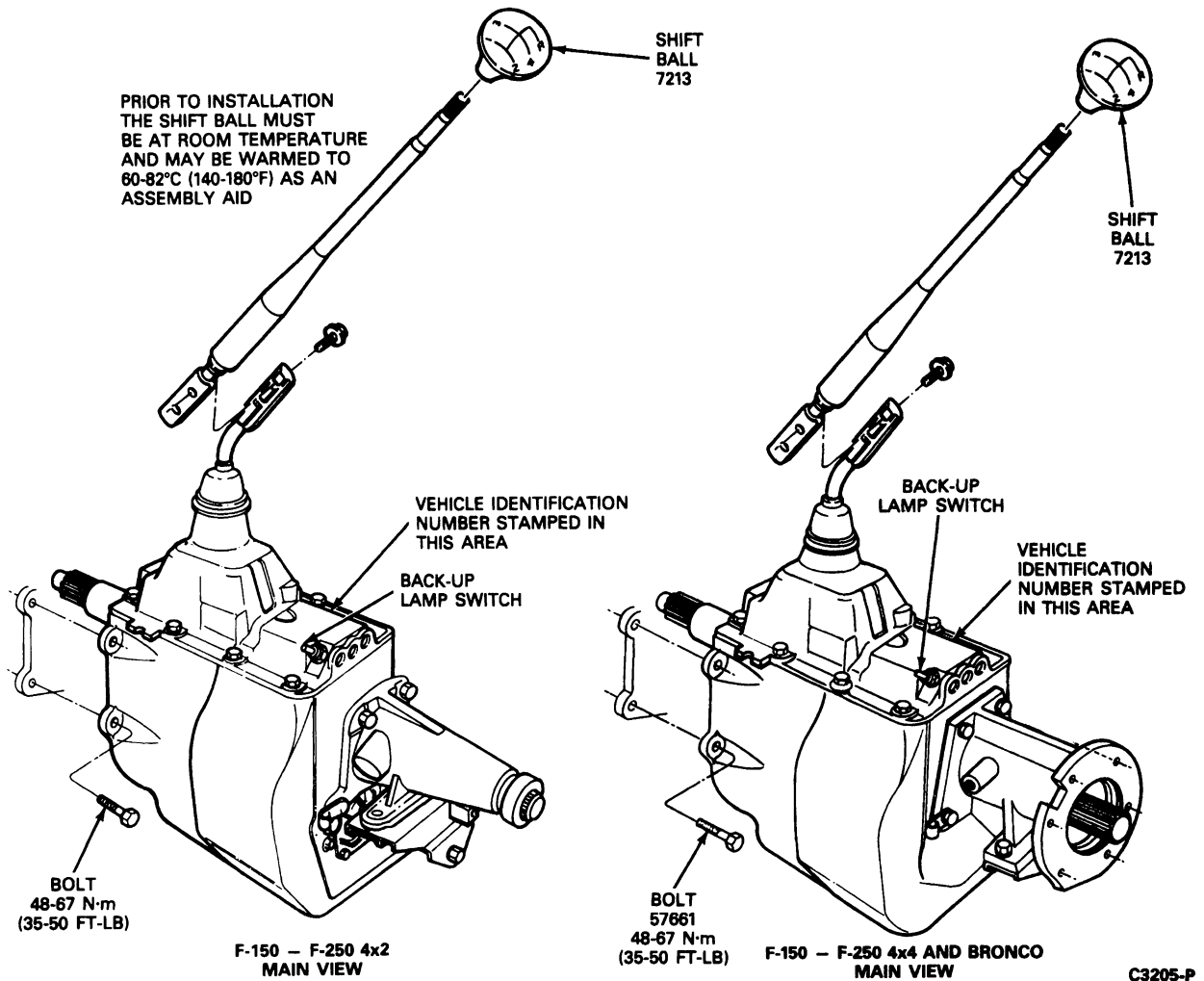
5. Disconnect the transmission mount and remove the transmission crossmember.
6. Remove the transmission attaching bolts.
7. Move the transmission to the rear until the input shaft clears the clutch housing. Lower the transmission.

Installation

1. Place the transmission on a transmission jack, install guide studs in the clutch housing and raise the transmission until the input shaft splines are aligned with the clutch disc splines. The clutch release bearing and hub must be properly positioned in the release lever fork.

REMOVAL AND INSTALLATION (Continued)

2. Slide the transmission forward on the guide studs until it is in position on the clutch housing. Install the attaching bolts and tighten them to 48-67 N·m (35-50 ft-lb). Remove the guide studs and install the two lower attaching bolts.
3. Install the crossmember and transmission mount. Tighten fasteners to specifications.
4. Connect the clutch actuator.
5. Install the bolts attaching the front U-joint of the coupling shaft to the transmission output shaft flange. Tighten the bolts and nuts to specifications as listed in the specifications of Section 05-01.
6. Connect the back-up lamp switch wiring.
7. Install the shift lever, boot, vapor seal and shift ball as an assembly and lubricate the spherical ball seat with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.

Transmission, F-150-250 4x2 and 4x4**F-150-250 4x4 and Bronco****Removal**

1. Open door and cover seat.
2. Remove the four screws holding the boot.
3. Remove two bolts holding upper shift lever.
4. Remove transmission shift lever, shift ball, boot and vapor seal as an assembly.
5. Raise the vehicle on a hoist.
6. Remove the drain plug and drain the transmission.
7. Disconnect the rear driveshaft from the transfer case and wire it out of the way.
8. Disconnect the front driveshaft from the transfer case and wire it out of the way.
9. Remove the shift link from transfer case.

REMOVAL AND INSTALLATION (Continued)

10. Remove transfer case drain plug and drain transfer case.
11. Position a transmission jack under the transfer case. Remove the six bolts holding the transfer case to the transmission and lower the transfer case from the vehicle.
12. Remove the eight bolts that hold the rear support bracket to the transmission.
13. Position a transmission jack under the transmission and remove the rear support bracket and brace.
14. Remove the four bolts that hold the transmission to the clutch housing.
15. Remove the transmission from the vehicle.

Installation

1. Place the transmission on a transmission jack and install it in the vehicle installing two guide studs in the clutch housing top holes, to guide the transmission into position.
2. Install the two lower bolts. Remove the guide studs and install the upper bolts.
3. Place the rear support bracket in position and install the eight retaining bolts.
4. Install the two bolts at the rear support insulator bracket. Remove the transmission jack.
5. Position the transfer case on the transmission jack and install the six retaining bolts and gasket. Position the transfer case on the transmission and tighten the bolts as listed in the appropriate transfer case section.
6. Install the transfer case shift link.
7. Remove wire and connect front driveshaft.
8. Remove wire and connect rear driveshaft.
9. Fill transfer case and transmission (as required) with MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX E4AZ-19582-B(ESP-M2C166-H) or equivalent.

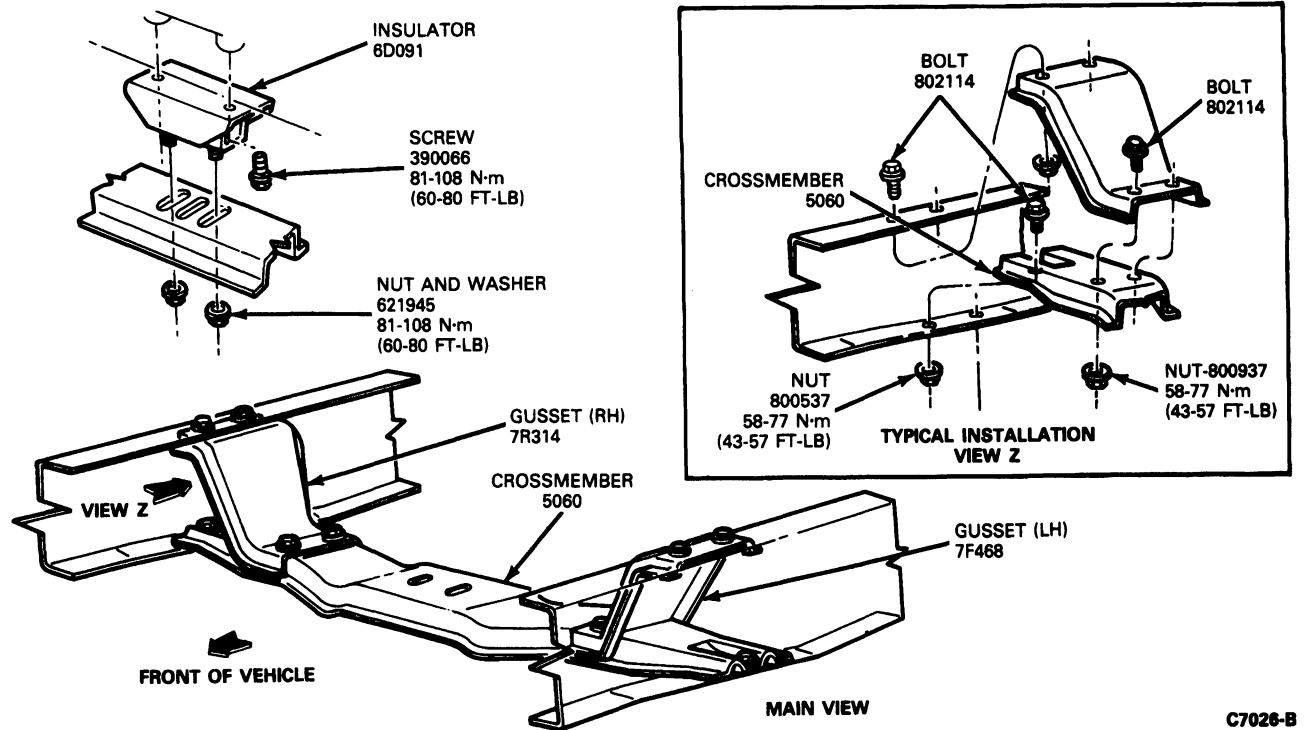
10. Lower vehicle.
11. Remove and prepare gasket area.
12. Position gasket and shift cover.
13. Install two pilot bolts, then install remaining shift cover retaining bolts.
14. Install transfer case shift lever, shift ball, vapor seal and boot as an assembly and transmission upper shift lever, shift ball and boot as an assembly.
15. Install dust cover and insulator.
16. Install two retainer bolts at upper shift lever. Tighten to 22-33 N·m (16-24 ft·lb).
17. Install the four boot area screws.

Crossmember, F-150-250 and Bronco**Removal**

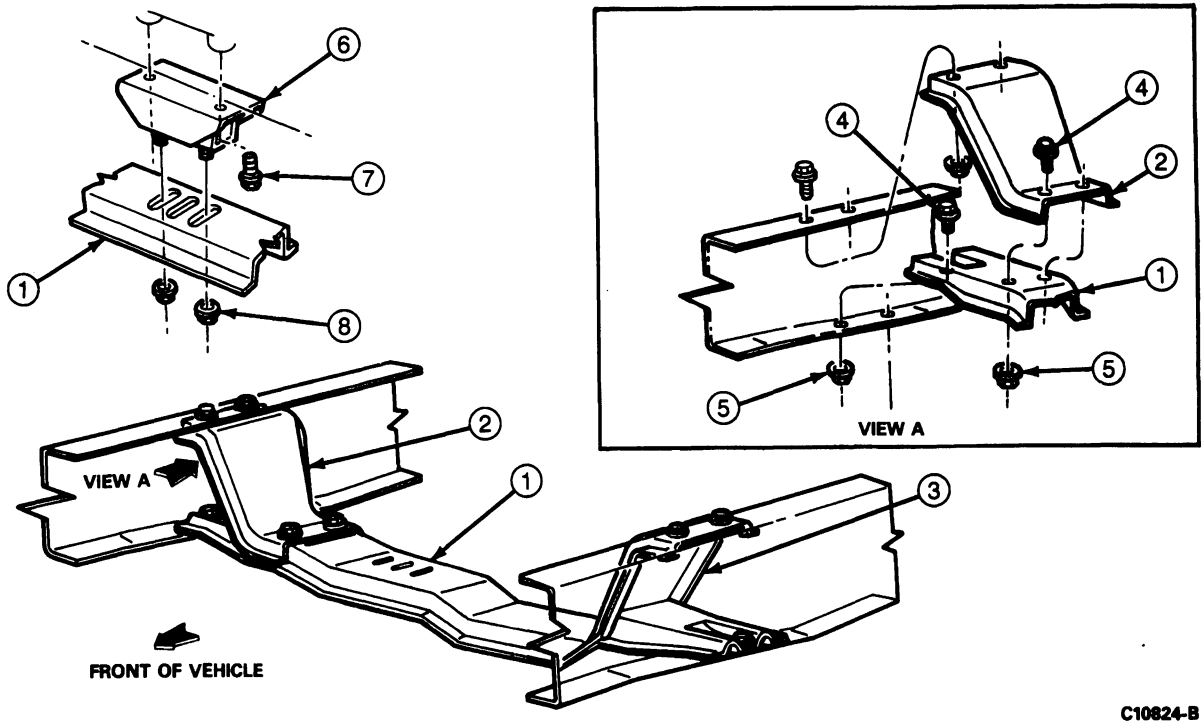
1. Raise vehicle on hoist.
2. Remove skid plate, if so equipped. Remove heat shield from catalytic converter.
CAUTION: Use extreme caution when working in the area of the catalytic converter because of the extremely high temperatures generated by the converter.
3. Remove two nuts connecting upper gusset to frame on both sides of the frame.
4. Remove nut and bolt assembly connecting gusset to crossmember. Remove gusset on left side.
5. Remove bolts holding transmission to transmission support plate on crossmember (4x4).
6. Remove bolts attaching transmission to insulator (4x2).

REMOVAL AND INSTALLATION (Continued)

Crossmember Installation, F-150-250 4x2



Crossmember Installation, F-150-250 4x4 and Bronco



REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	5060	Crossmember
2	7R314	Gusset (Right)
3	7F468	Gusset (Left)
4	N802114-S2	Bolt

(Continued)

Item	Part Number	Description
5	N800937-S2	Nut
6	6D091	Insulator and Retainer
7	390066	Screw and Washer
8	N621945-S2	Nut

TC11152A

7. Raise transmission with a transmission jack.
8. Remove the nut and bolt assemblies connecting the support plate to crossmember. Remove support plate. Remove right gusset (4x4).
9. Remove nuts attaching insulator to crossmember. Remove insulator. Remove right gusset (4x2).
10. Remove nut and bolt assemblies connecting crossmember to frame. Remove crossmember.

Installation

1. Install crossmember and transmission support plate, and position right and left gussets on bolts in frame (4x4).
2. Install crossmember and insulator and position right and left gussets on bolts to frame (4x2).
3. Install nuts on upper gusset to frame bolts and tighten to 58-77 N·m (43-57 ft-lb).
4. Install crossmember to frame nut and bolt assembly and tighten to 58-77 N·m (43-57 ft-lb).
5. Install nut and bolt assembly connecting gusset to crossmember and tighten to 58-77 N·m (43-57 ft-lb).
6. Install nut and bolt assemblies connecting transmission support plate to crossmember and tighten to 81-109 N·m (60-80 ft-lb) (4x4).
7. Install nuts connecting insulator to crossmember and tighten to 81-109 N·m (60-80 ft-lb) (4x2).
8. Lower the transmission.
9. Install bolts connecting transmission support plate to transmission and tighten to 81-109 N·m (60-80 ft-lb).
10. Install bolts connecting insulator to transmission and tighten to 86-96 N·m (64-71 ft-lb) (4x2).
11. Install skid plate, if so equipped. Install heat shield over catalytic converter. Tighten all nuts and bolts to 29-39 N·m (21-29 ft-lb).
12. Lower vehicle.

Shift Lever

NOTE: If the shift ball, boot or lever is to be replaced, remove the shift ball first from the upper lever. If none of the above items requires replacement, remove as an assembly.

Removal

1. If shift ball removal is required, remove the plastic insert from the shift ball. Warm the ball with a heat gun to 60°-82°C (140°-180°F) knock the ball off the lever with a block of wood and a hammer, taking care not to damage the finish on the shift lever.
2. If only the shift lever assembly is to be removed, shift the transmission into the NEUTRAL position. If the top cover assembly is to be removed, shift transmission into SECOND GEAR position.
3. Pull outer trim cover boot down off the upper lever to expose the two attaching bolts. Remove both bolts and remove lever from vehicle.
4. Remove the outer trim boot, inner boot and vapor seal. Remove the splash boot. Remove the floor pan cover.

Installation

NOTE: Make sure transmission is in neutral prior to shift lever installation.

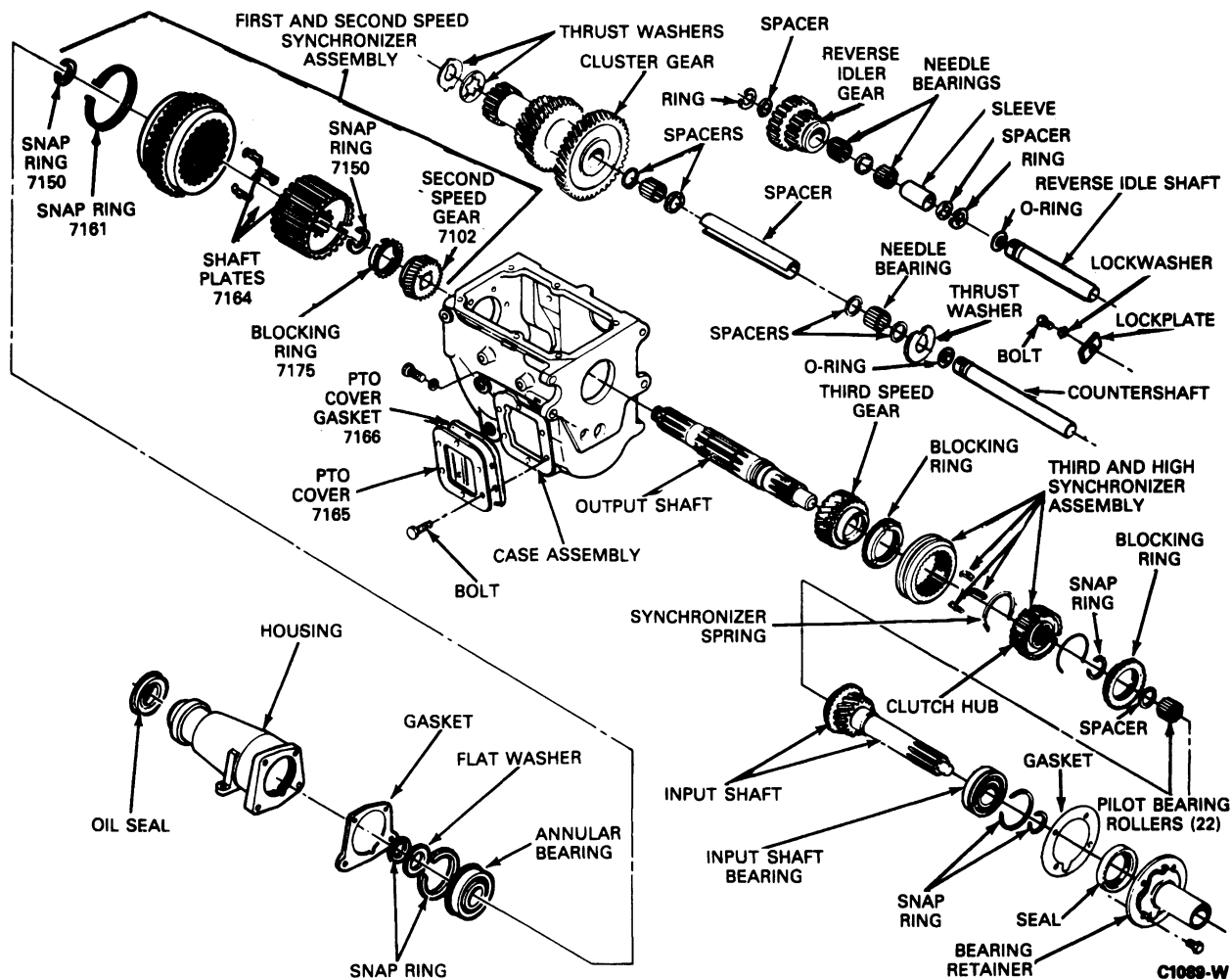
1. Install the splash boot.
2. Install floor pan cover, vapor seal and outer trim boot.
3. Install the upper lever and attaching bolts. Tighten bolts to 18-24 N·m (13-18 ft-lb).
4. Attach the trim boot to upper lever covering the attaching bolts.
5. Install shift ball to lever, and install the plastic shift pattern insert.

DISASSEMBLY AND ASSEMBLY**Transmission**

Refer to the following illustration for disassembled view.

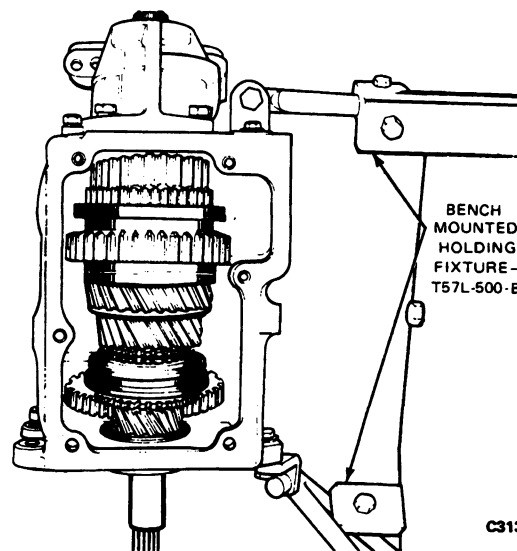
DISASSEMBLY AND ASSEMBLY (Continued)

Transmission, Disassembled View



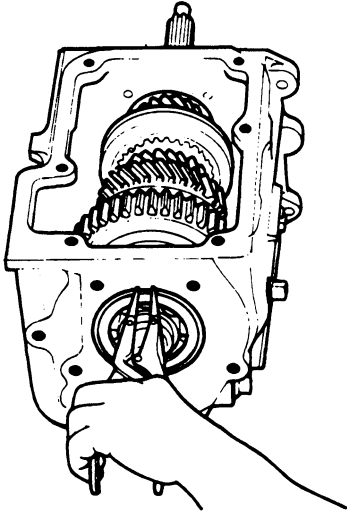
Disassembly

1. Position the transmission assembly in a suitable holding fixture, such as Bench Mounted Holding Fixture T57L-500-B. Drain the transmission and shift the unit into second gear before removing the housing assembly.



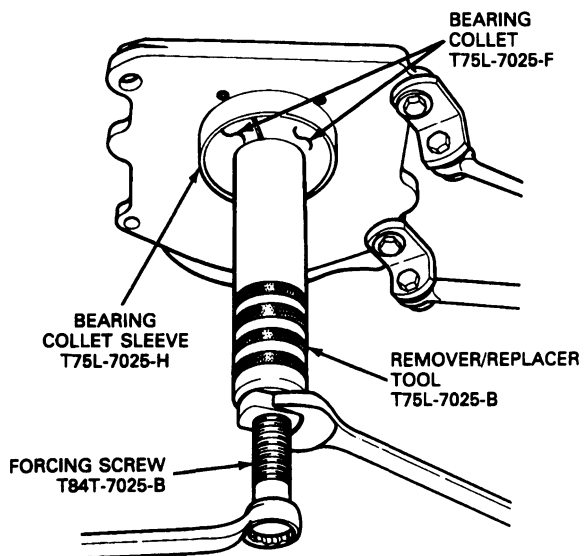
DISASSEMBLY AND ASSEMBLY (Continued)

2. Lock the transmission in two gears; then, remove the oil seal.
3. Remove the output shaft bearing retainer (or extension housing).
4. Remove the output shaft bearing snap ring retainers from the output shaft and from the bearing. Remove bearing spacer.



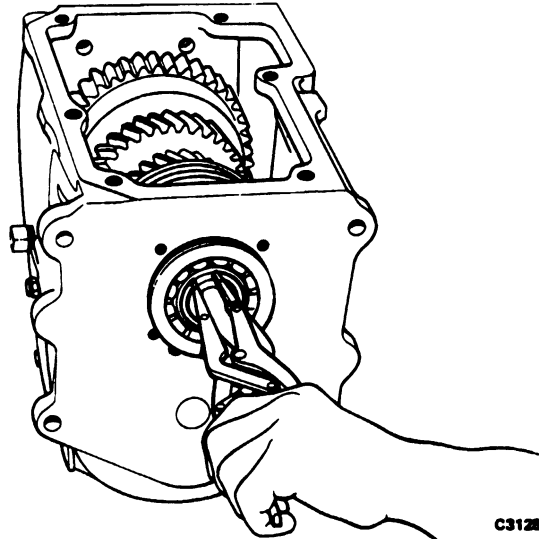
C3127-1A

5. Install Tool T75L-7025-B, F, H and T84T-7025-B on the output shaft and over the output shaft bearing. Remove the output shaft bearing.



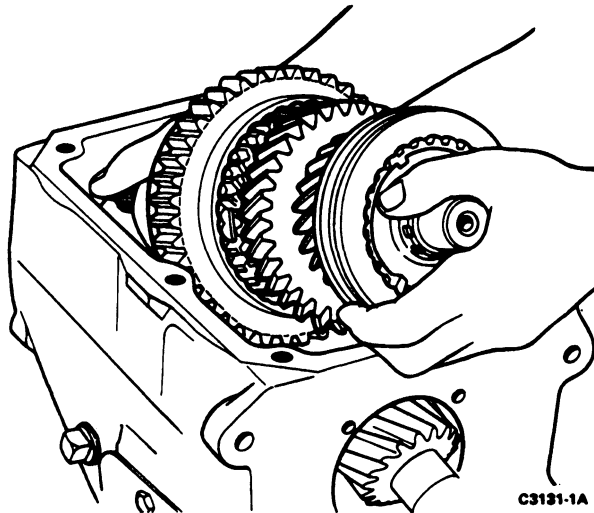
C3136-E

6. Remove the input shaft bearing retainer. Remove the input shaft bearing snap ring from the input shaft and from the bearing.



C3128-1A

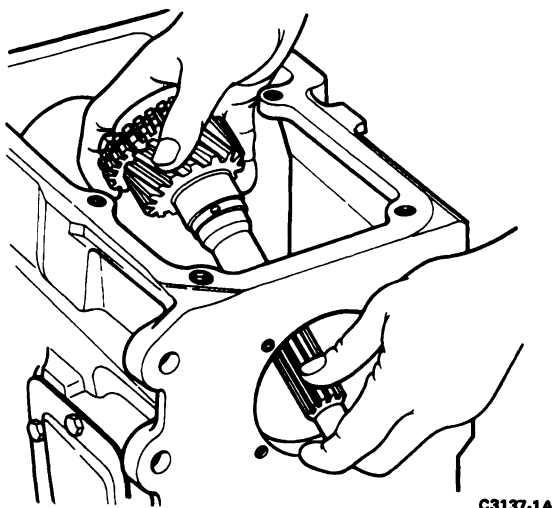
7. Using the same tool that was used for output shaft bearing removal, install tool on the input shaft and over the input shaft bearing. Remove the input shaft bearing.
8. Remove the output shaft assembly from the case.



C3131-1A

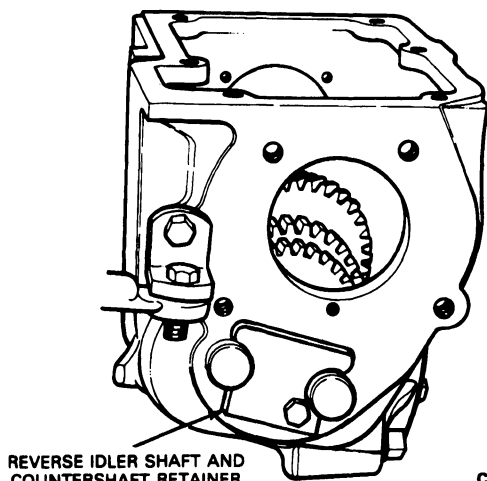
DISASSEMBLY AND ASSEMBLY (Continued)

9. Remove the input shaft assembly from the case. Do not lose the 22 pilot bearing rollers from the inner end of the shaft.



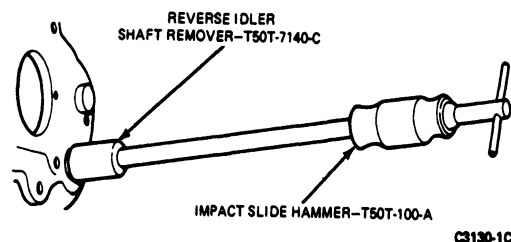
C3137-1A

10. Remove the reverse idler gear shaft and the countershaft retainer from the end of the transmission case.

REVERSE IDLER SHAFT AND
COUNTERSHAFT RETAINER

C3138-B

11. Remove the reverse idler gear shaft, using Slide Hammer T50T-100-A and a suitable reverse idler shaft remover.



C3130-1C

12. Remove the reverse idler gear from the case.
13. Remove the countershaft with the same tools used to remove the reverse idler gear shaft.
14. Install a suitable dummy shaft tool in the countershaft. Remove the countershaft gear assembly from the case. Guide the countershaft assembly (with the dummy shaft tool installed) out of the case so that the roller bearings and spacers that remain in the countershaft are not lost.

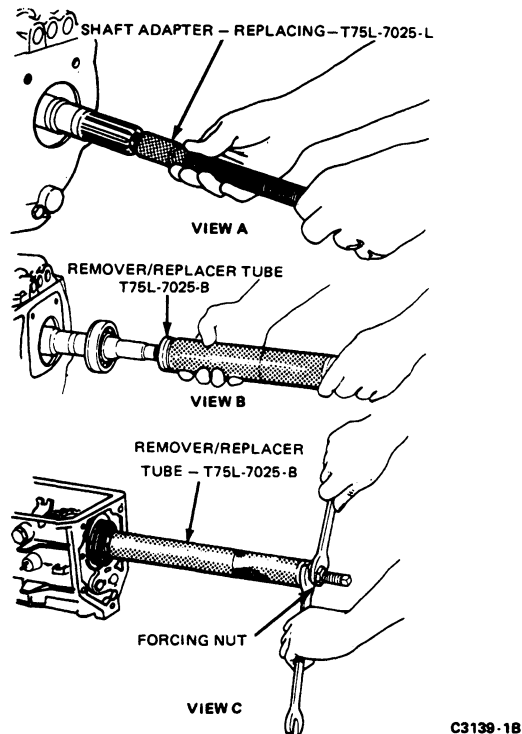
Assembly

NOTE: If a bearing is not used, be sure that a protector is used over the 3-4 synchronizer to prevent jamming the 4th blocking ring onto the cone seat.

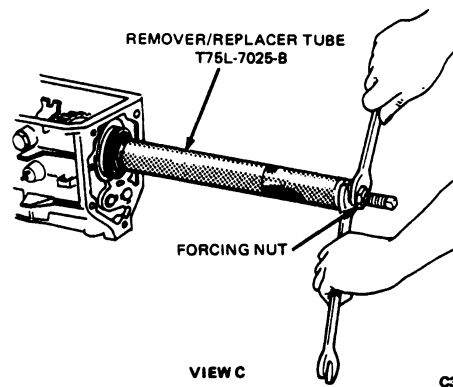
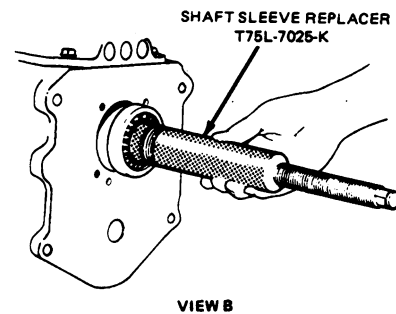
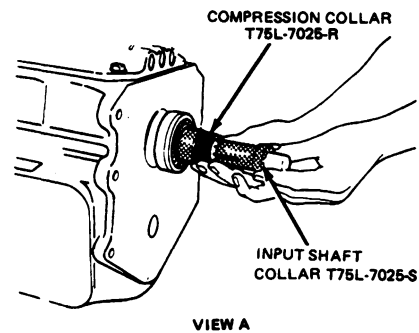
1. Coat all parts, especially the bearings, with the specified transmission lubricant to prevent scoring when the transmission is first put into operation.
2. Position the countershaft gear assembly thrust washers in the transmission case.
3. Position the countershaft gear assembly (with dummy shaft tool installed) in the transmission case. **Use care so that no roller bearings are lost, and so that the thrust washers are not moved out of position.**
4. Carefully, drive out the countershaft gear assembly dummy shaft by installing the countershaft from the rear of the transmission case. **Position the slot in the rear of the countershaft so that it can be engaged by the shaft retainer.**
5. Position the reverse idler gear assembly in the transmission case, and install the reverse idler gear shaft with a new O-ring. **Position the slot in the rear of the shaft so that it can be engaged by the shaft retainer.**
6. Install the countershaft and reverse idler gear shaft retainer.
7. Load the 22 pilot bearing rollers in the inner end of the input shaft (use petroleum jelly to keep the pilot bearings in position). Position the input shaft assembly in the transmission case and install the blocking ring on the input shaft.

DISASSEMBLY AND ASSEMBLY (Continued)

8. Install the output shaft assembly in the transmission case. **Use care so that the pilot bearing rollers are not permitted to drop out of the input shaft.**
9. Install a dummy bearing (Tool T75L-7025-Q) on the transmission input shaft. This tool is necessary to keep the input and output shafts in alignment when installing the output shaft bearing.
10. Assemble the locating snap ring to the outer race of the output shaft bearing in the groove provided.
11. Install the output shaft bearing using the tools shown.



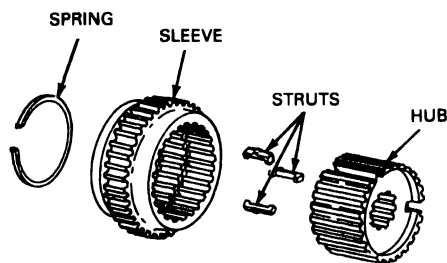
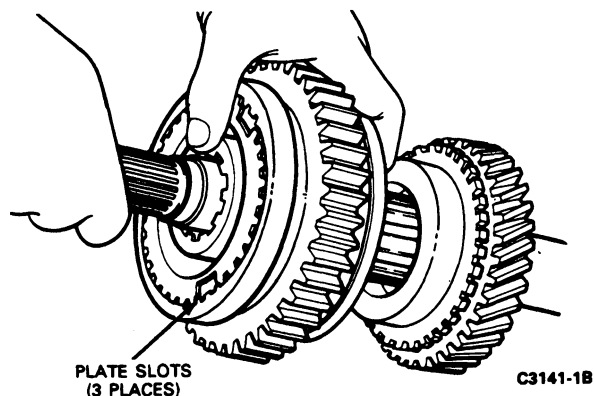
12. Install the flatwasher against the rearward face of the output shaft bearing. (The properly installed washer will be external to the main body of the transmission.)
13. Install a snap ring at the rearward surface of the washer in the output shaft groove provided.
14. Remove the dummy bearing from the input shaft.
15. Install the input shaft bearing using the tools shown and install the snap ring. Use the thickest select fit snap rings which will fit on the bearing.



16. Install the input shaft bearing spacer and retainer gasket and retainer. Tighten the bolts to 14-20 N·m (10-15 ft-lb).
17. Using a new gasket install the output shaft bearing retainer (or extension housing). Tighten the bolts to the specification listed at the end of this section.
18. Lubricate the extension housing bushing and seal and the U-joint flange with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.
19. Install the gear shift housing assembly with Standard Transmission Lubricant (SAE 80W), and unit shifted into second gear on the transmission and tighten the cover bolts to specification 34-47 N·m (25-35 ft-lb).
20. Fill the transmission to the proper level with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (ESP-M2C166-H) or equivalent.

DISASSEMBLY AND ASSEMBLY (Continued)**Output Shaft****Disassembly**

1. Remove the third- and high-speed synchronizer hub snap ring from the output shaft, and slide the third- and high-speed synchronizer assembly and the third-speed gear off the shaft.
2. Remove the synchronizer sleeve and the inserts from the hub.
3. Before removing the two snap rings from the ends of the hub, check the end play of the second speed gear. There should be 0.127-0.609mm (0.005 to 0.024 inch) of end play.
4. Make an index mark on gear and hub before disassembly to make sure that the hub and gear alignment is the same upon reassembly. These parts are matched parts. Slide the low and second speed gear off the hub. Be careful not to lose spring or plates.
5. Remove the snap ring from behind the synchronizer hub. Pull synchronizer hub from the shaft. Remove the blocking ring.
6. Remove the snap ring from behind the second speed gear and remove the gear and thrust washer from the output shaft.

**Assembly**

1. Place output shaft with splined (output) end up in a soft-jawed vise.
2. Place second speed gear against thrust washer flange on shaft, then assemble snap ring in groove behind gear.

3. Place blocking ring on second speed gear.
4. Assemble the second speed synchronizer assembly over the splines of main shaft, aligning the three blocking ring cut-outs with shifting plates. The low and second gear shift fork groove should be located to rear of transmission.
5. Place a snap ring in the main shaft groove behind clutch hub.
6. Turn output shaft over and assemble third speed gear against output shaft shoulder.
7. Place blocking ring on third speed gear.
8. Assemble third and high synchronizer assembly over output shaft splines. Align the three blocking ring slots with shifting plates and position the end of the hub which has the long chamfer to the front of the transmission.
9. Place snap ring in output shaft groove in front of third and high synchronizer assembly.
10. Assemble spacer on output shaft.

Countershaft Gear**Disassembly**

Remove the dummy shaft, bearing rollers, bearing spacers, and the center spacer from the countershaft gear.

Assembly

1. Slide the long bearing spacer into the countershaft gear bore, and insert the dummy shaft in the spacer.
2. Apply a film of petroleum jelly to the countershaft gear bore and install one of the bearing spacers. Position the 22 bearing rollers in the gear bore.
3. Place a spacer in the gear bore.
4. Hold a large thrust washer against the end of the countershaft gear to prevent the rollers from dropping out, and turn the assembly over and repeat the process.

Reverse Idler Gear

Replace the reverse idler gear if the gear or roller bearing is badly worn or if the teeth are chipped or burred. Replace the reverse idler gear shaft if it is excessively worn or scored.

Gear Shift Housing**Disassembly**

1. Remove the floor mat or carpet, rubber boot cover and floor pan cover. Remove front seat assembly if necessary.
2. Remove the vapor seal from the gear shift housing.

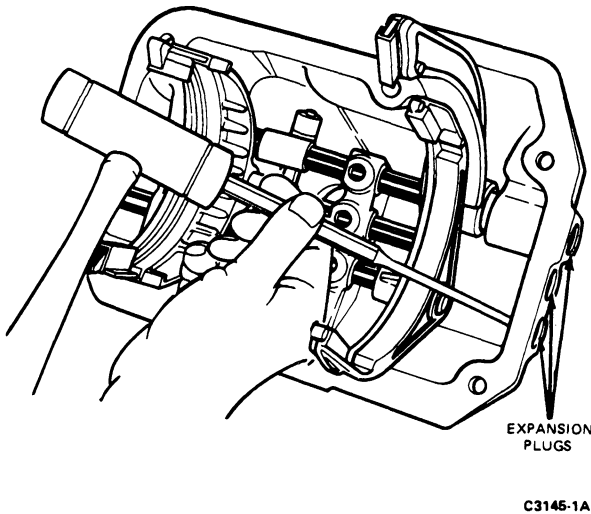
DISASSEMBLY AND ASSEMBLY (Continued)

3. Shift the unit into second gear and remove the gear shift lever from the transmission. Then, disconnect the back-up lamp switch from the connector and remove the back-up lamp switch from the rear of the gear shift housing.

4. Remove the shift housing tower from the transmission.

NOTE: After the shift housing tower is removed, inspect all internal transmission components for damage, chips and / or foreign material within the transmission case assembly.

5. Remove the three expansion plugs from the forward end of the shift housing. Using a pin punch, remove the three lock pins from the shift forks and the three lock (roll) pins from the gear shifter shaft gates.



6. Tap the shifter shaft(s) out of the housing (forward) while holding a shop towel over the poppet ball(s), and spring hole(s) in the housing to prevent loss of spring(s) and / or poppet ball(s).
7. Remove the interlock pin from the middle shift rail.
8. Remove the shift forks and shift gates.
9. Remove the poppet balls and springs from the housing. Then, remove the interlock plungers from the housing.

Assembly

1. Install the spring and plunger in the reverse gate, press the plunger through the gate and fasten it in place with the clip, if the reverse gate assembly has been disassembled.
2. Place the poppet spring and ball in the reverse shifter shaft hole in the gear shift housing. Insert the shaft part way into the housing. Install the reverse shift fork on the shaft (reverse shifter) then, press down on the poppet ball and spring with a long thin drift and position the reverse shifter ball notch so that it does not slide over the ball.

3. Slide the reverse gate onto the shaft (long end forward), and drive the shaft into the housing until the ball snaps into the groove of the shaft. Install the lock pin that fastens the gate to the shaft.

4. Insert the two interlocking plungers in the pockets between the shifter shaft holes. Place the poppet spring and ball in the low-and-second shifter shaft hole. Press down on the poppet ball and spring with a long thin drift and insert the shifter shaft part way into the housing.

5. Slide the low-and-second shifter shaft gate onto the shaft, and install the low-and-second shifter fork on the shaft so that the off-set of the fork is toward the rear of the housing. Push the shaft all the way into the housing until the poppet ball snaps into the shaft groove. Then, install the lock pins that fasten the fork and gate to the shaft.

6. Insert the three and four shifter shaft through the center rear hole of the housing. Then, insert the interlock pin into the interlock pin hole in the shifter shaft.

NOTE: Apply a daub of petroleum jelly to hold the pin in position.

7. Apply a coating of petroleum jelly to the interlock plungers and insert them into their respective holes in the housing.
8. Place the poppet spring and ball in the center shifter shaft hole in the housing. Press down on the poppet ball with a long thin drift, and carefully push the shifter shaft into the housing over poppet ball and spring.
9. Position the third and fourth shift gate onto the shifter shaft. The spring loaded-ball tang should be installed facing rear of transmission.

NOTE: It is extremely important that the shift gate be installed on the shifter shaft with the long flat "tang" end of the gate area facing forward of the gear shift housing. To obtain proper installation, measure the two flat "tang" of the shift gate, note the longer dimension 18.25mm (23 / 32 inch) and apply a daub of bright paint. This tang should be installed facing forward on the shifter shaft.

10. Position the three and four shifter fork on the shifter shaft so that the lock pin hole in the shifter fork is toward the rear of the housing. Push the shifter shaft into the housing until the poppet ball seats into the second detent (neutral). Install the lock pins attaching the shifter fork and shifter gate to the shifter rail.

NOTE: Install the shifter gate lock pin so that the pin is flush with the bottom of the notch in the shifter gate.

11. Install new expansion plugs in front and rear of transmission housing.
12. Shift the gear shift housing into the second gear position. Shift the transmission gears into the second gear position. Install the back-up lamp switch and connect the wiring. Then, place the transmission gear shift housing onto the transmission.

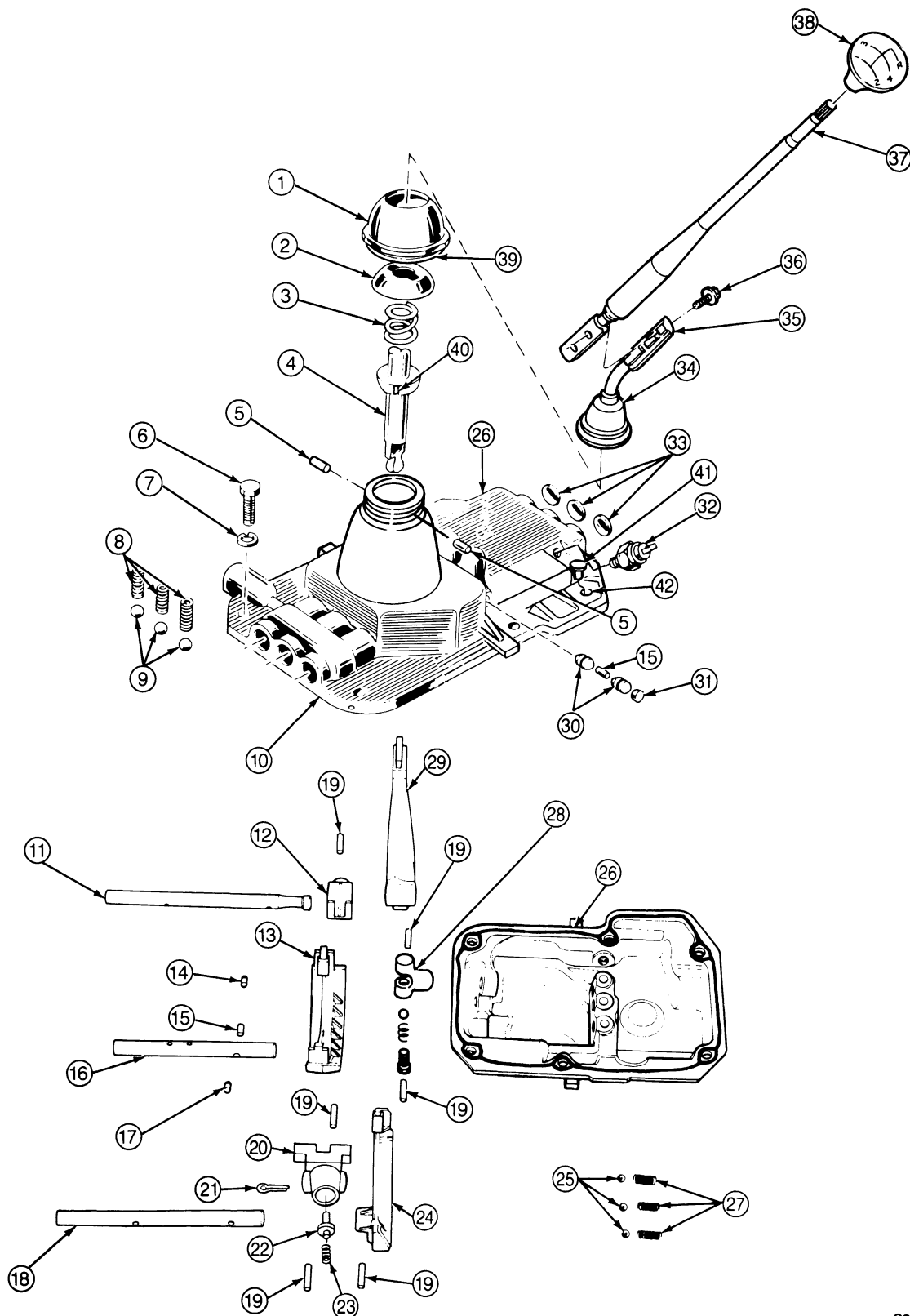
DISASSEMBLY AND ASSEMBLY (Continued)

13. Apply Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent to the six shift gear housing-to-transmission case attaching bolts. Tighten the bolts to 24-27 N·m (17-20 ft-lb).
14. Install the gear shift lever. Install cab floor pan cover, rubber boot and floor mat or carpet. Install front seat assembly if necessary.

15. Fill transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (ESP-M2C166-H) or equivalent, through the fill opening. Reinstall fill plug and tighten to specifications.

DISASSEMBLY AND ASSEMBLY (Continued)

Shift Housing, Disassembled View



C3879-G

DISASSEMBLY AND ASSEMBLY (Continued)

Item	Part Number	Description
1	7220	Cap
2	7228	Spring Seat
3	7227	Lever Spring
4	7210	Lever Assembly
5	7B125	Trunnion Pin
6	20388-S	Bolt
7	34807-S	Lockwasher
8	7234	Shaft Lock Plunger Spring
9	3727205	Poppet Balls
10	7223	Housing Gasket
11	7242	Reverse Shift Shaft
12	7219	Reverse Shift Gate and Plunger
13	7289	Third and Fourth Shift Fork
14	7247	Interlock Plunger
15	7235	Interlock Pin
16	7241	Third and Fourth Shift Shaft
17	7247	Interlock Plunger
18	7240	First and Second Shift Shaft
19	7245	Lock Pin
20	—	First and Second Head Assembly

(Continued)

Item	Part Number	Description
21	—	Cotter Pin
22	—	Bias Plunger
23	—	Spring
24	7289	First and Second Shift Fork
25	3727205	Poppet Balls
26	7222	Housing Assembly
27	7234	Shift Shaft Poppet Springs
28	—	Third and Fourth Shift Gate
29	7243	Reverse Shift Fork
30	7247	Shaft Lock Plunger
31	353096-S	Plug
32	15520	Back-Up Lamp Switch
33	741135	Expansion Plug
34	—	Splash Boot
35	7210	Top Portion of Lower Lever
36	N605906	Bolt (2 Required)
37	7K387	Upper Lever
38	7213	Shift Ball
39	7207	Gasket
40	—	Slot
41	7034	Breather Vent
42	—	Vent Hole

SPECIFICATIONS**TORQUE SPECIFICATIONS, WARNER T-18, TRANSMISSION**

Description	N-m	Lb-Ft
Back-Up Light Switch (9/16-18)	20-47	15-35
Clutch Housing to Transmission Mounting Bolts (7/16-14)	47-67	35-50
Case Cover (3/8-16)	34-47	25-35
Countershaft Rear Retainer (3/8-16)	34-47	25-35
Drain Plug (3/4-14)	34-54	25-40
Filler Plug (3/4-14)	34-54	25-40

(Continued)

TORQUE SPECIFICATIONS, WARNER T-18, TRANSMISSION (Cont'd)

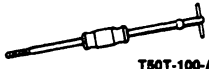
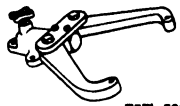
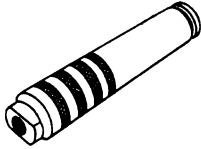
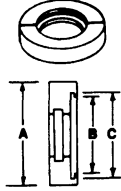


Description	N-m	Lb-Ft
Output Shaft Flange Nut (3/4-20)	102-149	75-110
Mainshaft Rear Retainer (3/8-16)	34-47	25-35
Mainshaft Rear Retainer (1/2-13)	54-67	40-50
P.T.O. Cover Bolt (3/8-16)	34-47	25-35
Reverse Idler Shaft / Countershaft Locking Bolt (3/8-16)	34-47	25-35
Front Bearing Retainer to Case (5/16-18)	14-20	10-15
Clutch Housing to Engine Block (7/16-14)	54-67	40-50

APPROXIMATE REFILL CAPACITY — WARNER T-18

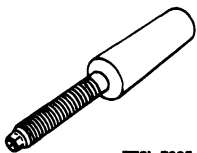



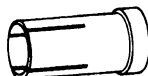
Lubricant	Approximate Capacity		
	U.S. (Pints)	Imperial (Pints)	Liters
Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (ESP-M2C166-H) or equivalent	7.0	5.5	3.3

TC3593A

SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number/ Description	Illustration
T50T-100-A Impact Slide Hammer — 2-1/2 Lbs.	 T50T-100-A
T57L-500-B Bench Mounted Holding Fixture	 T57L-500-B
T57L-7025-B Remover/Replacer Tube (Output Shaft Bearings)	 T75L-7025-B
T75L-7025-F Bearing Collet	 T75L-7025-F
T75L-7025-H Bearing Collet Sleeve	 T75L-7025-H
T84T-7025-B Forcing Screw (Use with Remover/Replacer Tube)	 T84T-7025-B

(Continued)

Tool Number/ Description	Illustration
T75L-7025-K Shaft Sleeve Replacer (Use with Compression Collar and Input Shaft Collet)	 T75L-7025-K
T75L-7025-L Shaft Adapter — Replacing (Use with Remover/Replacer Tube)	 T75L-7025-L
T75L-7025-Q Dummy Bearing	 T75L-7025-Q
T75L-7025-R Compression Collar (Use with Shaft Sleeve Replacer and Input Shaft)	 T75L-7025-R
T75L-7025-S Impact Shaft Collet (Use with Shaft Sleeve Replacer and Compression Collar)	 T75L-7025-S

ROTUNDA EQUIPMENT

Tool Number	Description
066-00017	Transmission Jack

SECTION 07-03C Transmission, Model S5-42 ZF

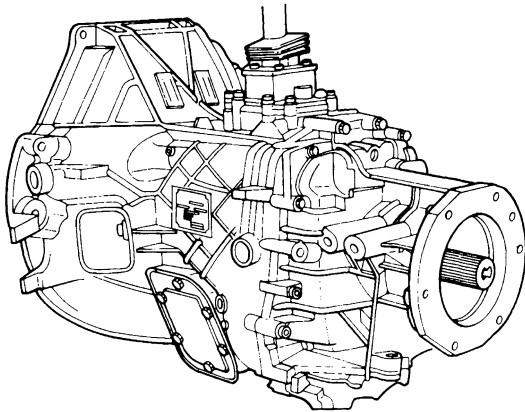
SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		INSPECTION	
Bearing Preload Adjustment	07-03C-61	Synchronizer Ring / Synchronizer Body Wear	
DESCRIPTION AND OPERATION	07-03C-2	Check	07-03C-63
DIAGNOSIS AND TESTING		REMOVAL AND INSTALLATION	
Additional Testing For 4x4 Trucks		Crossmember, All F-Series Except F-350	
(Non-Electronic Shift)	07-03C-3	4x4	07-03C-13
Cold Transmission	07-03C-3	Crossmember, F-350 4x4	07-03C-14
Warm Transmission	07-03C-3	Rear Oil Seal, 4x2 Transmissions (Except	
DISASSEMBLY AND ASSEMBLY		F-Super Duty)	07-03C-15
Countershaft	07-03C-60	Rear Oil Seal, 4x4 and F-Super Duty Series	
Gearshift Housing Assembly	07-03C-36	Transmissions	07-03C-16
Input Shaft	07-03C-60	Transmission (4x2)	07-03C-9
Mainshaft	07-03C-44	Transmission (4x4)	07-03C-11
Shift Lever Assembly	07-03C-35	SPECIAL SERVICE TOOLS / EQUIPMENT	07-03C-65
Shift Rails	07-03C-37	SPECIFICATIONS	07-03C-64
Transmission Front Case	07-03C-39	VEHICLE APPLICATION	07-03C-1
Transmission Rear Case	07-03C-37		

VEHICLE APPLICATION

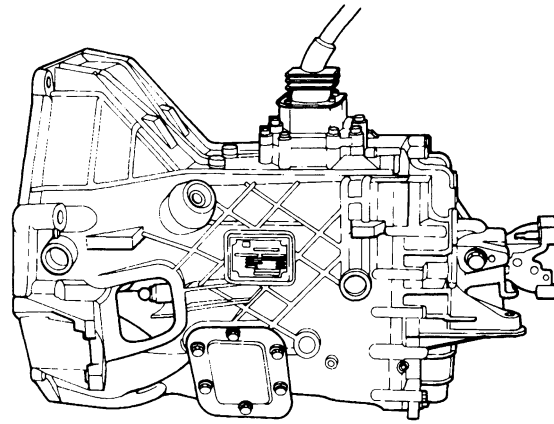
All F-Series Vehicles Over 8500 lbs GVW

DESCRIPTION AND OPERATION

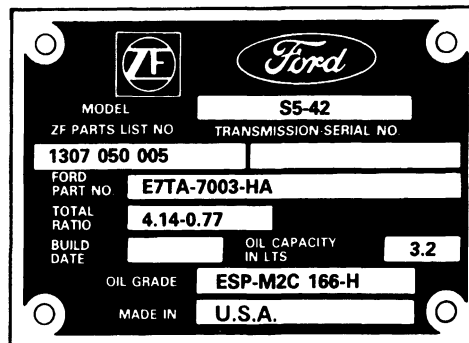
The model number for the ZF Transmission is S5-42. This model number can be divided into three parts. First, "S" designates a synchronized transmission. Second, "5" designates the number of forward gears. Finally, "42" is the approximate maximum input torque capacity in tens of ft-lbs. In this case 42 equals 420 ft-lbs. input torque capacity.



ZF S5-42 TRANSMISSION — 4 x 4 AND F-SUPER DUTY VERSION



ZF S5-42 TRANSMISSION — 4x2 VERSION
(EXCEPT F-SUPER DUTY)



TRANSMISSION IDENTIFICATION PLATE

C8192-C

The S5-42 ZF transmission is available in both wide ratio and close ratio versions. The wide ratio version is available for all F-Series vehicles over 8500 lbs. GVW, all engines, except F-Super Duty Commercial Stripped Chassis equipped with a diesel engine. The close ratio version is available only in F-Series vehicles with a 7.3L diesel engine and a GVW over 8500 lbs. The ratios are as follows:

	1st	2nd	3rd	4th	5th	Reverse
Close Ratio (Diesel)	4.14	2.37	1.42	1.0	0.77	3.79
Wide Ratio (Gasoline Diesel)	5.72	2.94	1.61	1.0	0.76	5.24

TC8193A

The transmission features an aluminum housing with an integral clutch housing. Because of the aluminum housing, the tapered roller bearings of the transmission shafts must be fitted under preload. This is because heat expansion of the aluminum transmission case is greater than that of the steel alloy mainshaft and countershaft. If the bearings were not pre-loaded, this would result in excessive end play when the transmission case expands in warm, loaded operating conditions. The transmission also features shrink-fit gears on the countershaft. Shrink-fit gears are connected to the countershaft by friction only, rather than connected to the countershaft through splines. The gear is heated and lightly pressed onto the shaft. The subsequent cooling of the gear provides the shrink fitting. The countershaft is serviced as an assembly.

DIAGNOSIS AND TESTING

A troubleshooting guide has been put together to assist in diagnosing transmission-related problems. Use the transmission noise evaluation procedure and troubleshooting guides on the following pages, or refer to Section 07-00B, Transmission, Manual, General. Also refer to Section 08-00, Clutch General Service. Remember, it is important to get an accurate description of the complaint before any diagnosis can be performed. Ask questions as to whether it occurs hot or cold, during shifting, driving at a particular speed or in a particular gear. If possible, have the customer demonstrate the concern.

Cold Transmission

- Drive the truck in all gears (1-5 and reverse gears).
- Evaluate the noise in neutral. Check if there are any noise changes in a particular gear, i.e., 4th gear. In 4th gear the countershaft is not under load.
- Check if the noise increases when the transmission is warming up.
- See if the noise is related to engine speed, road speed or gear selection.

Warm Transmission

- Check all gears plus reverse gear and make note of any noise changes in a particular gear.
- Check noise in neutral while parked. Check if the noise disappears at a certain engine rpm or with the clutch pedal depressed.
- Drive in the gear in which the noise is most noticeable. Press in the clutch and leave the gear engaged. If the noise changes or disappears, the noise may be amplified by the vibration of the engine.
- Drive under the same condition again. Press the clutch pedal in and shift into neutral. Release the clutch while the truck is coasting down the road. Evaluate the noise, as the drive axle turns the transmission mainshaft.

Additional Testing For 4x4 Trucks (Non-Electronic Shift)

- Check for any noise change when shifting the transfer case between 4x2, 4 high, 4 low or into neutral.

- With the truck at a complete stop and the transfer case in neutral, shift through all the gears and evaluate noise at different engine rpm. Check for any noises in neutral at different engine rpm.

NOTE: To isolate clutch concerns from transmission concerns, operate the transmission at no-load. On 4x4 models, place the transfer case in neutral. Remove the driveshaft on 4x2 models. Run the engine at 3000 rpm and operate the transmission throughout ranges with the clutch engaged. If hard shifting concern (power to transmission) disappears, the concern may be in the clutch system. An improperly operating clutch can result in hard shifting that is most noticeable in 1st, 2nd, and reverse. It is important that the hydraulic release mechanism is working properly. Continued operation with a defective clutch system may result in premature synchronizer wear or damage.

Hard shifting or difficulty engaging the transmission gears may be the result of improper clutch function. Check the release system travel. Minimum travel for the concentric slave cylinder bearing (4.9L and 5.8L engines) and the external system slave cylinder push rod (7.3L and 7.5L engines) is 11mm (7 / 16 inch). If system travel is less than 11mm, this is an indication of problems in the release system such as excessive flexing of the dash panel, cracked dash panel reinforcement at the clutch master cylinder mounting and air or water in the hydraulic line. Refer to Section 08-00.

If the release system travel is greater than 11mm, and the clutch is suspected, check for clutch reserve as follows:

1. Set the parking brake and put the transmission in neutral.
2. With the clutch pedal fully depressed, shift into reverse, then shift half way between reverse and neutral to defeat the transmission synchronizer.
3. Allow the clutch pedal to fully return and adjust the shift lever position to obtain light contact between the transmission gear teeth. A slight grind will occur.
4. Slowly depress the clutch pedal until gear contact grinding stops. Measure the clutch pedal travel from this pedal position to the full down position (clutch reserve position).

This clutch reserve dimension should be at least 1-1 / 2 inches. If the reserve is less than 1-1 / 2 inches, and there are no hydraulic control system concerns, remove the transmission and check for excessive clutch wear. On the 7.3L diesel and 7.5L engines, check for release bearing contamination and binding on the bearing retainer. Replace the clutch and / or release bearing as required.

DIAGNOSIS AND TESTING (Continued)

TROUBLESHOOTING GUIDE (In Neutral & Parked)

CONDITION	POSSIBLE SOURCE	ACTION
Noise present with clutch pedal fully depressed.	<ul style="list-style-type: none"> ● Engine noise ● Clutch release bearing failure. ● Pilot bearing failure. ● Misaligned transmission. 	Refer to appropriate Shop Manual section for these areas.
Noise disappears when engine RPM exceeds 1500 without depressing clutch pedal.	<ul style="list-style-type: none"> ● Neutral rollover is caused by the engine firing pulses transmitted through the gear set. Some neutral rollover is normal on the 7.5L application. The dual mass flywheel on the 7.3L Diesel and the two stage clutch on the 4.9L & 5.8L should eliminate this concern on these engines. 	<ul style="list-style-type: none"> ● Check engine idle quality and speed. A rough or low idle will aggravate this concern.
Noise present at engine speeds above idle.	<ul style="list-style-type: none"> ● Insufficient lubrication. ● Damaged tapered roller or needle bearing. ● Scuffed gear tooth contact surfaces. 	<ul style="list-style-type: none"> ● Drain oil (when required) and fill with the correct oil, conforming to Ford's specification ESP-M2C-166H Type "H" or MERCON (Motorcraft). ● Inspect bearings for failure. Pay special attention to the mainshaft front bearing (pocket bearing), located between the input and mainshaft. Turn the gears on the mainshaft to check for needle bearing failure by feeling for roughness. ● Disassemble transmission and check gear tooth contact surfaces. Replace gears as required.
Noise on PTO equipped transmissions. Remove the PTO and install a cover plate. Evaluate for noise without PTO.	<ul style="list-style-type: none"> ● Incorrect PTO gear mesh due to: Wrong model PTO, incorrect installation, defective PTO. 	<ul style="list-style-type: none"> ● Check the mating teeth on transmission countershaft gear and also on the input shaft gear for damage. If any parts are damaged, replace damaged transmission parts. Contact PTO supplier / manufacturer to verify model usage, shimming and PTO quality.

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TROUBLESHOOTING GUIDE (In Gear & Driving)

CONDITION	POSSIBLE SOURCE	ACTION
Noise is present in all or several gears. Noise occurs at high and low engine speeds and may vary with engine speed.	<ul style="list-style-type: none"> ● Worn or rough mainshaft rear bearing. ● Needle bearing under mainshaft gears damaged. ● Wrong preload on main or cluster shaft bearings. ● PTO installed wrong. 	<ul style="list-style-type: none"> ● Disassemble transmission and install new rear bearing on mainshaft. ● Replace bearing, gear and mainshaft as required. ● Disassemble transmission and correct preload. ● Check PTO installation.
"Rattle" noise when taking off from a stop and driving at less than 1000 RPM.	<ul style="list-style-type: none"> ● "Lugging Rattle". 	<ul style="list-style-type: none"> ● Operate truck without "lugging". Condition will not shorten the life of the transmission.
"Clunking" noise when shifting or speeding up or slowing down. Condition is worse on bumpy surfaces.	<ul style="list-style-type: none"> ● Freeplay in the system (clutch through axle and fuel injector shutoff timing). Some clunk is normal with the 4.9L & 5.8L engines. ● Loose yoke nut. 	<ul style="list-style-type: none"> ● Check for excessive axle backlash. Clunk cannot be corrected by repairing transmission unless a transmission defect is evident. ● Install a new locknut. Tighten to 250 N-m (184 ft-lb). Secure locknut by staking the locking shoulder of the nut into the groove of the output shaft.

DIAGNOSIS AND TESTING (Continued)

TROUBLESHOOTING GUIDE (In Gear & Driving) (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
Noise while driving in one gear increases with road speed.	<ul style="list-style-type: none"> Worn, imperfect or chipped gear teeth on the affected gear. 	<ul style="list-style-type: none"> Replace affected mating gears.
"Whining" noise at high engine RPM in 3rd and 5th gear.	<ul style="list-style-type: none"> Worn input shaft gear and countershaft drive gear. 	<ul style="list-style-type: none"> Check noise level in 4th gear under same engine conditions. If noise level is less, replace the input shaft and countershaft. Inspect and replace other gears as required.
Shift lever "buzz" present while driving, not present during a neutral engine run up while parked.	<ul style="list-style-type: none"> Upper shift lever damaged or loose. Lower shift lever defective. 	<ul style="list-style-type: none"> Change shift lever. If "buzz" is still present, see in which gear the buzz occurs. Disassemble and inspect specific gear. Check guide pieces for clearance. Replace lower shift lever. Shift lever E9TZ-7210-G is less sensitive to vibration than earlier design.
Shift lever "rattle" in neutral engine run up, primarily diesel 4x4.	<ul style="list-style-type: none"> Transfer case shift lever may not have plastic bushing at the pivot. Transmission lever boot incorrectly installed. 	<ul style="list-style-type: none"> Check by temporarily removing the transfer case shift lever. Replace if the noise is gone. Lever boot must make air-tight seal to shift lever. Replace boot if stretched or sealing surface is damaged.
Moan or vibration on F-Super Duty at road speeds greater than 50 MPH.	<ul style="list-style-type: none"> Aftermarket modifications to frame or driveshaft. 	<ul style="list-style-type: none"> Non-factory driveshafts should be inspected for: <ul style="list-style-type: none"> Driveshaft size 0 to 51 inches long — 3 inch diameter tube is OK. Up to 55 inches long — 3-1/2 inch diameter tube is required. Up to 59 inches long — 4 inch diameter tube is required. Working angles greater than 1/2° but less than 3°. System balanced to within 0.4 in / oz at the ends and 0.8 in / oz at the center support bearing.
Hard shift (particularly 1st, 2nd & reverse).	<ul style="list-style-type: none"> Clutch not releasing completely. Operator not fully depressing clutch. Dash panel flexing. Clutch hydraulic line routed too close to exhaust manifold. Air / water in clutch hydraulic line. Insufficient synchronizer reserve (a defective clutch system can result in premature loss of synchronizer reserve). 	<ul style="list-style-type: none"> See clutch procedure at the end of this diagnosis guide, or Section 08-00, Clutch General Service, in this manual. Interview operator. Repair dash panel. Move line or shield it. Bleed clutch system. Replace complete synchronizer assembly and corresponding gear, if required.

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DIAGNOSIS AND TESTING (Continued)**TROUBLESHOOTING GUIDE (Shift Concerns)**

CONDITION	POSSIBLE SOURCE	ACTION
Notchy shifting	<ul style="list-style-type: none"> Some notchiness is normal (especially in 3rd gear). 	<ul style="list-style-type: none"> Replace with revised synchronizers: 1/2 FOTZ-7 124-D 3/4 FOTZ-7 124-E 5/R FOTZ-7 124-C
"Grinding" noise during shifting	<ul style="list-style-type: none"> Synchronizer taper too smooth (after a few thousand miles). Synchronizer ring defective. Insufficient wear limit of synchronizer ring. 	<ul style="list-style-type: none"> Do 3 to 5 hard shifts with high engine RPM. If noise is still present, disassemble and check for damage (darkened patches OK). Refer to Synchronizer Ring / Synchronizer Body Wear Check, in this section. Change synchronizer assembly. Change synchronizer assembly.
Walking or jumping out on rough roads.	<ul style="list-style-type: none"> Interference or resistance in the mechanism preventing full engagement of the sliding collar. If sliding collar has been shifted completely into position, some other malfunction could move sliding collar and shift lever out of its proper location. 	<ul style="list-style-type: none"> Remove and disassemble transmission and check profile of internal grooves in the sliding sleeve. Check for shift lever interference. The stub lever, gear shift finger or shift forks could be worn. Remove transmission and replace damaged parts.
Note whether the unit walks out of gear under drive or on a coast load. Also, does the "walkout" occur on smooth or only on rough roads? A number of items that would prevent full engagement of gears are:	<ul style="list-style-type: none"> Worn or loose engine mounts. Shift fork pads or groove in sliding collar worn excessively. Transmission and engine out of alignment either vertically or horizontally. 	<ul style="list-style-type: none"> Check engine mounts. Remove and disassemble transmission and replace damaged parts. Make sure transmission is tightly bolted to the engine.
Walk or jump out on rough roads.	<ul style="list-style-type: none"> Use of heavy shift lever extensions. Shift rail detent springs broken or missing. Detent spring cap not pressed in properly. No preload in drive gear, mainshaft or countershaft, caused by worn bearings. Grated selector teeth. 	<ul style="list-style-type: none"> Use original equipment shift lever. Install heavy duty detent springs (E8TZ-7E2 18-A). Remove sealing cap on detent and replace springs. Replace with new cap and press in 1mm (3/64 inch). Remove and disassemble transmission and replace defective bearings (necessary to reset bearing preload). Change synchronizer package and gear.
Excessive lever movement in 3rd gear.	<ul style="list-style-type: none"> 3-4 synchronizer body snap ring not seated in groove on mainshaft. 	<ul style="list-style-type: none"> Disassemble and replace affected parts, paying special attention to 3-4 synchronizer assembly, input gear, pocket bearing and shift fork.
Gear cannot be engaged.	<ul style="list-style-type: none"> Clutch not releasing (see hard shift) Interlock shifting plate jammed in transmission. Damage to teeth on sliding collar or improper installation (dog teeth worn). Jammed pressure pieces in synchronizer unit. Shift rails out of proper position. 	<ul style="list-style-type: none"> Check clutch per procedure at the end of this diagnosis guide, or Section 08-00, Clutch General Service, in this manual. If bent or damaged, replace the interlocking shifting plate. Replace or correct synchronizer package. Check for damage on the corresponding mainshaft gear in clutch teeth area. Replace as required. Remove and disassemble transmission and replace pressure pieces. Replace all shift rails, detents and interlock shifting plate.

DIAGNOSIS AND TESTING (Continued)**TROUBLESHOOTING GUIDE (Shift Concerns) (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
Sticking in gear.	<ul style="list-style-type: none"> Clutch not releasing (see hard shift above). Interlock shifting plate jammed in transmission. Sliding collar tight on splines (dog teeth damaged). 	<ul style="list-style-type: none"> Check clutch per procedure at the end of this diagnosis guide, or Section 08-00, Clutch General Service, in this manual. If bent or damaged, replace the interlocking shifting plate. Remove and disassemble transmission and replace affected parts.
Stuck in gear.	<ul style="list-style-type: none"> Shift rails out of proper position. 	<ul style="list-style-type: none"> Replace all shift rails, detents and interlock shifting plate.
High shift efforts.	<ul style="list-style-type: none"> Lack of lubricant or wrong lubricant used, causing build-up of sticky and sludgy deposits on splines of sliding collar. Input shaft pilot bearing rough, or dragging. Damaged mainshaft (pocket) bearing. 	<ul style="list-style-type: none"> Inspect through the PTO openings. If sludge is present, remove and clean the transmission. Place transmission in 4th gear and rotate the output shaft by hand while the clutch is depressed. If a roughness is felt, remove the transmission, inspect and replace the input shaft pilot bearing and input shaft, if required. (Input bearing preload must be reset if input shaft is replaced.) Install a new input shaft and bearing. (Necessary to reset bearing preload.)
High shift effort in one gear only.	<ul style="list-style-type: none"> Sliding sleeve tight on splines. Synchronizer teeth chipped or badly mutilated. Binding or interference of shift lever with other objects or rods inside the cab. Mainshaft gears, seized or galled on either the thrust face or diameters. Synchronizer failure (wear limit too low, fractures). Synchronizer cone smoothness. 	<ul style="list-style-type: none"> Remove transmission and replace affected synchronizer assembly. Remove and disassemble transmission and replace damaged parts. Check shift operation in cab. Remove and disassemble transmission, replace synchronizer package. Remove and disassemble transmission, replace synchronizer package. Make 3 to 5 hard shifts with high engine RPM.
High shift efforts in cold weather, all gears.	<ul style="list-style-type: none"> Incorrect, hi-viscosity fluid. 	<ul style="list-style-type: none"> Install Type H or MERCON® fluid. Road test the truck to identify possible damage caused by the wrong fluid. Synthetic MERCON® E6AZ-19582-B will improve cold weather shiftability.

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TROUBLESHOOTING GUIDE (Leak Concerns)

CONDITION	POSSIBLE SOURCE	ACTION
Leak at shift tower.	<ul style="list-style-type: none"> Re-used or damaged gasket. 	<ul style="list-style-type: none"> Replace with new gasket. Never use RTV.
Leak at drain or fill plug.	<ul style="list-style-type: none"> Sealing ring missing from plug (transmissions with an E9TA prefix or later have a sealing surface machined on the housing). 	<ul style="list-style-type: none"> Install a new sealing ring.
Leak at PTO side plate.	<ul style="list-style-type: none"> Bolts loose or damaged gasket. 	<ul style="list-style-type: none"> Replace gasket, tighten bolts to 38 N·m (28 ft·lb).
Leak at shift detent plug.	<ul style="list-style-type: none"> Re-used or damaged plugs. 	<ul style="list-style-type: none"> Use new plugs when reassembling. Do not deform case around plug to retain.

DIAGNOSIS AND TESTING (Continued)**TROUBLESHOOTING GUIDE (Leak Concerns) (Continued)**

CONDITION	POSSIBLE SOURCE	ACTION
Leak at large welch plug inside clutch housing. Look for cracks around the hole.	<ul style="list-style-type: none"> Improper assembly. 	<ul style="list-style-type: none"> Reseal, using anaerobic sealant (E2AZ-19562-B). If cracked, replace housing.
Leak at input shaft bearing oil passage plug (inside clutch housing w/ 7.5L & 7.3L engines and on left side w/ 4.9L & 5.8L engines).	<ul style="list-style-type: none"> Improper assembly. 	<ul style="list-style-type: none"> Reseal, using anaerobic sealant (E2AZ-19562-B). If cracked, replace housing.
Leak at output shaft seal.	<ul style="list-style-type: none"> Output yoke nut loose or improperly staked (4x2, except F-Super Duty). 	<ul style="list-style-type: none"> Replace seal, using a new locknut. Torque to 250 N·m (184 ft-lb) and stake. Install a new locknut. Tighten to 250 N·m (184 ft-lb). Secure locknut by staking the locking shoulder of the nut into the groove of the output shaft.
Leak at input shaft seal.	<ul style="list-style-type: none"> Improper assembly. Seal lip may have rolled during assembly, garter spring may have become dislodged during a previous repair. 	<ul style="list-style-type: none"> Replace seal using extreme caution that input shaft does not contact the seal during reassembly (if the seal lip is rolled, leaking may not occur for several hundred miles).
Leak between quill pipe and clutch housing (7.3L and 7.5L engines only).	<ul style="list-style-type: none"> Damaged O-ring during assembly. 	<ul style="list-style-type: none"> Remove quill pipe, inspect sealing surfaces and replace O-ring. Lubricate O-ring prior to assembly to prevent damage.
Leak at case joint.	<ul style="list-style-type: none"> Damaged case mating surfaces or assembly error. Use of RTV on a previous repair. 	<ul style="list-style-type: none"> Repair or replace damaged case. Reseal with anaerobic sealant, E2AZ-19562-B. Torque bolt to 22 N·m (16 ft-lb). Never use RTV on this transmission.

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TROUBLESHOOTING GUIDE (Miscellaneous Concerns)

CONDITION	POSSIBLE SOURCE	ACTION
Cracked clutch housing.	<ul style="list-style-type: none"> Drivetrain vibration: Caused by assembly error. Vehicle modification (driveshaft lengthened or shortened). 	<ul style="list-style-type: none"> Check the integrity of driveshaft attachment. Non-factory driveshafts should be inspected for: <ul style="list-style-type: none"> Driveshaft size 0 to 51 inches long — 3 inch diameter tube is OK. Up to 55 inches long — 3-1/2 inch diameter tube is required. Up to 59 inches long — 4 inch diameter tube is required. Working angles greater than 1/2° but less than 3°. System balanced at 3000 RPM to within 0.4 in / oz at the ends and 0.8 in / oz at the center support.
Cracked rear engine mount transmission attachment ears.	<ul style="list-style-type: none"> Broken front engine mounts. Vibration caused by a driveline imbalance. Rear mount upper flange not flat. 	<ul style="list-style-type: none"> Inspect and replace front engine mounts if required. See cracked clutch housing. Replace rear mount.

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DIAGNOSIS AND TESTING (Continued)**TROUBLESHOOTING GUIDE — BEARING FAILURE**

CONDITION	POSSIBLE SOURCE	ACTION
NOTE: THE SERVICE LIFE OF MOST TRANSMISSIONS IS GOVERNED BY THE LIFE OF THE BEARINGS. THE MAJORITY OF BEARING FAILURES CAN BE RELATED TO DRIVELINE VIBRATION OR CONTAMINATION OF THE FLUID. ADDITIONAL REASONS FOR BEARING FAILURES ARE:	<ul style="list-style-type: none"> Extended start-up idle in extreme cold may lead to mainshaft bearing wear. Any combination of operation at or above GVW in high ambient temperatures, on steep grades, or vehicles with high frontal areas (exceeding 60 square feet) can affect all bearings due to temperature build-up. Pocket bearing not lubricated due to missing, damaged or misinstalled input shaft oil dam. Pocket bearing not lubricated due to damaged oil baffle in the input bearing shim pack. Damage due to towing a vehicle greater than 50 miles or at speeds exceeding 35 MPH with the driveshaft installed. Mainshaft tapered bearing and needle caged bearings are especially susceptible to damage. Vibration break-up of retainer and brinelling of races-fretting corrosion. Incorrect preload causes faster wearing of the bearings, due to incomplete contact area. Lack of lubricant or wrong type. Acid etch of bearing due to water in lube. Worn out due to other part failure. 	<ul style="list-style-type: none"> Synthetic MERCON® (E6AZ-19582-B) provides improved lubrication when transmission temperatures remain below minus 20°F for extended periods. Heat build-up may cause break down of the ATF. Synthetic MERCON® can withstand higher operating temperatures. Replace damaged components and make sure of proper oil dam installation. Check for proper installation of the snap ring, which retains the 3-4 synchronizer body, on the mainshaft next to the oil dam. Replace damaged components making sure the tin oil baffle is not damaged during reassembly. Provide correct towing procedures to tow operator. Refer to driveshaft restrictions in the Miscellaneous Concerns chart of this diagnosis guide. Be sure to follow preload setting procedure in this section. Check for leaks and repair as required. Replace with correct fluid. Identify and correct source of water entry. Remove, disassemble and clean the transmission, then replace damaged parts (necessary to reset bearing preload if any input shaft or mainshaft tapered bearings are replaced).

TC10837B

REMOVAL AND INSTALLATION**Transmission (4x2)****Removal**

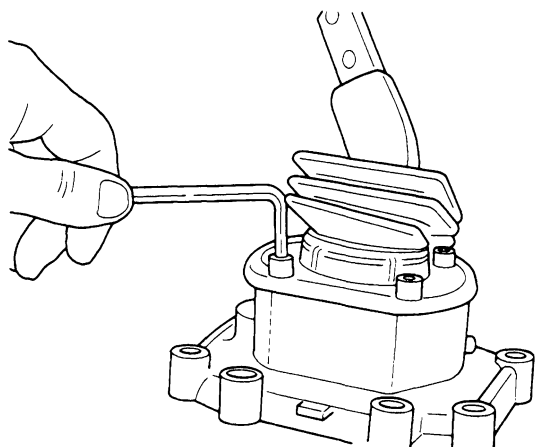
- Shift the transmission into neutral.
- Remove the four screws and remove the boot and bezel assembly from the transmission opening cover.

- Remove the two bolts and remove the upper shift lever from the lower shift lever.

REMOVAL AND INSTALLATION (Continued)

4. Remove the four Allen-head capscrews from the shift tower cover and remove the entire shifter assembly from the top of the transmission.

CAUTION: Remove lower lever from the vehicle to prevent getting transmission fluid on the floor mat or carpet.



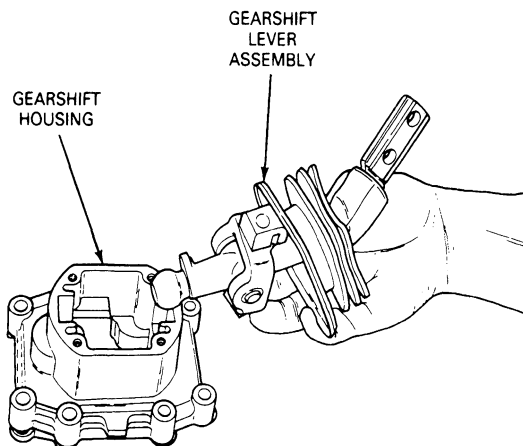
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5. Raise the vehicle on a hoist and position safety stands under the vehicle.
6. Disconnect the back-up lamp switch located at the top left hand side of the transmission.
7. If the transmission is to be disassembled, remove the drain plug and drain the oil from the transmission.
8. Position a transmission jack, such as Rotunda Transmission Jack 077-00008 or equivalent under the transmission. Secure the transmission to the jack stand.
9. Remove the driveshaft from the vehicle. Disconnect the clutch linkage from the transmission. Refer to Section 05-01 and Section 08-02. Keep transmission in upright position to avoid fluid leakage.
10. On F-Super Duty series vehicles remove the transmission parking brake from the transmission. Refer to the Body / Chassis Manual, Section 06-05. Keep parking brake in upright position to avoid fluid leakage.
11. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember Removal and Installation in this section.
12. Remove the bolts that retain the transmission to the engine block.
13. Move the transmission to the rear until the input shaft clears the engine flywheel. Lower the transmission from the vehicle. Keep transmission in upright position to avoid fluid leakage.

Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent. Secure the transmission to the jack. Install guide studs in the front case and raise the transmission until the input shaft splines are aligned with the clutch disc splines. The clutch release bearing and hub must be properly positioned in the release lever fork.
2. Slide the transmission forward on the guide studs until it is in position on the front case. Install the attaching bolts and tighten them to 54-68 N-m (40-50 ft-lb). Remove the guide studs and install the two remaining attaching bolts.
3. Install the crossmember as described under Crossmember Removal and Installation in this section. Position the insulator and retainer between the transmission and crossmember. Install bolts and tighten to 60-80 N-m (45-60 ft-lbs). Install the nut retaining the insulator and retainer to crossmember. Tighten to 68-94 N-m (50-70 ft-lbs). Remove the transmission jack.
4. Connect the clutch linkage. Refer to Section 08-02.
5. Connect the back-up lamp switch.
6. On F-Super Duty series vehicles, install the transmission parking brake. Refer to the Body / Chassis Manual, Section 06-05.
7. Install the driveshaft. Refer to Section 05-01.
8. Fill the transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX or -DDX E4AZ-19582-B or equivalent. Remove safety stands and lower the vehicle.
9. Place a **new**, dry gasket on the upper surface of the gearshift housing. Place the gearshift lever with the attached guide pieces into the guide piece grooves. The slotted ends of these guide pieces must face upward.

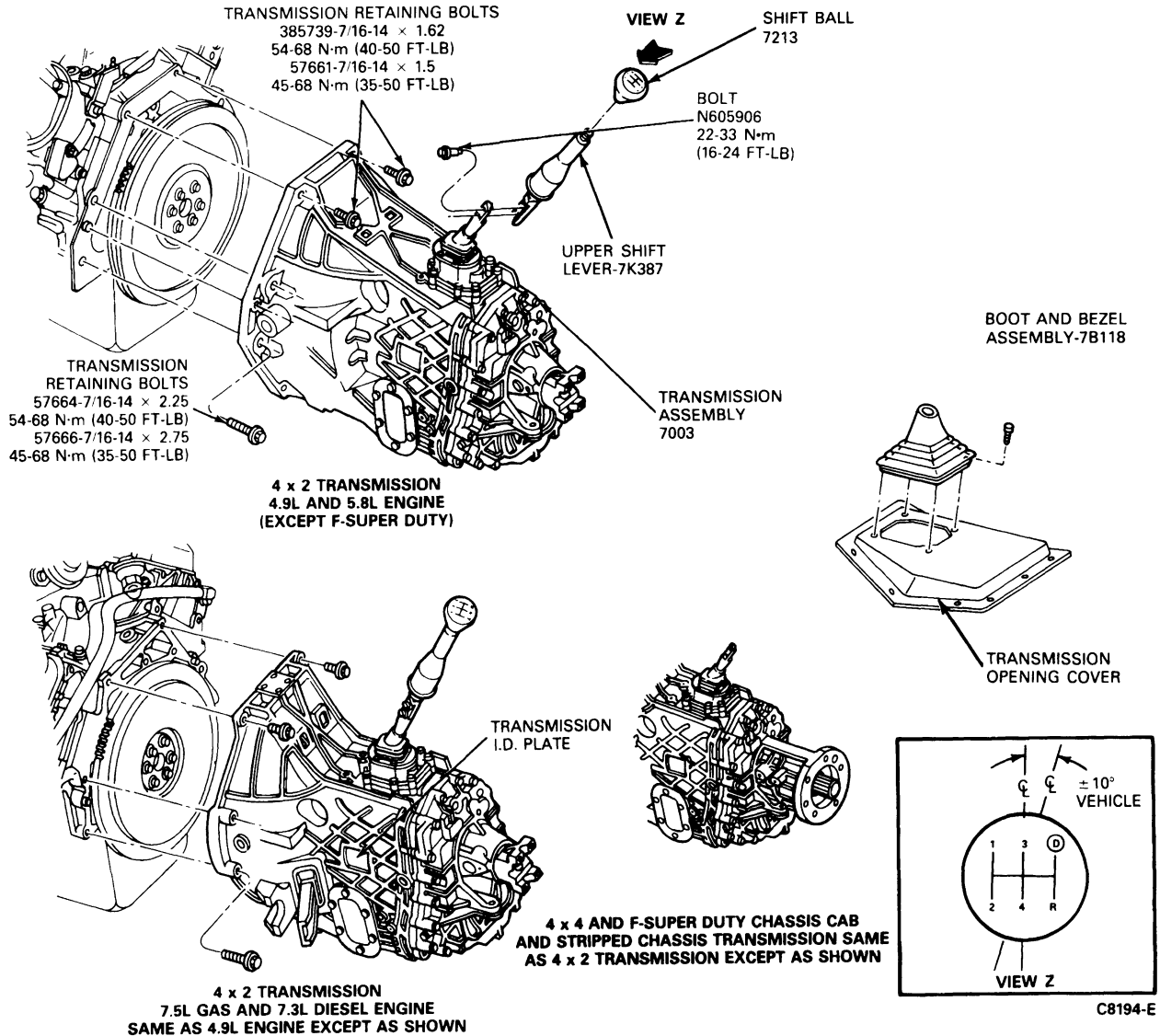
CAUTION: Do not use any sealant on gasket.



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REMOVAL AND INSTALLATION (Continued)

10. Tighten the four Allen-head capscrews that secure the cover assembly to the gearshift housing to approximately 10 N·m (7 ft-lbs).
11. Install the inner boot over the lower shift lever.
12. Install the upper shift lever to the lower shift lever and tighten the two retaining screws to 22-33 N·m (16-24 ft-lbs).
13. Install the inner boot and the boot and bezel assembly to the transmission opening cover.
14. Install the shift ball on the upper shift lever if removed.

Manual Transmission Assembly**Transmission (4x4)****Removal**

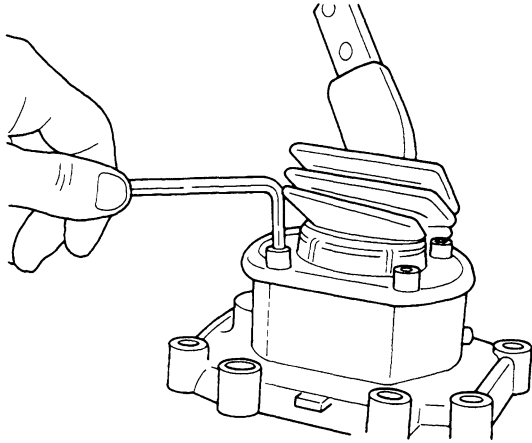
1. Shift the transmission into neutral.

2. Remove the four screws and remove the boot and bezel assembly from the transmission opening cover.

REMOVAL AND INSTALLATION (Continued)

3. Remove the four Allen-head capscrews from the shift tower cover and remove the entire shifter assembly from the top of the transmission.

CAUTION: Remove lower lever from the vehicle to prevent getting transmission fluid on the floor mat or carpet.



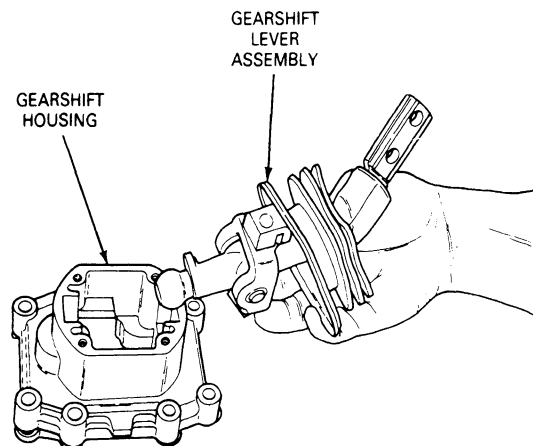
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4. Raise the vehicle on a hoist and position safety stands under vehicle.
5. If transmission is to be disassembled, remove the drain plugs and drain the transmission and transfer case.
6. Remove the rear driveshaft from the vehicle. Refer to Section 05-01.
7. Remove the front driveshaft from the vehicle. Refer to Section 05-01.
8. Disconnect the back-up lamp switch.
9. Disconnect the clutch linkage from the transmission.
10. If equipped, remove the skid pan from beneath the transfer case.
11. Remove the transfer case according to the procedure outlined in Section 07-07B.
12. Position a transmission jack, such as Rotunda Transmission Jack 077-00008 or equivalent, under transmission. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember Removal and Installation in this section.
13. Remove the bolts that retain the transmission to the engine block.
14. Move the transmission to the rear until the input shaft clears the engine flywheel housing. Lower the transmission from the vehicle.

Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent, and install two guide studs in the transmission front case top holes, to guide the transmission into position. Join together the transmission and engine block mating surfaces.
2. Install the two lower bolts and tighten to 54-68 N·m (40-50 ft-lbs). Remove the guide studs and install the upper bolts.
3. Place the rear support bracket in position and install the retaining bolts. Refer to Crossmember Installation in this section. Tighten the bolts to 60-80 N·m (45-60 ft-lbs).
4. Install the two bolts at the rear support insulator bracket. Remove the transmission jack.
5. Position the transfer case on the transmission jack. Position the transfer case on the transmission, using care to guide the transfer case shift lever through the opening in the floor pan. Install the gasket and six retaining bolts. Tighten the bolts to specifications listed in the appropriate transfer case section in Group 07 in this manual.
6. Install the front driveshaft.
7. Install the rear driveshaft.
8. Fill transfer case and transmission with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX E4AZ-19582-B or equivalent.
9. Connect the back-up lamp switch.
10. Remove safety stands and lower vehicle.
11. Place a **new**, dry gasket on the upper surface of the gearshift housing. Place the gearshift lever with the attached guide pieces into the guide piece grooves. The slotted ends of these guide pieces must face upward.

CAUTION: Do not use any sealant on gasket.



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REMOVAL AND INSTALLATION (Continued)

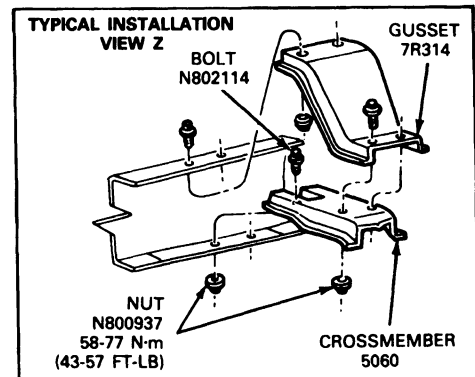
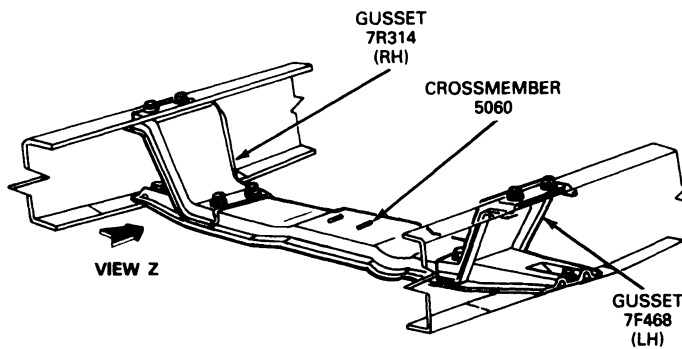
12. Tighten the four Allen-head capscrews that secure the cover assembly to the gearshift housing to approximately 10 N·m (7 ft-lbs).
13. Install the inner boot over the lower shift lever.
14. Install the upper shift lever to the lower shift lever and tighten the two retaining screws to 22-33 N·m (16-24 ft-lbs).
15. Install the inner boot and the boot and bezel assembly to the transmission opening cover.
16. Install the shift ball on the upper shift lever if removed.

Crossmember, All F-Series Except F-350 4x4**Removal**

1. Raise vehicle on a hoist and position suitable safety stands under vehicle.
2. Remove skid plate, if so equipped. Remove heat shield from catalytic converter.

CAUTION: Use extreme caution when working in the area of the catalytic converter because of the extremely high temperatures generated by the converter.

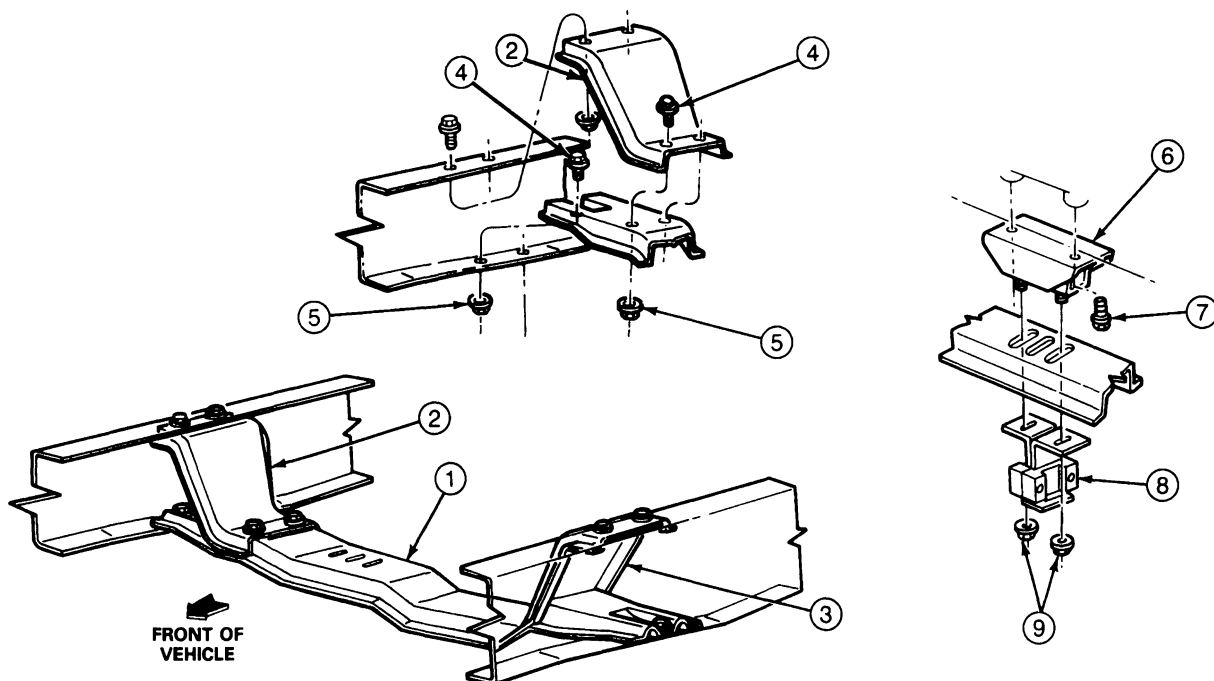
3. Remove two nuts connecting upper gusset to frame on both sides of frame.
4. Remove nut and bolt assembly connecting gusset to crossmember. Remove gusset on left side.
5. Remove bolts holding transmission to transmission support plate on crossmember.
6. Raise transmission with a transmission jack.
7. Remove the nut and bolt assemblies connecting the support plate to the crossmember. Remove support plate. Remove right gusset.
8. Remove nut and bolt assemblies connecting crossmember to frame. Remove crossmember.

F-Series 4x2 and F-Super Duty

C10311-A

REMOVAL AND INSTALLATION (Continued)

F-250 4 x 4



C10827-A

Item	Part Number	Description
1	5060	#2 Crossmember
2	7R314	Gusset (RH)
3	7F468	Gusset (LH)
4	N802114-S2	Bolt M12-1.75 x 35
5	N800937-S7	Nut M12-1.75 43-57 N-m (32-42 Ft-Lb)

(Continued)

Item	Part Number	Description
6	6D901	Insert and Retainer Assembly
7	390066-S2	Screw and Washer Assembly 64-71 N-m (47-52 Ft-Lb)
8	4A263	Damper
9	N621945-S2	Nut 81-109 N-m (60-81 Ft-Lb)

TC10827A

Installation

1. Install crossmember and transmission support plate, and position right and left gussets on bolts on frame. Install nuts on upper gusset-to-frame bolts and tighten to 58-77 N-m (43-57 ft-lb).
2. Install crossmember to frame nut and bolt assembly and tighten to 58-77 N-m (43-57 ft-lb).
3. Install nut and bolt assembly connecting gusset to crossmember and tighten to 58-77 N-m (43-57 ft-lb).
4. Install nut and bolt assemblies connecting transmission support plate to crossmember and tighten to 81-109 N-m (60-81 ft-lb).
5. Lower the transmission.
6. Install bolts connecting transmission support plate to transmission and tighten to 64-71 N-m (47-52 ft-lb).

7. Install skid plate, if so equipped. Install heat shield over catalytic converter. Tighten all nuts and bolts to specification.

Crossmember, F-350 4x4**Removal**

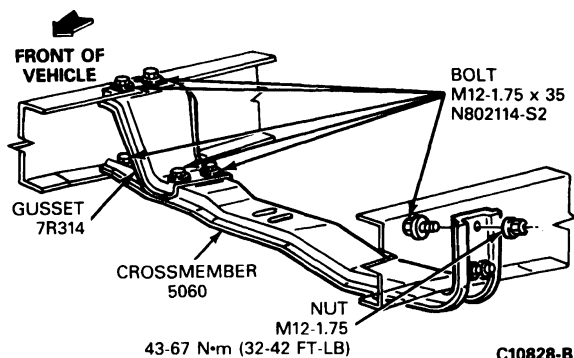
1. Raise vehicle on hoist and position safety stands under vehicle.
2. Remove skid plate, if equipped. Remove heat shield from catalytic converter.
CAUTION: Use extreme caution when working in the area of the catalytic converter because of the extreme high temperatures generated by the converter.
3. Remove two nuts and bolts connecting upper gusset to the right frame rail.

REMOVAL AND INSTALLATION (Continued)

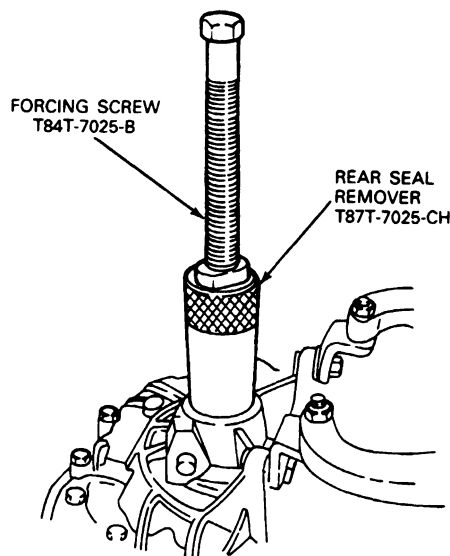
4. Remove bolts holding transmission to the transmission support plate on the crossmember.
5. Raise transmission with a transmission jack such as Rotunda 077-00008 or equivalent.
6. Remove nuts and bolts holding lower end of gusset to the crossmember. Remove the gusset.
7. Remove bolts holding crossmember to frame. Remove crossmember from vehicle.

Installation

1. Position crossmember to frame. Install bolts and nuts and tighten and 43-57 N·m (32-42 ft·lb).
2. Position gusset on right side frame rail. Install retainer bolts and nuts and tighten to 43-57 N·m (32-42 ft·lb).
3. Lower transmission into place on the crossmember transmission support plate and install retainer nuts. Tighten nuts to 81-109 N·m (60-81 ft·lbs). Remove transmission jack.
4. Install catalytic converter heat shield and skid plate, if equipped.
5. Remove safety stands and lower vehicle.

F-350 4x4

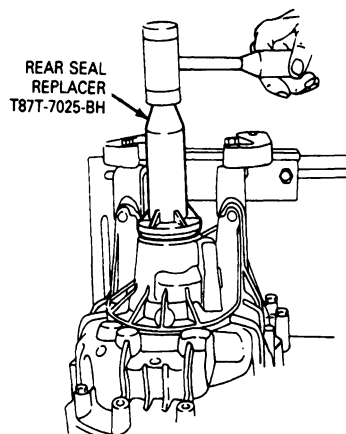
6. Insert Rear Seal Remover T87T-7025-CH over output end of mainshaft and tighten into rear seal.
7. Assemble Forcing Screw T84T-7025-B into seal remover. Turn forcing screw while holding seal remover to pull seal.

**4 x 2 OUTPUT SEAL REMOVAL**

C8196-1A

Installation

1. Position the output shaft seal on Output Seal Replacer T87T-7025-BH and position the seal and tool over the output end of the mainshaft.
2. Apply a little liquid soap around the circumference to minimize friction. Using a soft hammer, gently tap the output seal replacer until it seats in the opening.

**4 x 2 TRANSMISSION REAR OIL SEAL INSTALLATION**

C8199-1A

Rear Oil Seal, 4x2 Transmissions (Except F-Super Duty)**Removal**

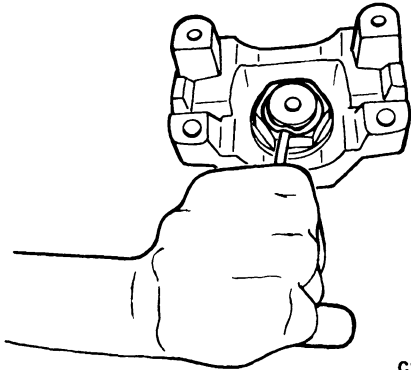
1. Disconnect the driveshaft from the output flange. Refer to Section 05-01.
2. Using a chisel, bend back the locking shoulder of the output flange retaining locknut.
3. Attach Companion Flange Holding Tool T78P-4851-A to the transmission output flange with four hex bolts.
4. Loosen the hex nut that holds the output flange to the mainshaft with Locknut Socket T87T-7025-AH. Remove the flange holding tool after loosening the nut.
5. Remove the output flange from the output end of the mainshaft.

REMOVAL AND INSTALLATION (Continued)

3. Install the output flange on the output end of the mainshaft.
4. Attach Companion Flange Holding Tool T78P-4851-A to the transmission output flange with four hex bolts.
5. Install a new output flange retaining nut (E7TZ-7045-A) on the mainshaft with Locknut Socket T87T-7025-AH. Tighten the nut to 250 N-m (184 ft-lbs). Remove the flange holding tool after tightening the nut.

CAUTION: Do not reuse the output flange retaining nut after any servicing of the transmission. Always replace it with a new one.

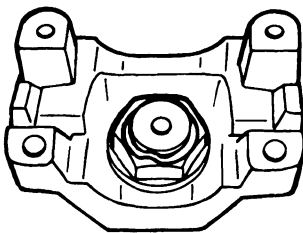
6. Position a 4.76mm (3/16-inch) punch on the locking shoulder of the retaining nut over the groove of the output shaft.



C10312-A

7. Strike the punch with a hammer. Make sure that the shoulder of the retaining nut is contacting the bottom of the groove.

CAUTION: When staking the nut, make sure the locking shoulder of the nut and the groove of the output shaft are the only areas used in this staking operation. If the nut is struck in any other area, the torque will be lost and the nut may come loose in service.

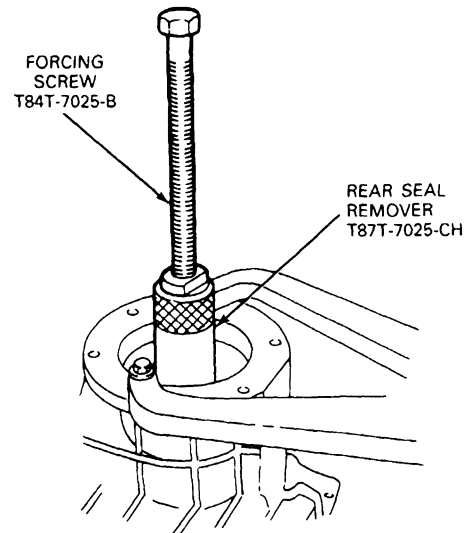


C10313-A

8. Connect the driveshaft to the output flange. Refer to Section 05-01, Driveshaft.

Rear Oil Seal, 4x4 and F-Super Duty Series Transmissions**Removal**

1. On 4x4 vehicles, remove the transfer case as described in the appropriate transfer case section in Group 07 in this manual. On F-Super Duty series vehicles, remove the transmission mounted parking brake as described in the Body / Chassis Manual, Section 06-05.
2. Insert Rear Seal Remover T87T-7025-CH over output end of mainshaft and tighten into rear seal.
3. Assemble Forcing Screw T84T-7025-B into seal remover. Turn forcing screw while holding seal remover to pull seal.



4 x 4 OUTPUT SEAL REMOVER

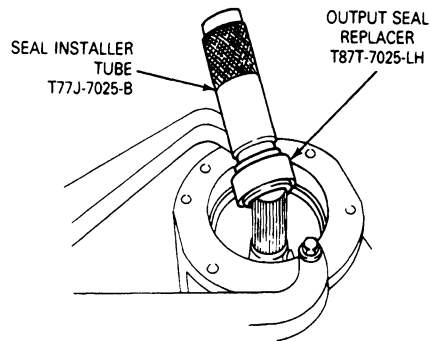
C8198-1A

Installation

1. Place a new oil seal and Output Seal Replacer T87T-7025-LH over the output end of the mainshaft.
2. Slide Puller Tube T77J-7025-B over the output end of the mainshaft.
3. Apply a little liquid soap around the circumference to minimize friction. Using a soft hammer, gently tap the output seal replacer tube until it seats in the opening.

REMOVAL AND INSTALLATION (Continued)

4. On 4x4 vehicles, install the transfer case as described in the appropriate transfer case section in Group 07 in this manual. On F-Super Duty vehicles, install the transmission mounted parking brake as described in the Body / Chassis Manual, Section 06-05.

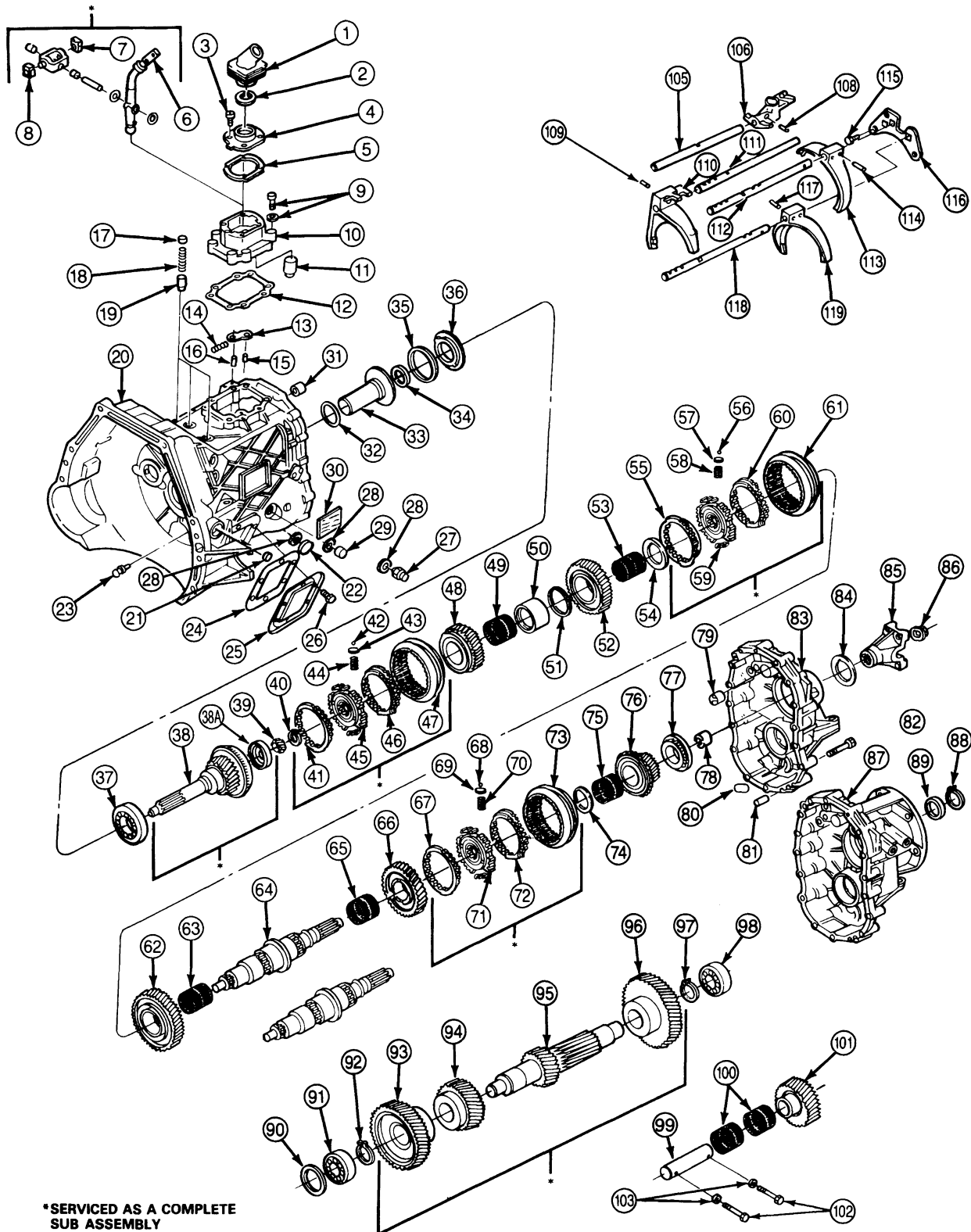


4 x 4 TRANSMISSION REAR OIL SEAL INSTALLATION

C8197-1A

DISASSEMBLY AND ASSEMBLY

Model S5-42 ZF



C8200-E

DISASSEMBLY AND ASSEMBLY (Continued)

Item	Part Number	Description
1	7277	Shift Lever Boot
2	7D152	Snap Ring
3	N603264	Capscrew
4	7262	Shift Lever Retainer
5	7207	Gasket
6	7210	Lower Shift Lever
7	7C371	Guide Piece
8	—	Guide Piece
9	7A443 & 7C015	Hex Bolts & Washers
10	7203	Shift Housing
11	7E218	Shift Detent Plunger Assy
12	7185	Gasket
13	7F194	5th-Reverse Interlock
14	7234	Interlock Spring
15	7B096	Interlock Roll Pin
16	7B096	Interlock Roll Pin
17	7L013	Case Plug
18	7N120	Spring
19	7247	Shift Rail Detent Plunger
20	7005	Front Case
21	7L018	Case Plug
22	7A010	Plug — Drain
23	7B602	Clutch Release Lever Stud
24	7166	Gasket (PTO)
25	7165	PTO Cover
26	304650	Bolt
27	—	Backup Lamp Switch
28	—	Sealing Ring
29	7A010	Plug — Filler
30	—	ID Plate
31	7D362	Central Shift Rail Bearing
32	7288	O-Ring
33	7080	Release Bearing Retainer
34	7052	Oil Seal
35	7029	Shim(s) Kit
36	7040	Baffle
37	7025	Input Shaft Bearing
38	7017	Input Shaft
38A	7046	Oil Dam
39	7120	Bearing Input Pocket
40	7B331	Snap Ring (Kit)
41	—	Gear Synchronizer Ring
42	—	Ball
43	7124	Pressure Piece
44	—	Spring
45	—	3rd-4th Synchronizer Body
46	—	3rd Gear Synchronizer Ring
47	—	3rd-4th Sliding Sleeve
48	7186	3rd Gear
49	7133	Caged Needle Rollers
50	7173	Bushing
51	7114	Thrust Washer
52	7103	2nd Gear
53	7133	Caged Needle Rollers
54	7B331	Snap Ring (Kit)
55	7124	2nd Gear Synchronizer Ring

(Continued)

Item	Part Number	Description
56	7124	Ball
57	7124	Pressure Piece
58	7124	Spring
59	7124	1st-2nd Synchronizer Body
60	7124	1st Gear Synchronizer Ring
61	7124	1st-2nd Sliding Sleeve
62	7100	1st Gear
63	7127	Needle Rollers
64	7061	Mainshaft
65	7127	Caged Needle Rollers
66	7142	Reverse Gear
67	7124	Reverse Gear Synchronizer Ring
68	7124	Ball
69	7124	Pressure Piece
70	7124	Spring
71	7124	5th-Reverse Synchronizer Body
72	7124	5th-Gear Synchronizer Ring
73	7124	5th-Reverse Sliding Sleeve
74	7B331	Snap Ring (Kit)
75	7121	Caged Needle Rollers
76	7158	5th Gear
77	7R205	Mainshaft Bearing
78	7072	Bushing (Speedo Replacement)
79	7D362	Central Shift Rail Bearing
80	7E290	Magnet
81	—	Dowel
82	7A443	Bolt
83	7A039	Rear Case (4 x 2)
84	7052	Rear Oil Seal (4 x 2)
85	7089	Output Yoke (4 x 2)
86	7045	Output Yoke Locknut (4 x 2)
87	7A039	Rear Case (4 x 4 and F-Super Duty)
88	7B331	Snap Ring (4 x 4 and F-Super Duty) (Kit)
89	7052	Oil Seal (4 x 4 and F-Super Duty)
90	7119	Shim
91	7065	Front Countershaft Bearing
92	7064	Snap Ring
93	7113	Countershaft Drive Gear
94	7113	Countershaft 3rd Gear
95	7113	Countershaft
96	7113	Countershaft 5th Gear
97	7064	Snap Ring
98	7065	Countershaft Rear Bearing
99	7140	Reverse Idler Shaft
100	7E139	Caged Needle Rollers
101	7141	Reverse Idler Gear
102	7214	Screw
103	7K267	Sealing Ring
105	7240	Central Shift Rail
106	7243	Shift Finger
108	7B096	Roll Pin

(Continued)

DISASSEMBLY AND ASSEMBLY (Continued)

Item	Part Number	Description
109	7B096	Roll Pin
110	7230	Shift Fork — 3/4
111	7241	Shift Rail — 3/4
112	7242	Shift Rail — 1/2
113	7231	Shift Fork — 1/2
114	7B096	Roll Pin

(Continued)

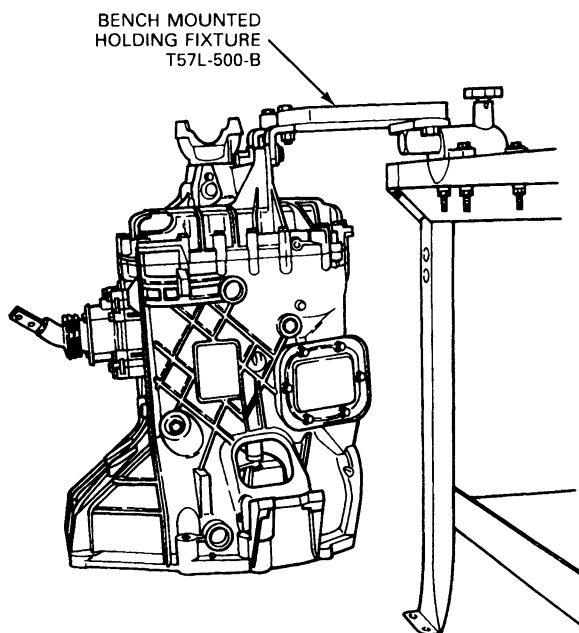
Item	Part Number	Description
115	7A443	Bolt
116	7K201	Interlock Plate
117	7B096	Roll Pin
118	7358	Shift Rail — 5/R
119	7239	Shift Fork — 5/R

TC8200A

Disassembly

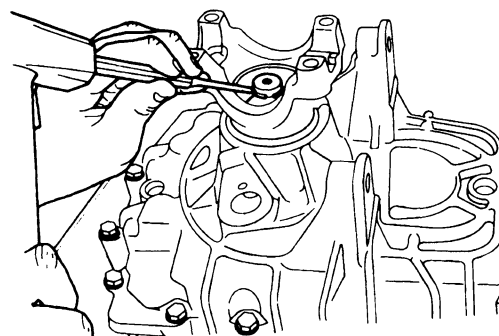
NOTE: For 4x4 and F-Super Duty vehicles, skip to Step 5.

1. Attach the transmission to the Bench Mounted Holding Fixture T57L-500-B. Place the transmission in a vertical position with the front case pointing downward.



C8676-B

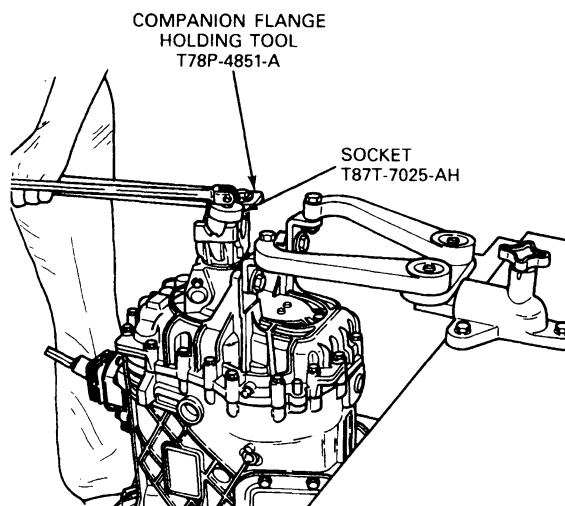
2. Using a chisel, bend back the locking shoulder of the output flange retaining locknut (4x2 models only).

BEND LOCKING SHOULDER
ON LOCKNUT

C8677-B

3. Attach Companion Flange Holding Tool T78P-4851-A to the transmission output flange.
4. Loosen the hex nut that holds the output flange to the mainshaft with Locknut Socket T87T-7025-AH. Remove the flange holding tool after loosening the nut.

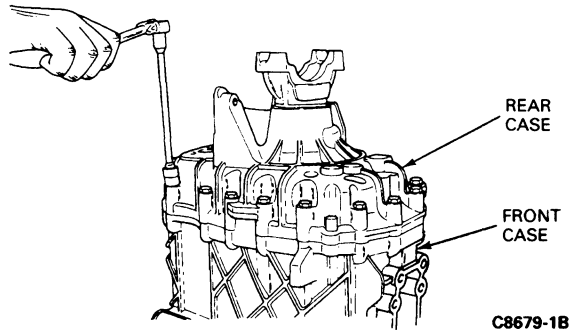
CAUTION: Do not remove the hex nut or output flange at this time.



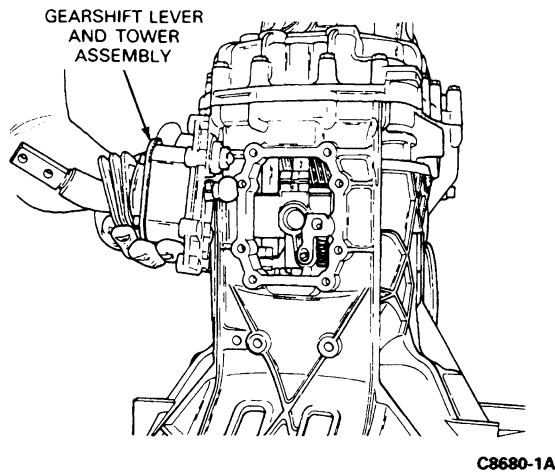
C8678-B

DISASSEMBLY AND ASSEMBLY (Continued)

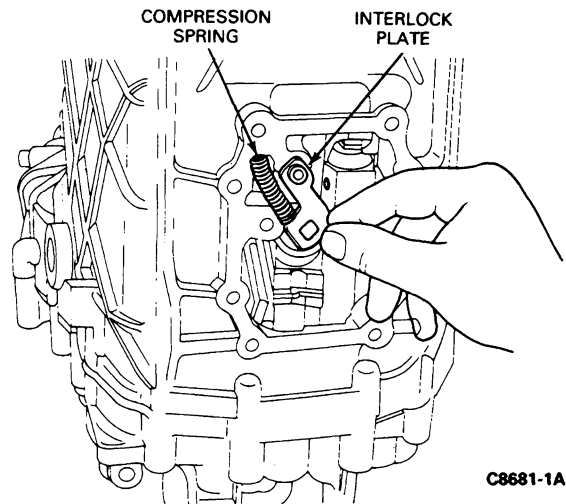
5. Remove 15 of the 17 8mm hex head screws that hold the front and rear cases together. Leave two screws at opposite sides of the case installed.



6. Remove any power take-off equipment installed on the transmission.
7. Remove the eight 8mm hex bolts that attach the shift tower assembly to the front case. Remove the complete gearshift lever and tower as an assembly. Rotate transmission on holding fixture so that the front case is pointing upward.



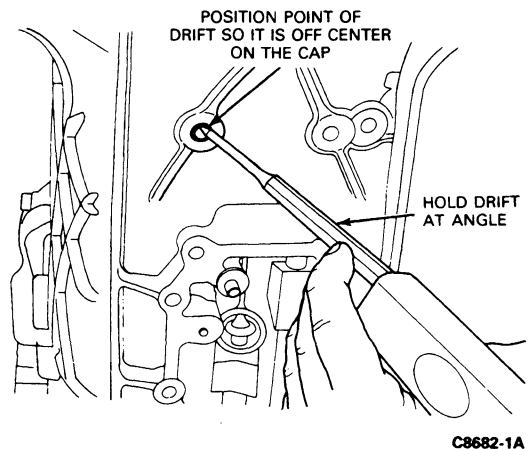
8. Remove the interlock plate and compression spring which serves as a reverse gear interlock.
- CAUTION:** Make sure that parts do not inadvertently fall into transmission.



9. Place a drift punch against the detent bolt sealing cap. Hold the drift at an angle. Position the point of the drift punch so it is off-center on the cap. Drive the cap inward until spring pressure against its underside forces the cap out of its hole. Repeat this procedure for the other two detent bolt sealing caps in the front case.

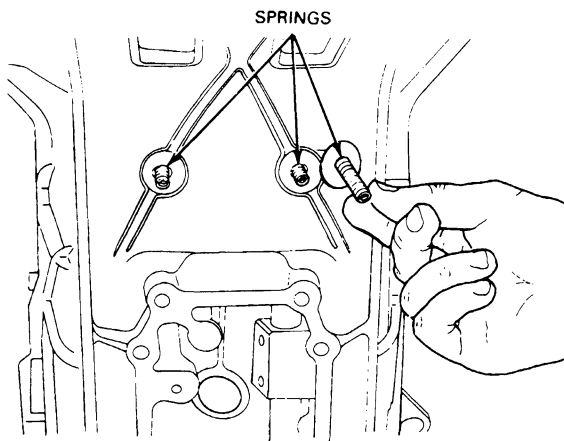
WARNING: CAP IS UNDER SPRING PRESSURE. ALWAYS WEAR PROTECTIVE EYEGLASSES WHEN PERFORMING THIS PROCEDURE TO ENSURE THAT CAP DOES NOT STRIKE EYES WHEN IT IS FORCED OUT BY SPRING PRESSURE.

NOTE: Discard removed caps and replace with new sealing caps.



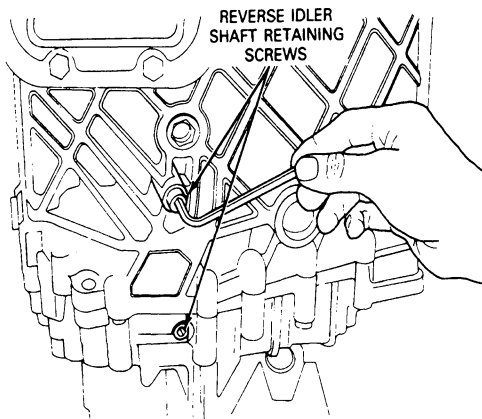
DISASSEMBLY AND ASSEMBLY (Continued)

10. Remove the springs that are now protruding from the sealing cap holes.



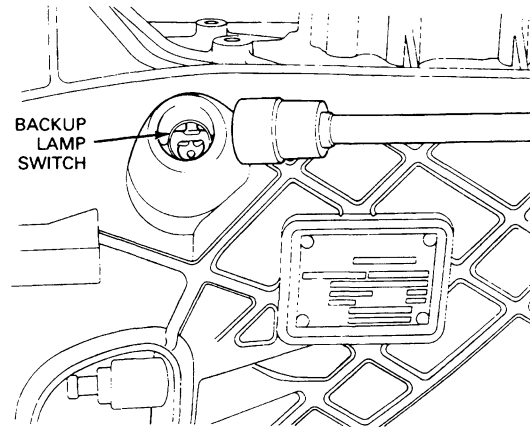
C8683-1A

11. Drive out the sealing caps for the two reverse idler shaft cap screws. Remove the reverse idler shaft cap screws.



C8684-1A

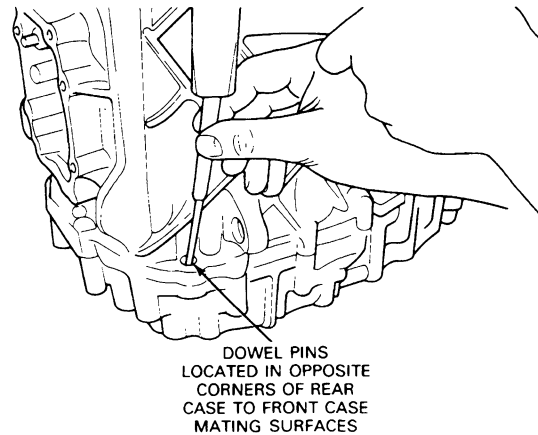
12. If required, remove the back-up lamp switch, located above and slightly forward of the transmission nameplate. Remove the back-up lamp switch sealing ring.



C8685-1A

13. Use a suitable punch to remove the two dowel pins located in opposite corners of the rear case to front case mating surfaces. Drive them out toward the rear of the transmission.
14. Remove the two remaining hex bolts from the rear case.

NOTE: The transmission input shaft is facing upward during this operation.

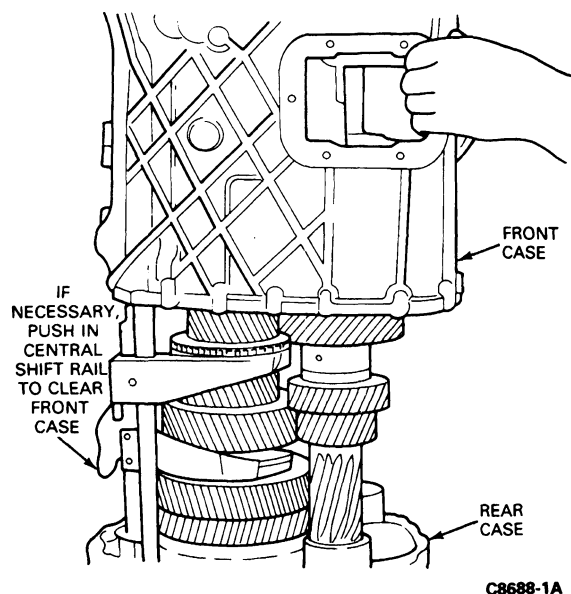


C8687-1B

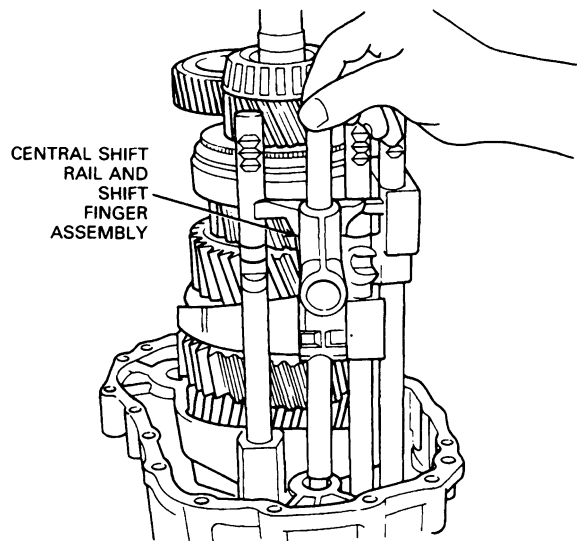
DISASSEMBLY AND ASSEMBLY (Continued)

15. Carefully lift the front case off of the rear case. It may be necessary to push the central shift rail inwards to prevent it from "hanging up" on the front case as it is being removed. Use care to make sure that the central shift rail is not lifted off together with the front case. Refer to Transmission Front Case in this section for front case disassembly and assembly procedures.

CAUTION: The mating surfaces of the two housing assemblies are coated with an adhesive sealing agent. If it is difficult to separate the two housings because of this adhesive, carefully tap the front of the front case with a soft hammer until the bond is loosened. Never use a prying device, such as a screwdriver or chisel, to force the housings apart. It could damage the surface and cause leaks.

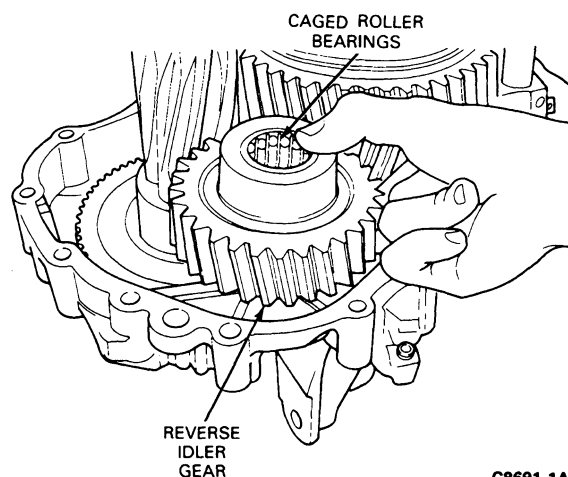


16. Remove the central shift rail and shift finger assembly.



C8689-1A

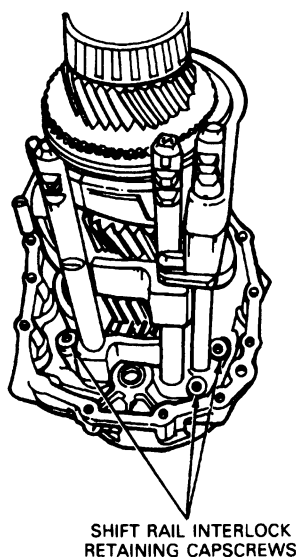
17. Lift the shaft out of the reverse idler gear, and remove the gear and two caged roller bearings from the rear case.



C8691-1A

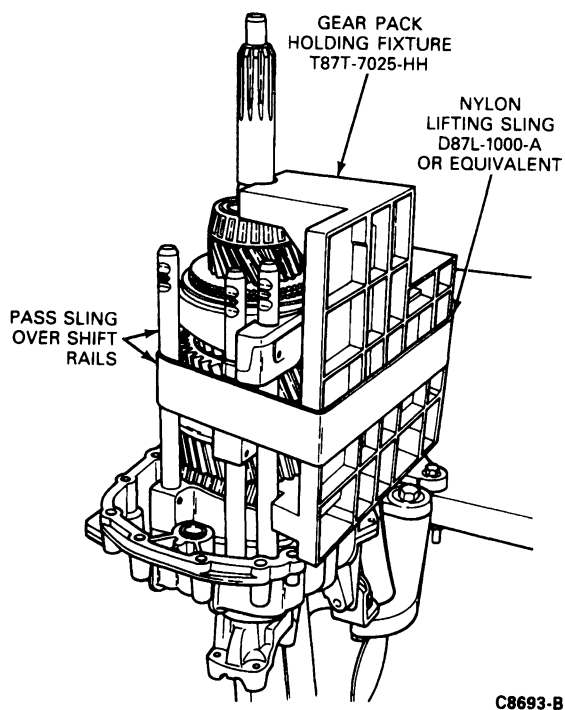
DISASSEMBLY AND ASSEMBLY (Continued)

18. Remove the three capscrews that retain the shift interlock to the rear case.



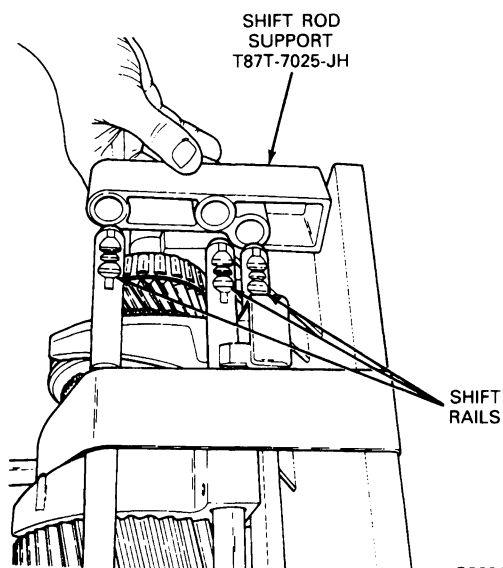
C8692-1A

19. With the transmission in a vertical position, use Nylon Lifting Sling D87L-1000-A or equivalent to strap Gear Pack Holding Fixture T87T-7025-HH to the mainshaft and output shaft assemblies. Pass the sling over the shift rails.



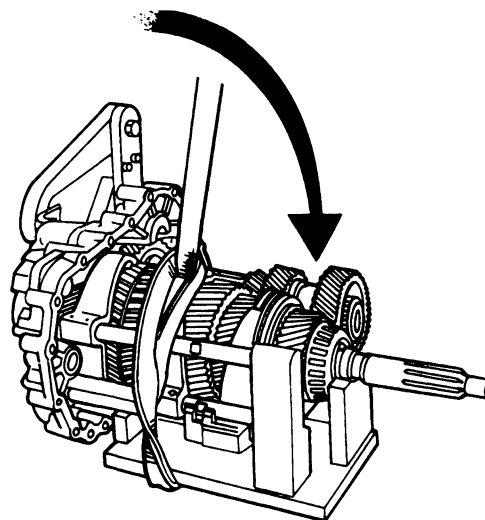
C8693-B

20. Place the Shift Rod Support T87T-7025-JH over the ends of the shift rails.



C8694-B

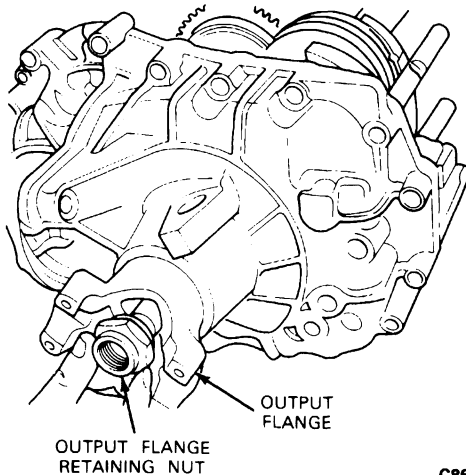
21. Carefully rotate the transmission, together with the gear pack holding fixture, into a horizontal position with the holding fixture beneath the gear pack.



C8695-1A

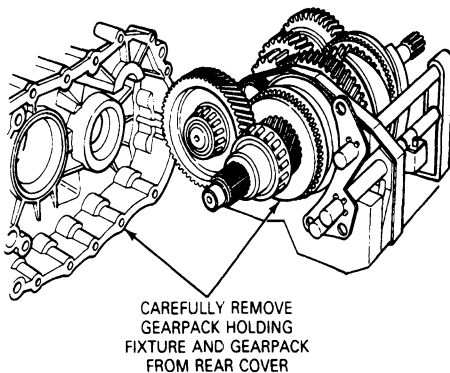
DISASSEMBLY AND ASSEMBLY (Continued)

22. Remove the output shaft flange retaining nut from the output shaft. Remove the flange from the output shaft. If the flange is difficult to remove, tap it loose with a hammer.



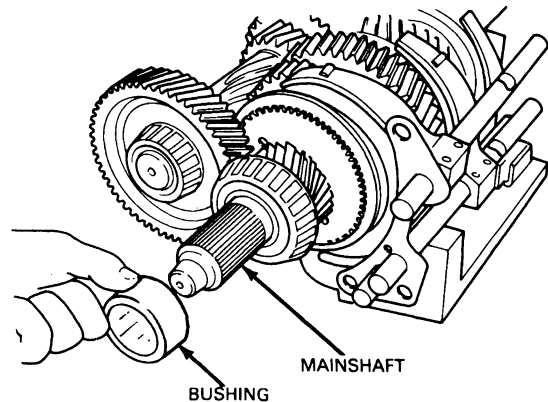
C8696-1A

23. Carefully pull the gearpack and shift rails and their holding fixtures forward to dislodge them from the rear case. Place this assembly on a workbench.



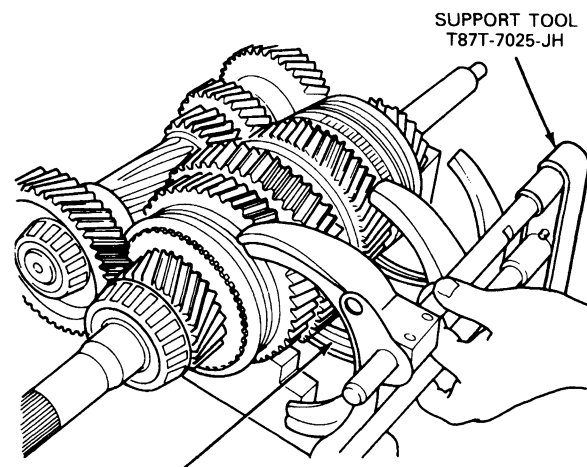
C8697-1A

24. If equipped, remove the bushing from the mainshaft.



C8698-1C

25. Remove the sling from around the shift rails, gearpack, and holding fixture.
26. Turn the gearshift rails approximately 45 degrees to release them from the shift hubs. Lift the gearshift rails, forks and interlock, together with Support Tool T87T-7025-JH, off the mainshaft.

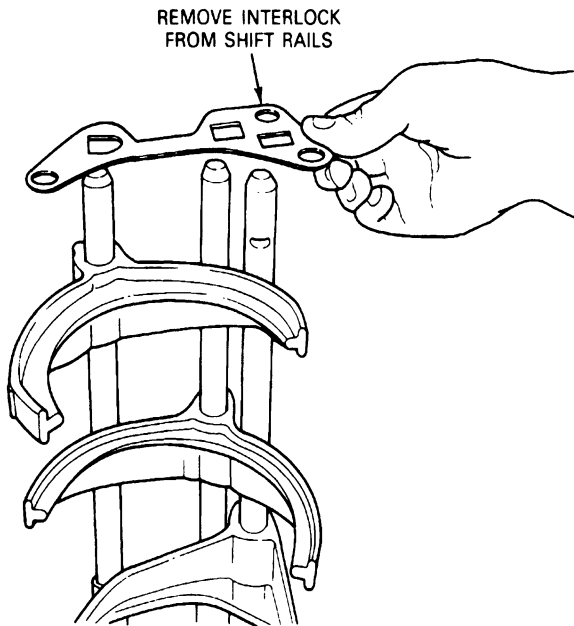


LIFT THE SHIFT RAILS,
FORKS, INTERLOCK
AND SUPPORT TOOL
OFF THE MAINSHAFT

C8699-C

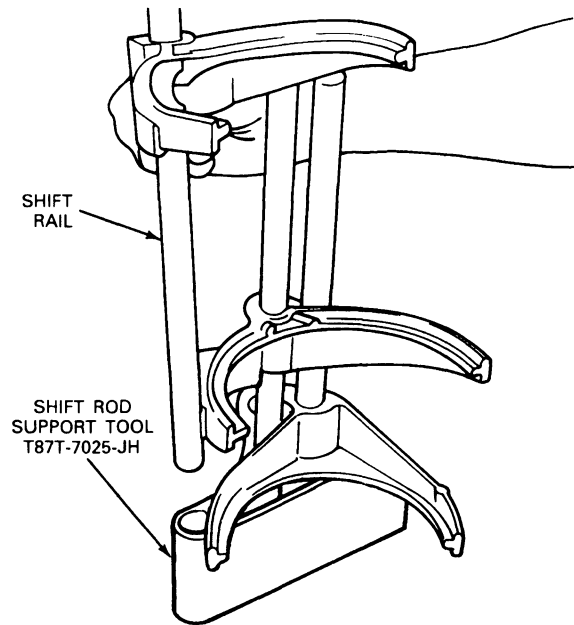
DISASSEMBLY AND ASSEMBLY (Continued)

27. Using the shift rod support tool as a base, set the shift rail assembly on a workbench with the shift rails in a vertical position. Remove the interlock.



C8700-1A

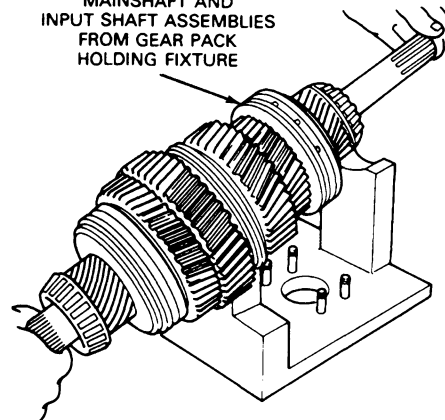
28. Mark each shift fork, shift rail, and position in the holding fixture to make reassembly easier. Lift the shift rails from the support tool. Refer to Shift Rails in this section for shift rail disassembly procedures.



C8701-C

29. Lift the countershaft off the bench stand. Separate the input shaft from the mainshaft. Lift the mainshaft from the stand. Refer to Mainshaft, Countershaft and Input Shaft in this section for mainshaft, countershaft and input shaft disassembly and assembly procedures.
30. Remove the rear cover from the holding fixture. Refer to Transmission Rear Case in this section for rear case disassembly and assembly procedures.

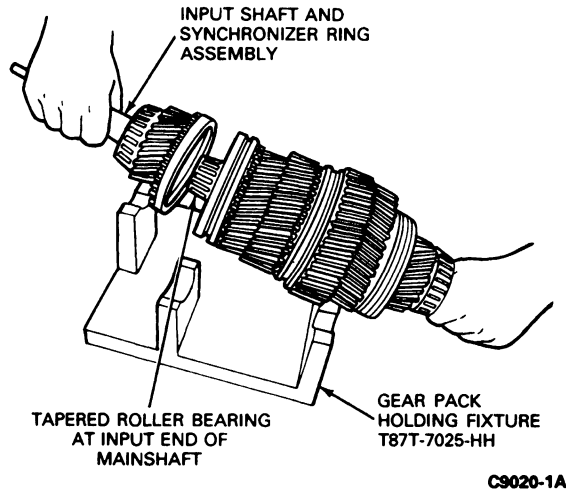
LIFT COUNTERSHAFT,
MAINSHAFT AND
INPUT SHAFT ASSEMBLIES
FROM GEAR PACK
HOLDING FIXTURE



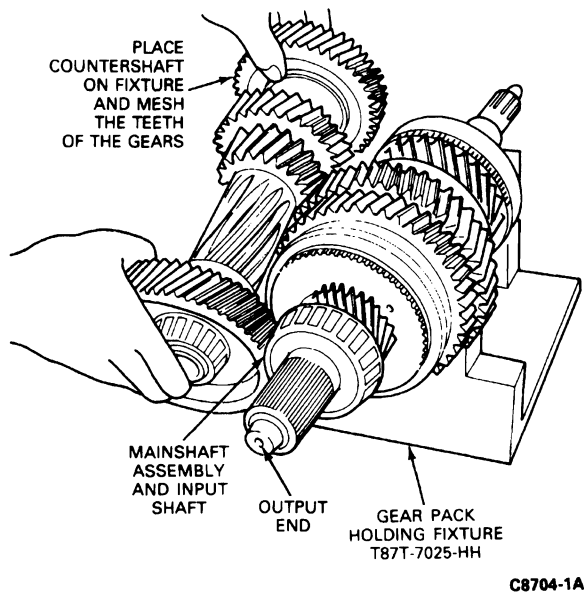
C8702-1A

DISASSEMBLY AND ASSEMBLY (Continued)**Assembly**

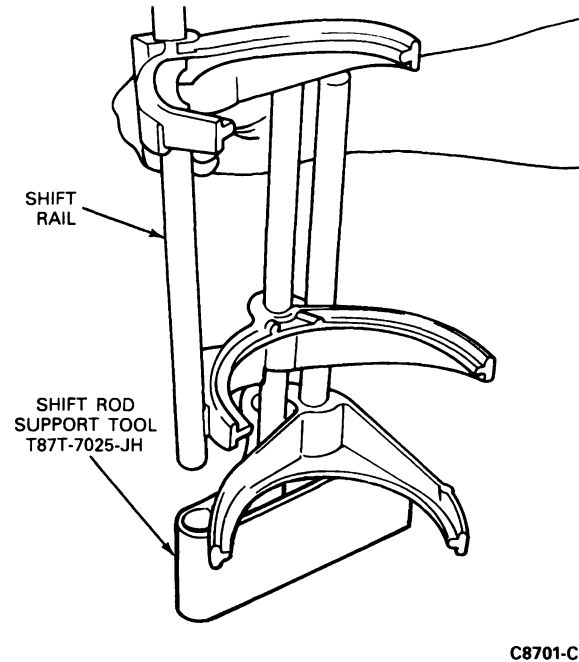
1. Place the input shaft and synchronizer ring assembly over the tapered roller bearing on the input end of the mainshaft.



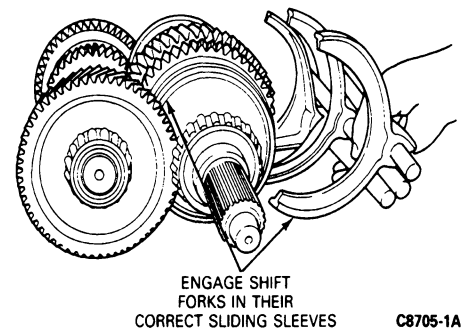
2. Place the mainshaft and input shaft on the Gear Pack Holding Fixture T87T-7025-HH. Place the countershaft on the fixture and mesh the gears of the two shafts.



3. Place the three shift rails and fork assemblies into the Shift Rod Support Tool T87T-7025-JH in the position from which they were removed during disassembly.

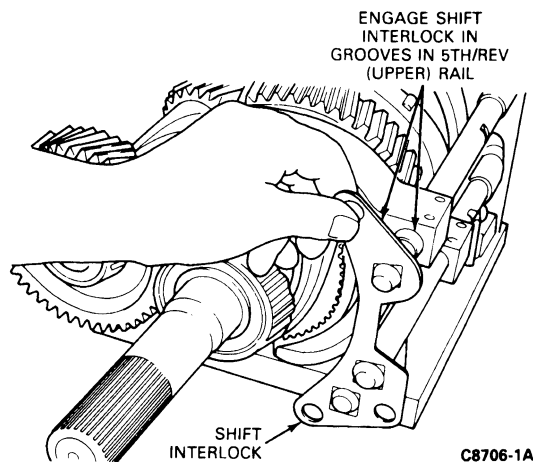


4. Position the three shift rail assemblies together with the shift rod support tool and interlock so that the shift forks engage in the correct mainshaft sliding sleeves.

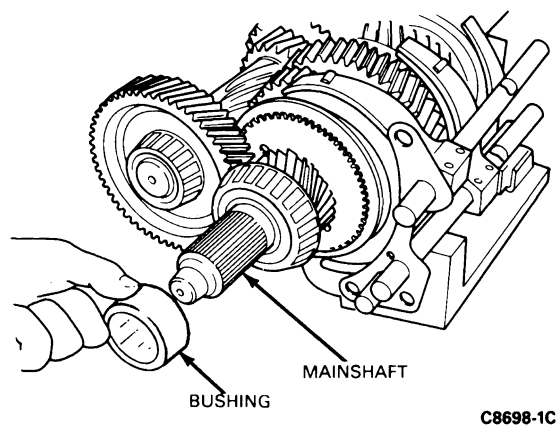


DISASSEMBLY AND ASSEMBLY (Continued)

5. Place the shift interlock on the three gearshift rails and engage it in the interlock grooves in the 5th-reverse (upper) rail.



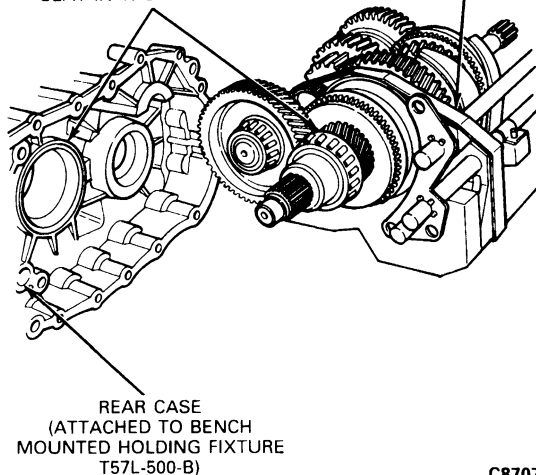
6. Install bushing onto mainshaft.



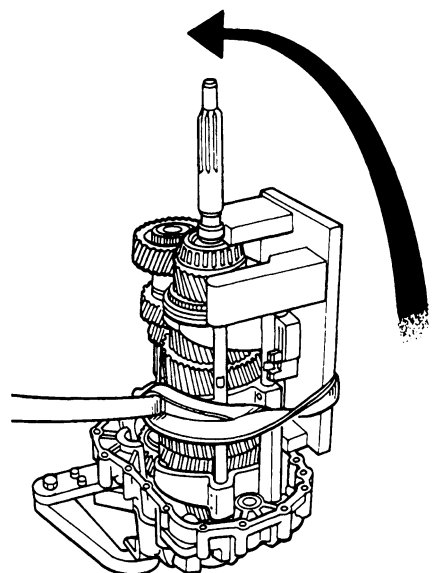
7. Secure the rear case into the bench mounted holding fixture T57L-500-B.
8. Position Nylon Lifting Sling D87L-1000-A or equivalent around the shift rails, the holding fixture and the mainshaft and countershaft. Position the gear pack into the rear case and push the shafts and rails forward until the bearings seat in their outer races in the housing and the gearshift rails slide into their retaining holes in the housing.

POSITION GEAR PACK IN REAR COVER AND PUSH SHAFTS AND RAILS FORWARD UNTIL BEARINGS SEAT IN THEIR RACES

NYLON LIFTING SLING D87L-1000-A OR EQUIVALENT

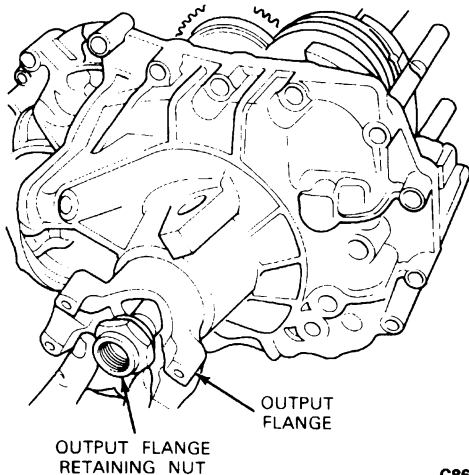


9. Rotate the gear pack and rear case upwards 90 degrees so it is in a vertical position with the input shaft pointing upwards.



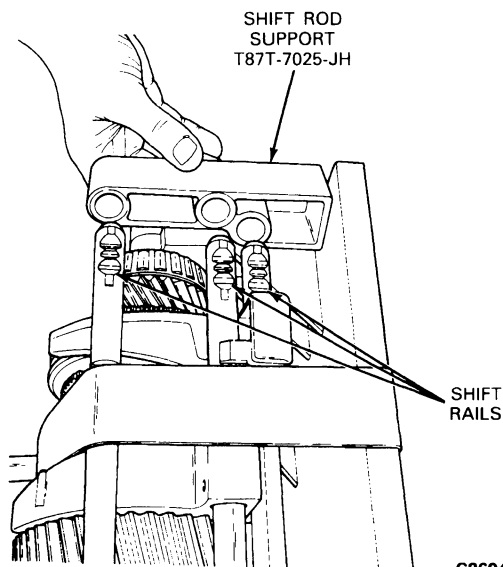
DISASSEMBLY AND ASSEMBLY (Continued)

10. If equipped, slide the output flange onto the output end of the mainshaft until it seats against its stop. Screw the hex nut onto the shaft until it is finger-tight.



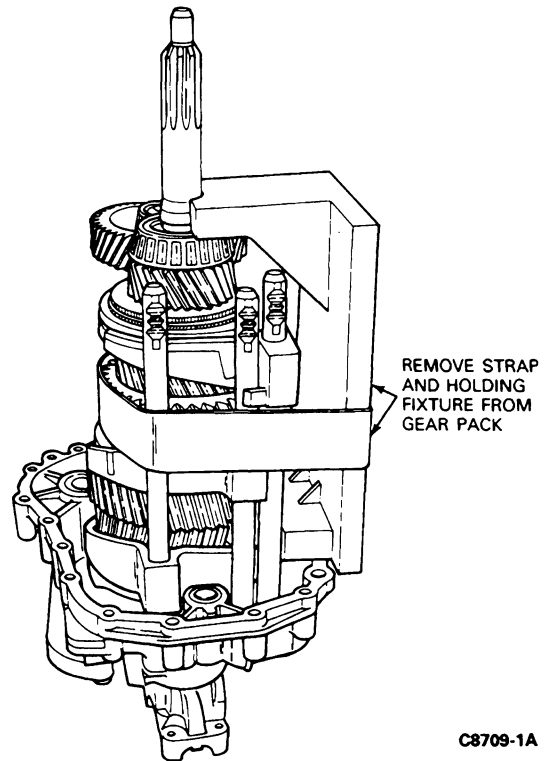
C8696-1A

11. Remove the shift rod support tool T87T-7025-JH from the ends of the shift rails.



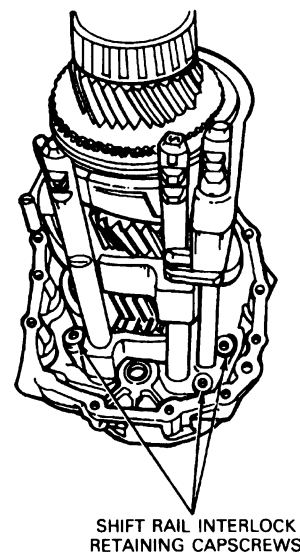
C8694-B

12. Remove the strap and remove the gear pack holding fixture from the mainshaft and countershaft.



C8709-1A

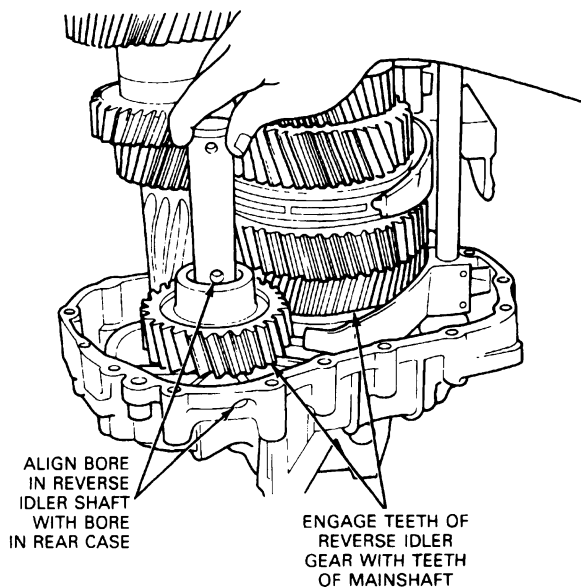
13. Attach the three cap screws that secure the shift interlock to the rear transmission housing. Tighten them to 10 N·m (7 ft-lbs). Be sure that the interlock moves freely after tightening the screws.



C8692-1A

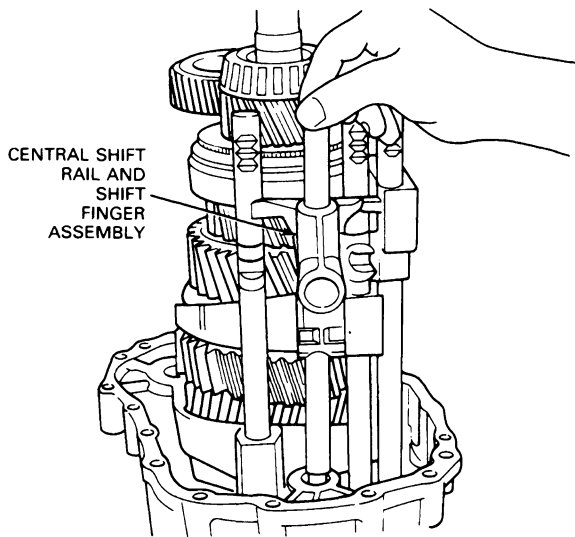
DISASSEMBLY AND ASSEMBLY (Continued)

14. Engage the teeth of the reverse idler gear with the reverse gear on the mainshaft. Slide the reverse idler shaft downward through the bearings and into the rear case. Align the lower of the two threaded holes in the shaft with the bore in the rear case. Place a sealing ring on the capscrew and attach the screw through the bore in the housing into the shaft. Tighten the screw finger-tight.



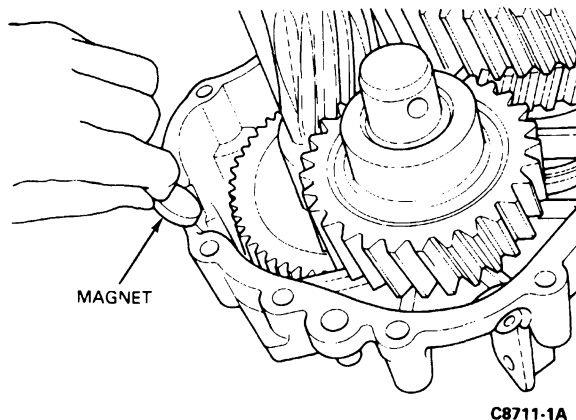
C8710-1A

15. Insert the central shift rail and finger assembly into its bore in the rear case.



C8689-1A

16. If the magnet was removed during disassembly, insert it in the recess in the housing.



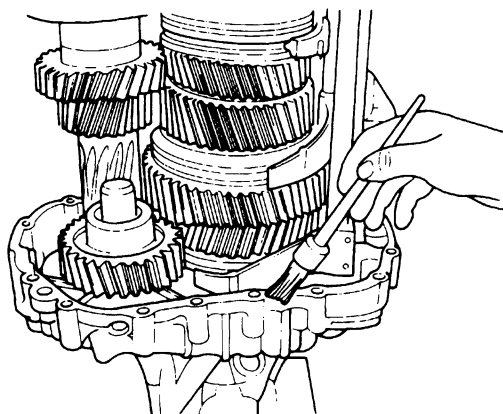
C8711-1A

CAUTION: The tapered roller bearings preload should be adjusted if either the front or rear cases, countershaft, mainshaft, input shaft, or a bearing has been replaced. If the tapered roller bearings on the mainshaft, input shaft, or countershaft have to be adjusted, do not apply the sealant at this time.

17. If the tapered roller bearings on the mainshaft, input shaft or countershaft do not have to be adjusted, thinly coat the sealing surface of the rear case with Gasket Maker E2AZ-19562-B (ESE-M4G234-A2) or equivalent.

NOTE: Do not wait longer than ten minutes to tighten all 17 bolts, due to the rapid curing time of the sealant.

CAUTION: Do not use silicon Sealing Compound or equivalent.

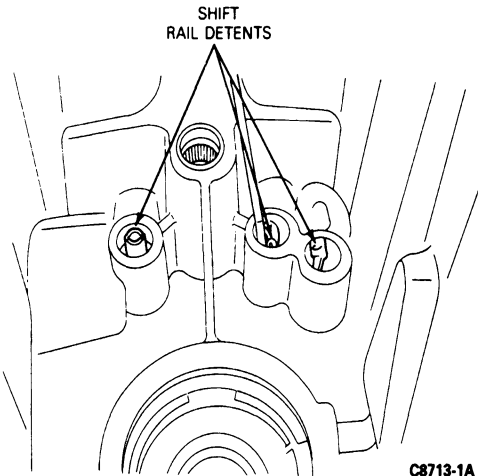


C8712-1A

DISASSEMBLY AND ASSEMBLY (Continued)

18. If removed, push the three shift rail detents back into their holes in the front case.

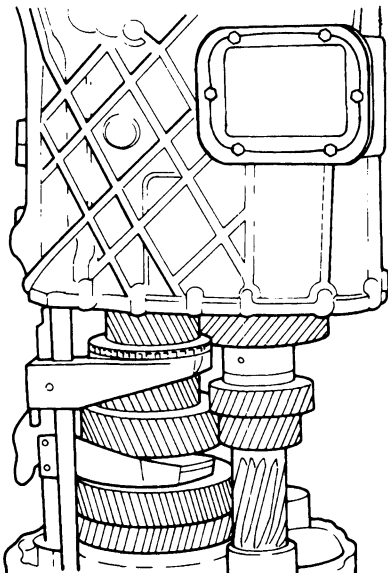
CAUTION: Make sure that the shift rail detents do not obstruct entry of the shift rails.



C8713-1A

CAUTION: Be careful that the input shaft does not damage the front seal. Also be careful that the shim pack oil baffle is not bent when the case is positioned over the input shaft.

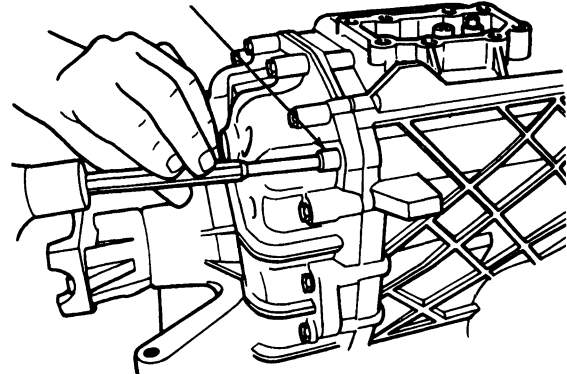
19. Carefully place the front case over the shafts and gearshift rails until it rests on its mating surface on the rear case. It may be necessary to push the central shift rail inward to clear the inner surfaces of the front case.



C9019-1A

20. Drive in the two dowels that align the rear case and the front case. Next, insert two hex screws and tighten them finger-tight.

DOWEL PINS
LOCATED IN TWO
OPPOSITE CORNERS OF
REAR CASE TO
FRONT CASE
MOUNTING SURFACE

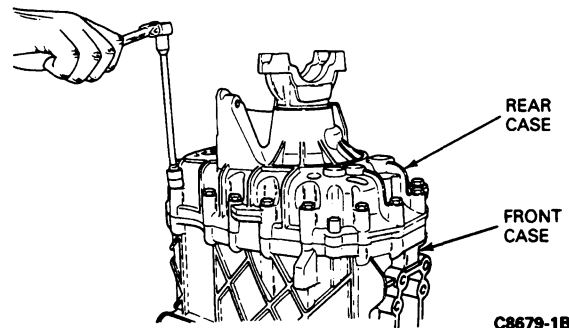


C9022-C

21. Screw two additional hex screws into the rear case bores near the shafts finger-tight.

NOTE: If it is not necessary to adjust the mainshaft/input shaft preload, install all of the hex screws that attach the two cases and tighten to 22 N·m (16 ft-lb).

CAUTION: Adjustment of tapered roller bearing preload is necessary if either the front or rear cases, countershaft, mainshaft or input shaft has been replaced, or if a tapered roller bearing on either shaft has been replaced. Refer to adjustments in this section for tapered roller bearing preload adjustment procedure before continuing assembly procedures.



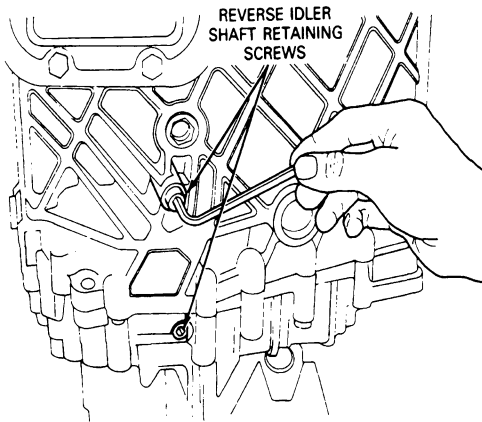
C8679-1B

22. Fit sealing ring to the remaining reverse idler shaft retaining capscrews. Install the screw into the bore in the front case and tighten both capscrews to 22 N·m (16 ft-lbs). With a screwdriver, push caps into the capscrews until they are flush with the surface of the screw head.

NOTE: The rear case capscrew was installed finger-tight in step fourteen.

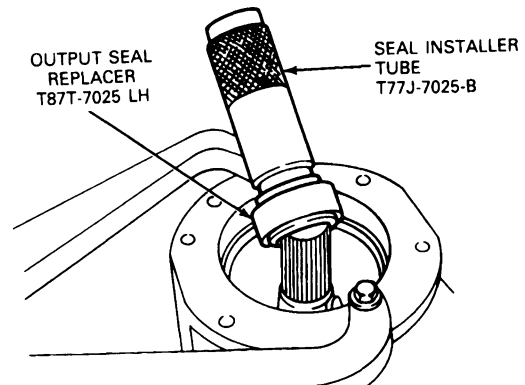
DISASSEMBLY AND ASSEMBLY (Continued)

CAUTION: Use hand pressure for screwdriver only, do not hammer the caps into position.

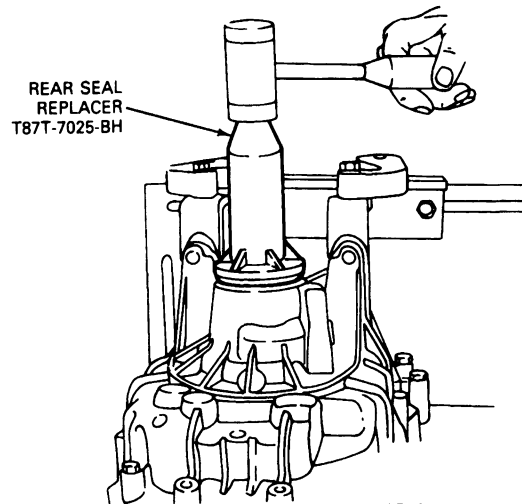


C8684-1A

23. Rotate the transmission so the input shaft is pointing down.
24. On 4x2 transmissions (except F-Super Duty), remove the hex nut that secures the output flange to the mainshaft, then remove the flange from the shaft. Position the output shaft seal on Output Seal Replacer T87T-7025-BH and position the seal and tool in the opening in the rear case. Apply a little liquid soap around the circumference to minimize friction. Using a soft hammer, gently tap the output seal replacer until it seats in the opening.
25. On 4x4 and F-Super Duty transmissions, use Output Seal Replacer T87T-7025-LH and Seal Installer Tube T77J-7025-B to install the output shaft oil seal. Gently tap on tube with a soft hammer until tool seats against its stop.



**4 x 4 AND F-SUPER DUTY TRANSMISSION
REAR OIL SEAL INSTALLATION**



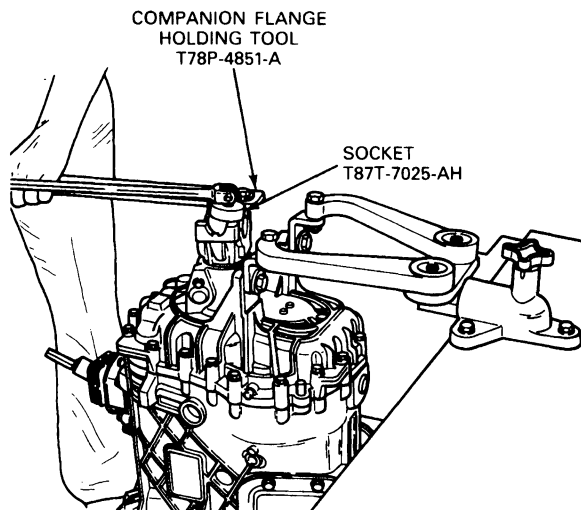
**4 x 2 TRANSMISSION REAR OIL SEAL
INSTALLATION
(EXCEPT F-SUPER DUTY)**

C8715-B

DISASSEMBLY AND ASSEMBLY (Continued)

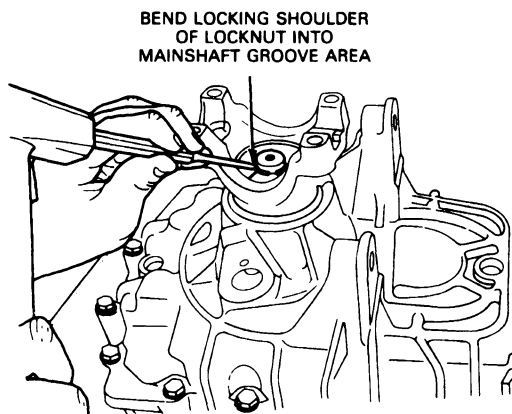
26. On 4x2 transmissions (except F-Super Duty), reinstall the output flange on the output shaft. Install Companion Flange Holder T78P-4851-A. Install a new hex nut onto the mainshaft using locknut socket Tool T87T-7025-AH. Tighten the nut to 250 N-m (184 ft-lbs).

CAUTION: Do not reuse the output flange retaining nut after any servicing of the transmission. Always replace it with a new one.



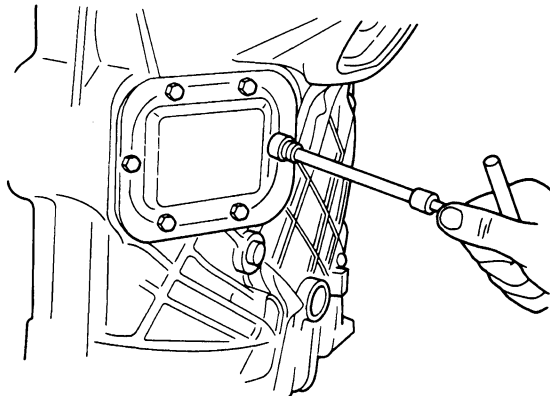
C8678-B

27. Position a 4.76mm (3/16-inch) punch on the locking shoulder of the retaining nut and bend the shoulder into the groove of the output shaft.



C9023-B

28. If required, install new gaskets and PTO covers over the openings in the front case using the original attaching screws which have self-sealing threads and tighten to 38 N-m (28 ft-lbs).



C8716-1A

29. Position the 5th-reverse gear interlock plate into its installed position as shown in the illustration following Step 31. Place the gasket over the shift tower mating surface in the front case.

NOTE: Make sure that the stop plate moves freely and that the gasket does not interfere with it. The interlock plate must be in a position which is lower than the gasket so that the plate may move freely.

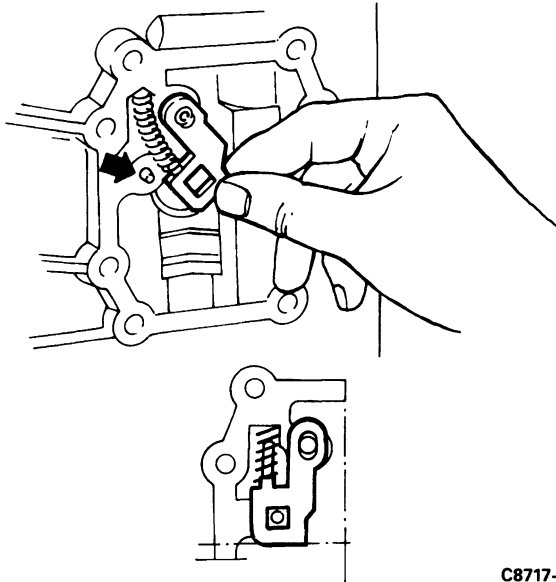
NOTE: Make sure that the interlock plate and spring do not drop into the front case.

30. Check the interlock plate compression spring against Spring Specifications at the end of this section to be sure that its unloaded length is satisfactory.

DISASSEMBLY AND ASSEMBLY (Continued)

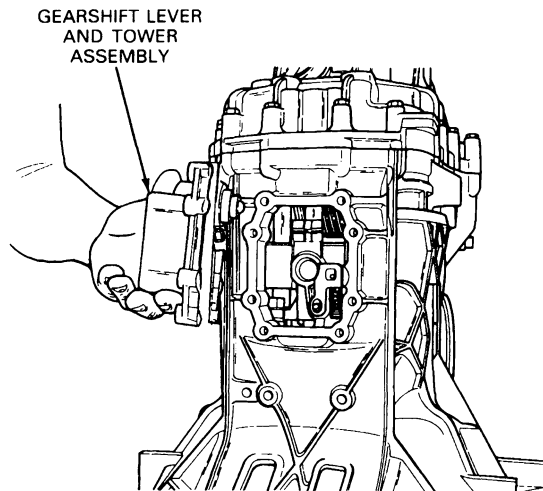
31. Place the spring above the nose in the interlock plate and move both parts into their installed positions.

CAUTION: The procedure must be followed exactly to make sure that the interlock function between fifth gear and reverse gear operates properly.



C8717-B

32. Install the shift tower assembly.

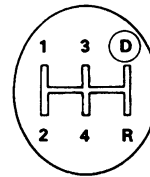


C8718-B

33. Check the functioning of the interlock.

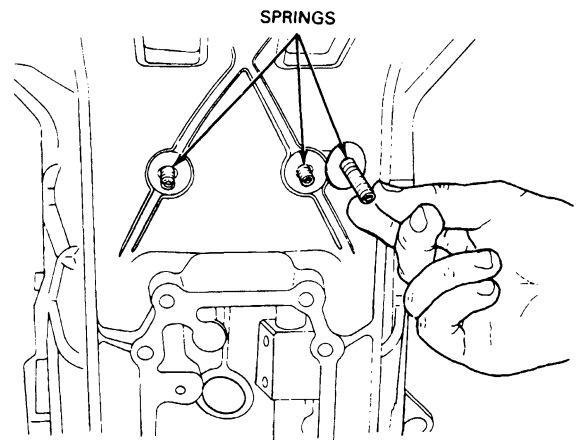
- Temporarily install the shift lever assembly. The nose on the gearshift finger must point toward the interlock plate. Install spring washers and tighten screws to 22 N·m (16 ft-lbs).
- The shift lever cannot be shifted between fifth and reverse if the interlock was properly installed.
- Once proper installation of the interlock is confirmed, remove shift lever assembly.

CAUTION: Do not force the lever to shift into reverse. Damage to the interlock components could occur.



C8719-1A

34. A compression spring is installed into each of the three detent bolts. The positions are shown in the illustration. Before installing the springs, check that their unloaded length is 44.1 mm (1.736 inch).

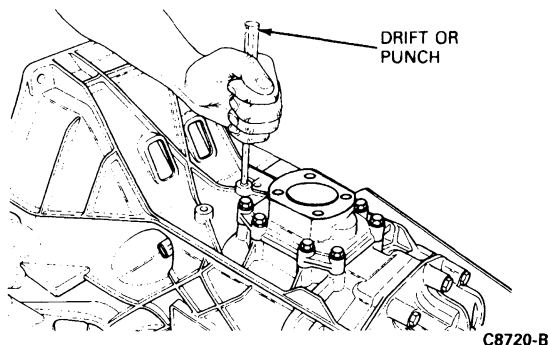


C8683-1A

DISASSEMBLY AND ASSEMBLY (Continued)

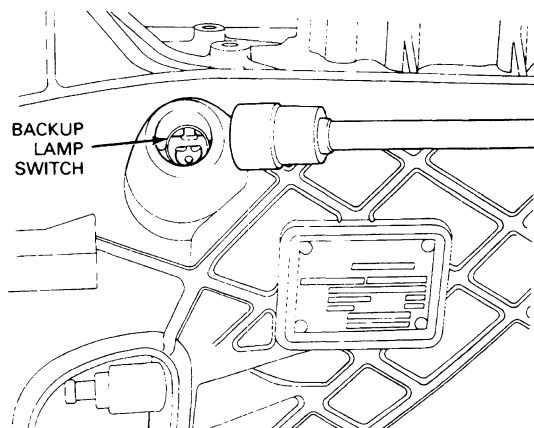
35. Install a new sealing cap in each bore in the front case where the detents, bolts and springs were installed. Use a suitable drift or punch to drive each cap in until it seats 1mm (3/64 inch) below the surface of the housing.

NOTE: Deeper installation of the sealing caps will cause high shift efforts.



C8720-B

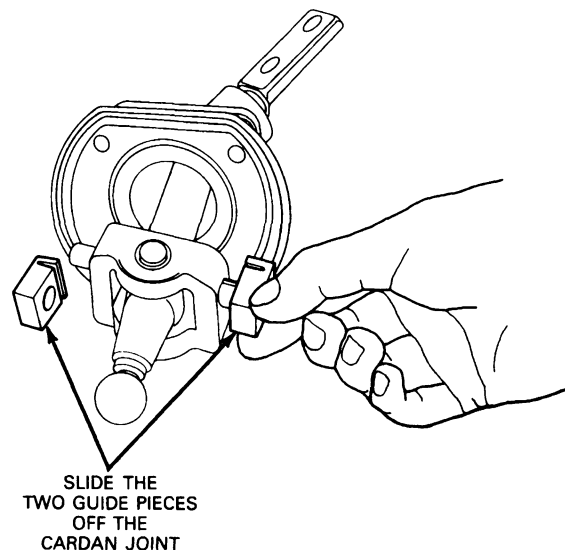
36. If removed, install the back-up lamp switch with a new sealing ring into its mounting boss on the side of the front case near the transmission nameplate. Tighten the switch to 20 N·m (15 ft-lbs).



C8685-1A

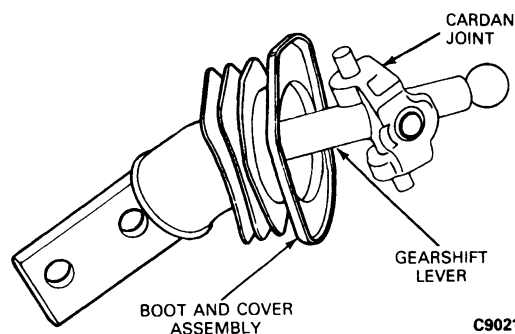
Shift Lever Assembly**Disassembly**

1. Slide the two guide pieces off the cardan joint.



C8728-B

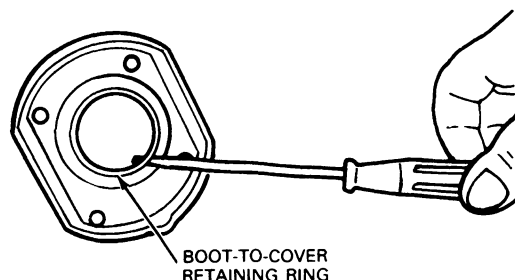
2. Slide the boot and cover as an assembly off past the top of the gearshift lever.



C9021-B

3. Invert the cover with attached boot and remove the snap ring that secures the two parts.

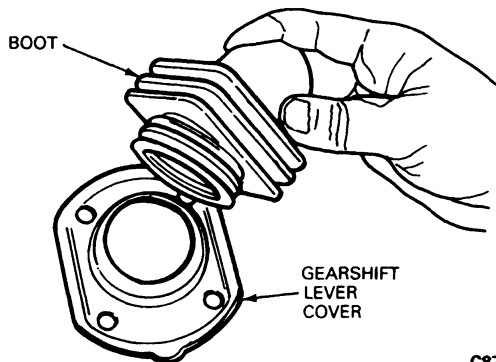
NOTE: A cross-shaft passes through the cardan joint and is pressed into the gearshift lever. Do not disassemble these components.



C8730-1A

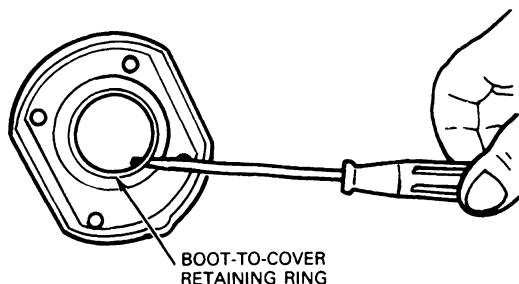
DISASSEMBLY AND ASSEMBLY (Continued)**Assembly**

1. Insert the boot in its upright position in the gearshift lever cover.



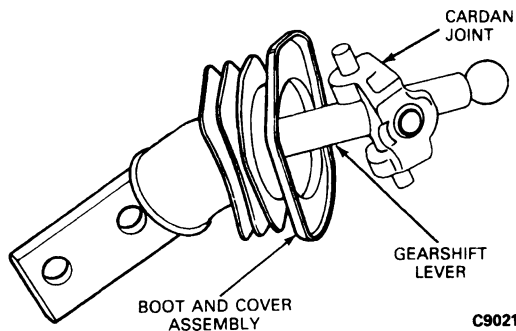
C8731-1A

2. Using a screwdriver, install the snap ring inside the boot so that the boot and ring will be secured in the groove in the cover.



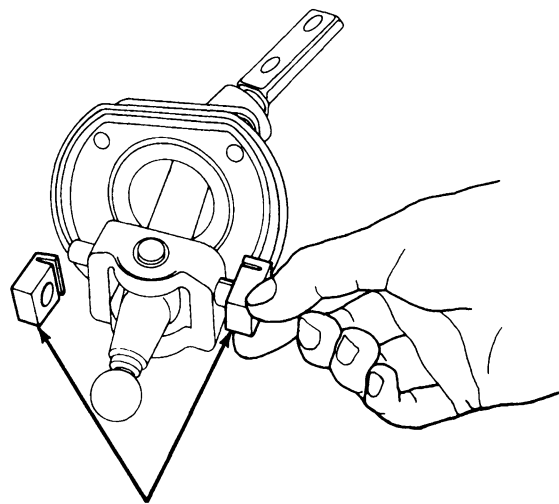
C8730-1A

3. Slide the boot and cover as an assembly on past the gearshift lever.



C9021-B

4. Place the two guide pieces on the lugs on the cardan joint. The slotted ends of the guide pieces should be located near the cover pointing inwards toward the shift lever.

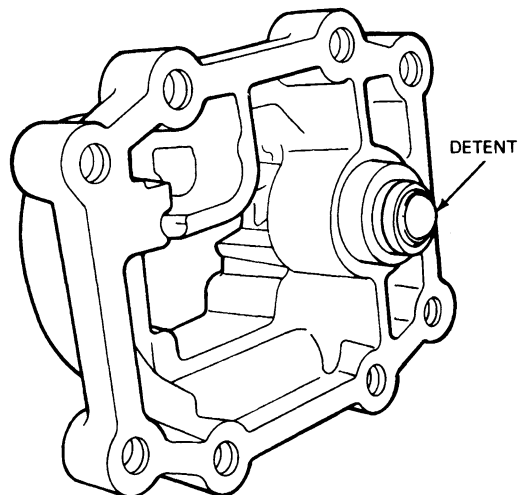


C8732-B

Gearshift Housing Assembly**Disassembly**

NOTE: Disassembly of parts inside the gearshift housing should be confined to replacement of the detent when necessary.

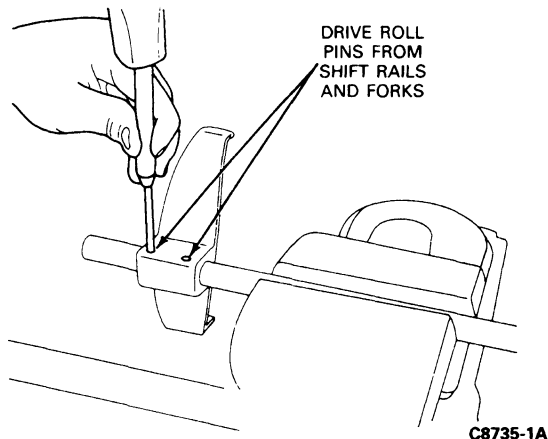
1. If required, install a new detent in the gearshift housing. Using Rotunda Heat Gun 107-00300,
2. Heat the detent mounting area in the housing to approximately 248° F (120°C). Press the detent into its mounting hole until it rests against its stop in the base of the hole.



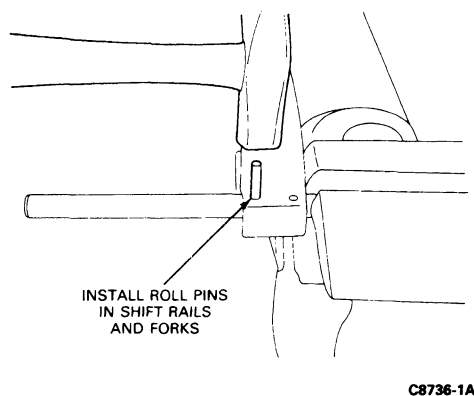
C8733-B

DISASSEMBLY AND ASSEMBLY (Continued)**Shift Rails****Disassembly**

1. Install each rail in a vise with soft jaws or equivalent and, using a suitable drift punch or equivalent, drive two roll pins out of the 1st-2nd and 5th-Reverse shift fork and the gearshift finger on the central shift rail and one roll pin out of the 3rd-4th shift fork. Slide each of the forks off its rail and the finger off the central shift rail.

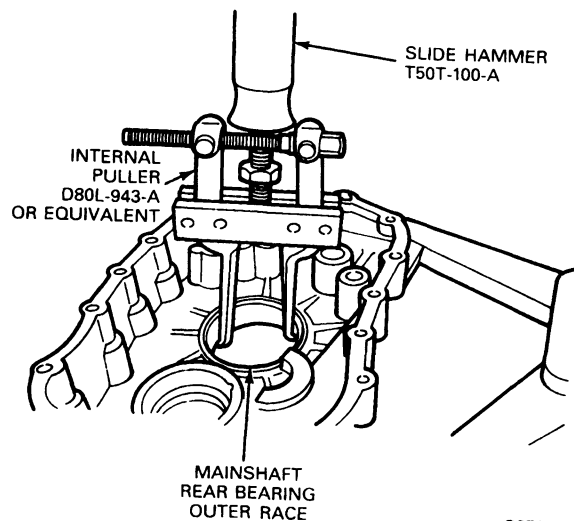
**Assembly**

1. Position each shift rail in a vise equipped with soft jaws or equivalent to prevent damage.
2. Slide the fork onto the rail from which it was removed.
3. Drive the roll pins through the fork or finger and through the rail.

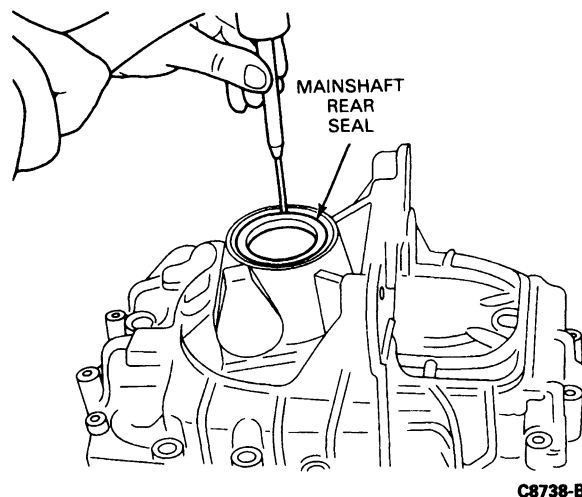
**Transmission Rear Case****Disassembly**

1. If required, drive the two dowel pins out of the rear case.

2. Using Slide Hammer T50T-100-A and Internal Puller D80L-943-A or equivalent, remove the mainshaft rear bearing outer race from the rear case.

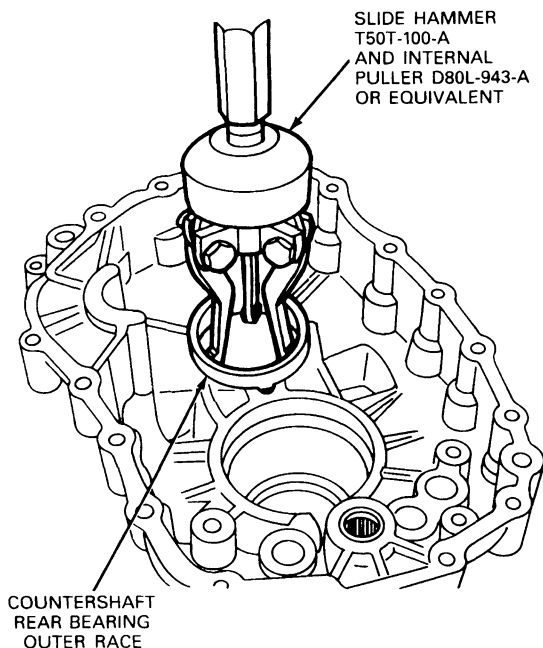


3. Using a suitable drift, drive the mainshaft rear seal out of the rear case. Discard the seal.



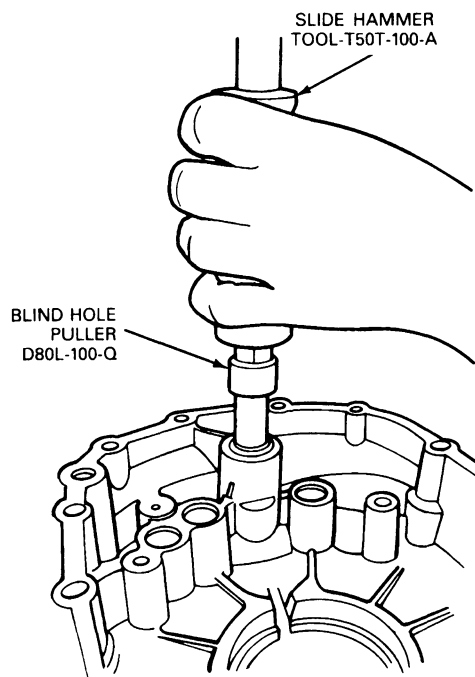
DISASSEMBLY AND ASSEMBLY (Continued)

4. Using Slide Hammer T50T-100-A and Bearing Cup Puller T77F-1102-A, remove the countershaft rear bearing outer race from the rear case.



C8739-B

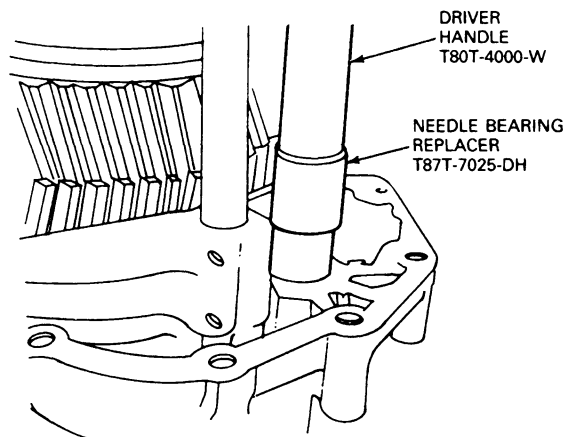
5. If required, remove the central shift rail bearing from the rear case. Use Blind Hole Puller D80L-100-Q or equivalent and Slide Hammer T50T-100-A to remove the bearing.



C8740-B

Assembly

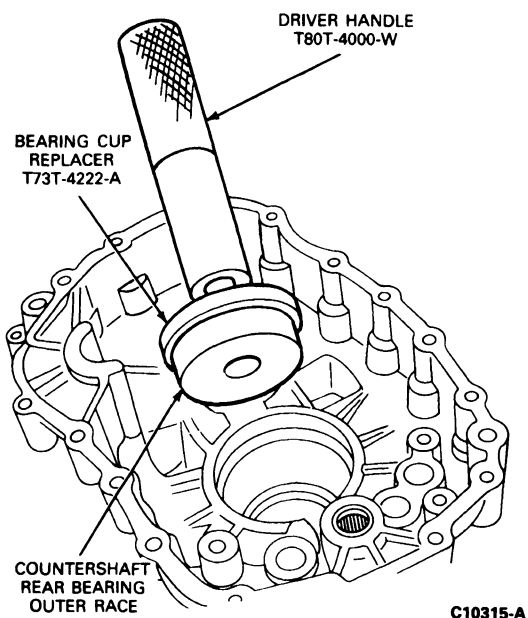
1. If removed, install the central shift rail bearing into the rear case. Heat the rear case in the area of the bearing bore to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Insert the ball sleeve and drive the bearing in until it seats against its stop using Needle Bearing Replacer T87T-7025-DH and Driver Handle T80T-4000-W.



C8741-1A

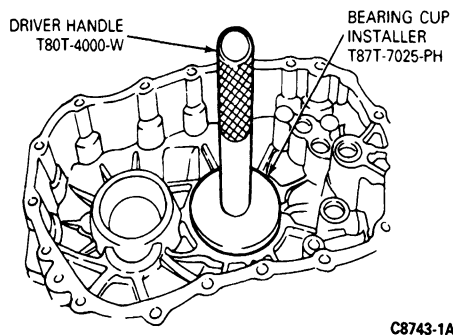
DISASSEMBLY AND ASSEMBLY (Continued)

- Heat the rear case in the area of the countershaft rear bearing outer race to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. With Driver Handle T80T-4000-W and Bearing Cup Replacer T73T-4222-A, drive the countershaft bearing cup into its bore until it seats against its stop.



- Heat the rear case in the area of the mainshaft outer race to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Using Driver Handle T80T-4000-W and Bearing Cup Installer T87T-7025-PH, drive the mainshaft bearing cup into its bore until it seats against its stop.

NOTE: Do not install the mainshaft rear seal at this time. The mainshaft rear seal is installed just prior to installing the output flange.



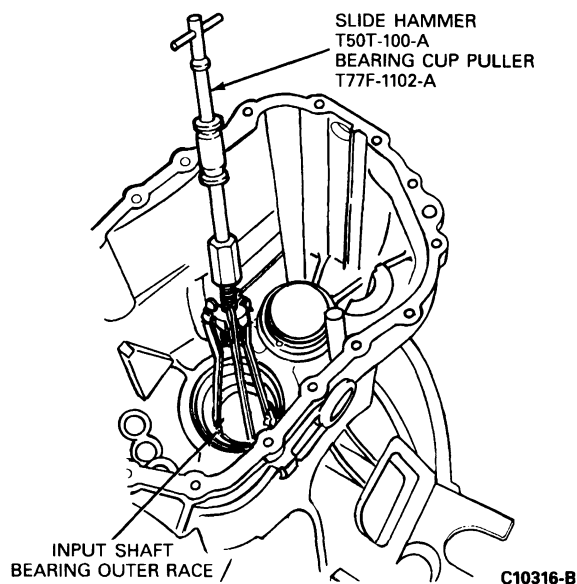
Transmission Front Case

Disassembly

NOTE: Case disassembly is required to enable reuse of smaller parts.

- Using Slide Hammer T50T-100-A and Bearing Cup Puller T77F-1102-A, remove the input shaft bearing outer race from the front case.
- Remove the baffle and shims.

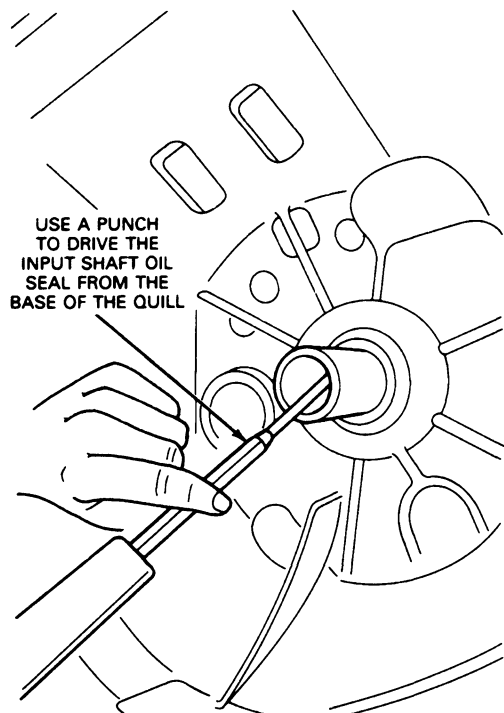
NOTE: The oil baffle will be destroyed when the race is removed. Discard the oil baffle and install a new one during assembly.



DISASSEMBLY AND ASSEMBLY (Continued)

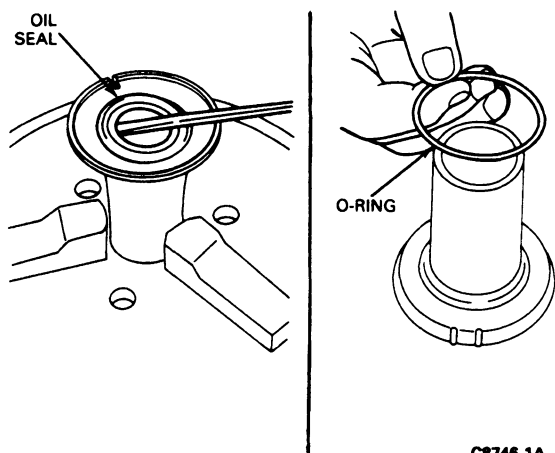
3. Using a punch, remove the input shaft oil seal from the base of the quill (7.3L and 7.5L housings only).

NOTE: If the quill is being removed, the input shaft seal may be removed later when the quill is out of the housing.



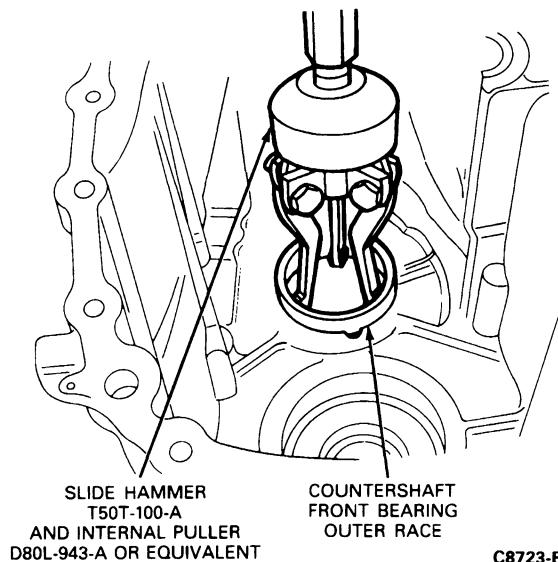
C8745-1A

4. If required, carefully drive the quill from the front case using a soft mallet.
5. Remove the O-ring from the quill. If the quill is removed, it must be replaced with a new quill.



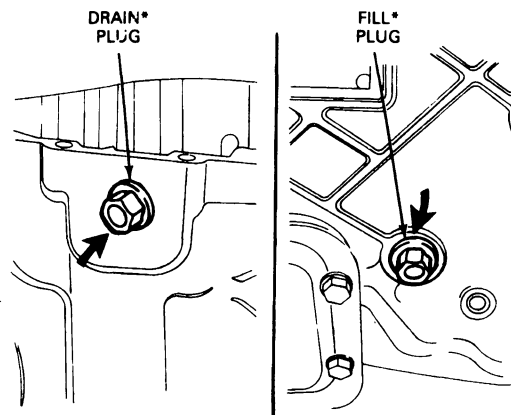
C8746-1A

6. Remove the countershaft front bearing outer race with Slide Hammer T50T-100-A and Internal Puller D80L-943-A.

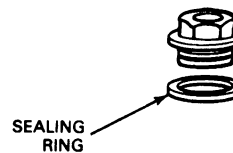


C8723-B

7. If required, remove the fluid drain and fill plugs, and sealing rings from the front case.



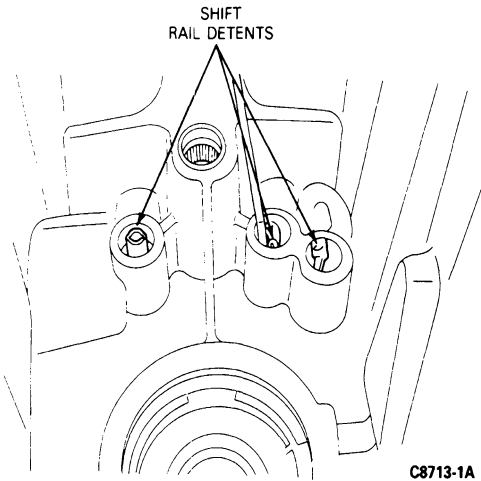
*DRAIN AND FILL PLUG (WITH STRAIGHT THREADS) AND SEALING RING.



C8747-C

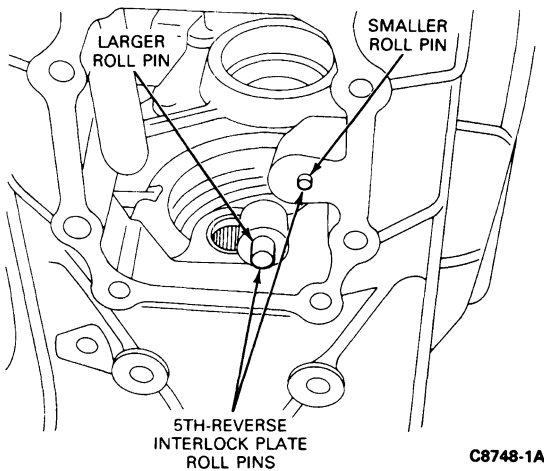
DISASSEMBLY AND ASSEMBLY (Continued)

8. If case replacement is required, remove the three shift rail detents from the front case.



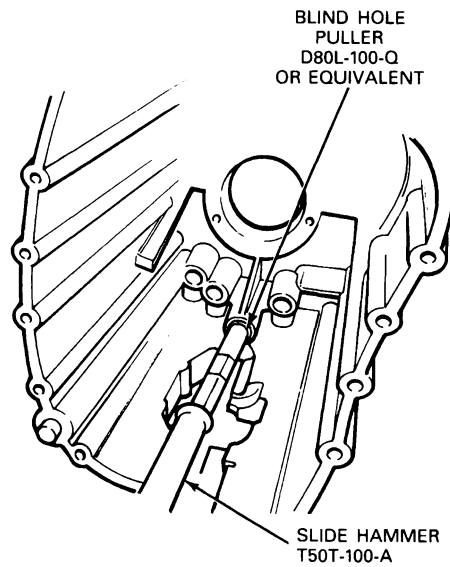
C8713-1A

9. If required, remove the roll pins that hold the 5th-reverse interlock plate from their bores in the front case just below the gearshift housing.



C8748-1A

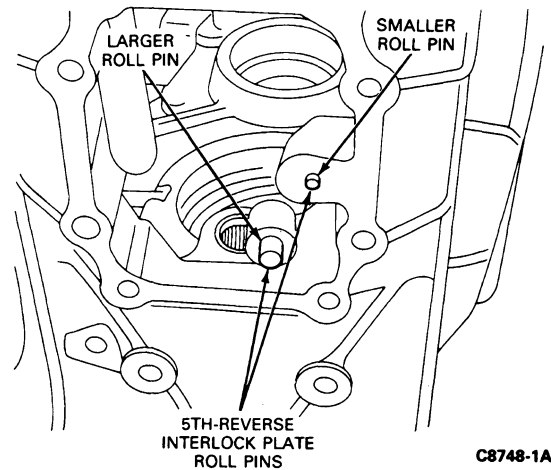
10. If required, remove the central shift rail needle bearing from the front case using Slide Hammer T50T-100-A and Blind Hole Puller D80L-100-Q or equivalent.



C8749-B

Assembly

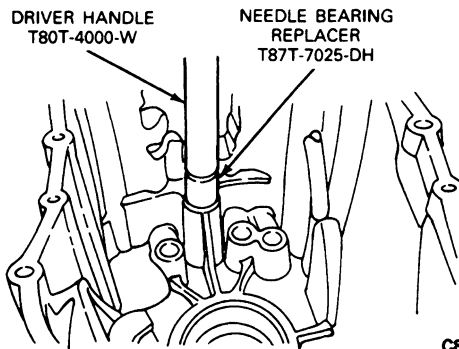
1. If they were removed, tap the 5th-reverse interlock plate roll pins into their bores in the front case until the bigger one bottoms out (sticks out approximately 8mm (.315 inch); the small one sticks out 4-5mm (.158-.197 inch). Do not allow it to bottom out.



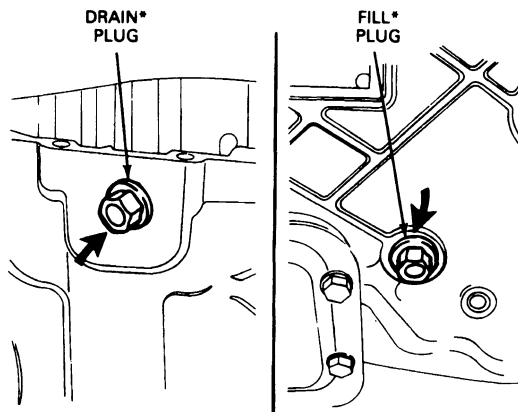
C8748-1A

DISASSEMBLY AND ASSEMBLY (Continued)

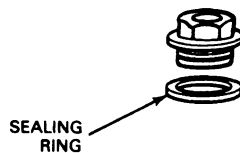
2. Heat the front case in the area of the central shift rail bearing bore to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Drive the bearing sleeve in with Needle Bearing Replacer T87T-7025-DH and Driver Handle T80T-4000-W until it is flush with the surface of the bore.



3. If removed, install the drain and fill plugs into the front case. Tighten to 50 N·m (37 ft-lbs). Both fill and drain plugs are of the straight thread type which require sealing rings to prevent leakage. (These torque values apply to a cold housing.)

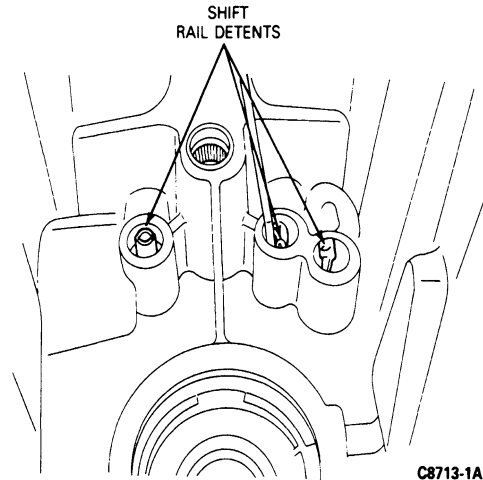


*DRAIN AND FILL PLUG
(WITH STRAIGHT THREADS)
AND SEALING RING.

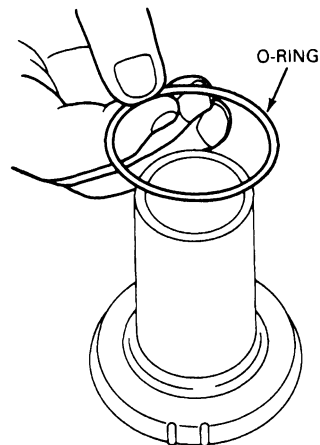


C8747-C

4. Insert the three shift rail detent bolts into their respective bores in the front case. They must seat in the detents in their respective shift rails and must move freely when in their installed positions.



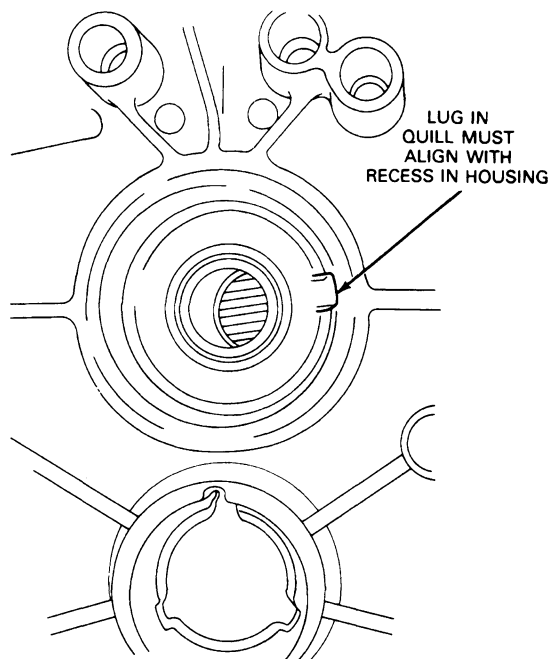
5. Place a new O-ring on the input shaft quill (7.3L and 7.5L housings only).



C8751-1A

DISASSEMBLY AND ASSEMBLY (Continued)

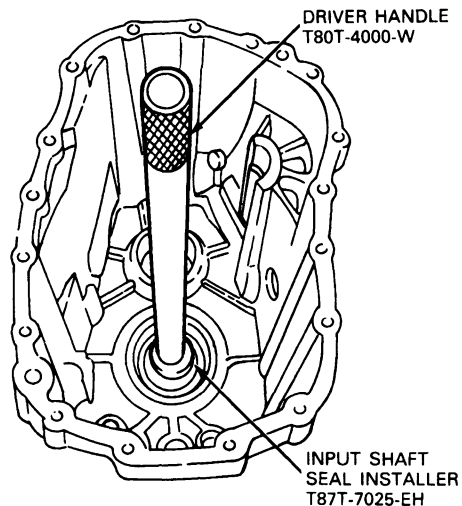
6. Position the quill in the housing in such a way that the lug in the quill is in alignment with the recess in the housing. Push the quill in until it bottoms against its bore in the housing (7.3L and 7.5L housings only).



C8752-1A

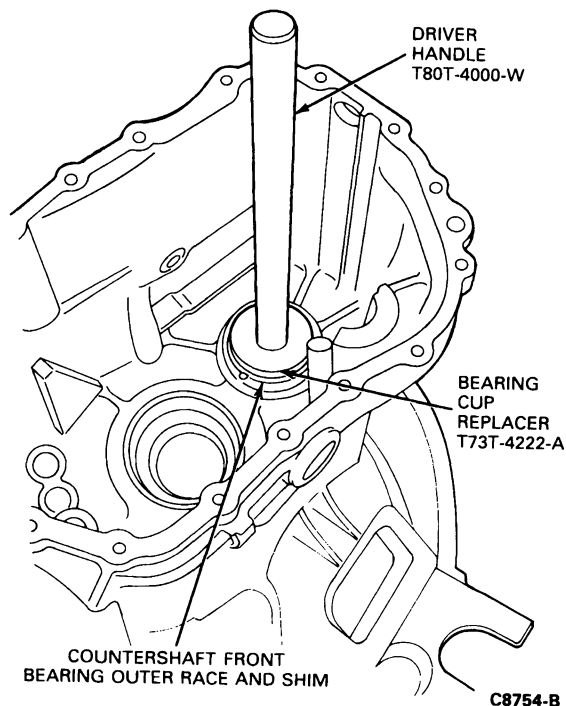
7. Position the seal in the front case. Using Driver Handle T80T-4000-W and Input Shaft Seal Installer T87T-7025-EH, drive in the seal until it seats against its stop.

CAUTION: If the countershaft, input shaft, mainshaft or one or more tapered roller bearing has been replaced, it is mandatory that the tapered roller bearings be adjusted to obtain a preload of 0.02 to 0.11mm (0.00079 to 0.00434 inch). Refer to adjustments in this section for procedure.



C8753-B

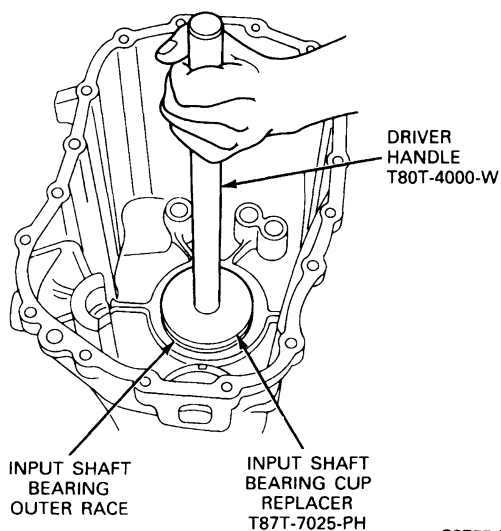
8. Heat up the mounting bore in the front case for the taper roller bearing outer race of the countershaft to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent.
9. Position the shim with proper thickness in the bore. Using Driver Handle T80T-4000-W and Bearing Cup Replacer T73T-4222-A, drive the countershaft bearing outer race in until it seats against the stop in the case.



C8754-B

DISASSEMBLY AND ASSEMBLY (Continued)

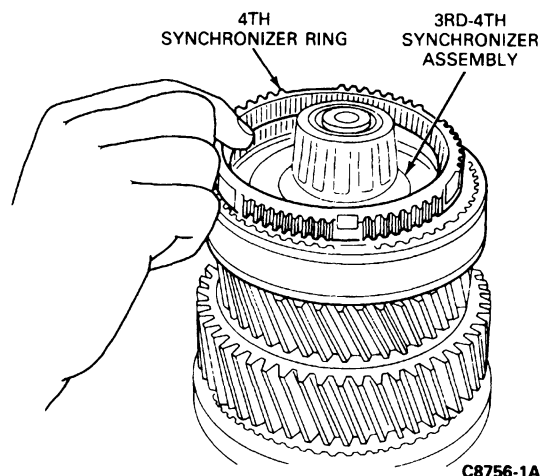
10. Heat the front case in the area of the input shaft tapered roller bearing outer race to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent.
11. Position the correct shim / sealing disc pack in the bore for the input shaft bearing outer race. Using driver handle T80T-4000-W and Mainshaft Bearing Cup Replacer T87T-7025-PH, drive the bearing cup in until it seats against its stop in the bore.



C8755-B

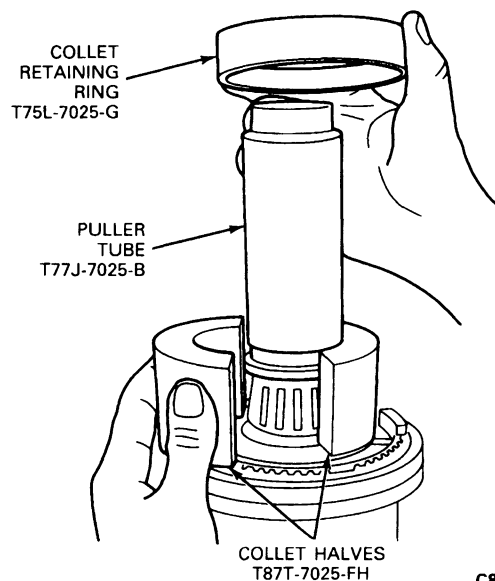
Mainshaft**Disassembly**

1. Clamp the output end of the mainshaft firmly in a vise.
NOTE: Use brass pads or equivalent in vice jaws to prevent damage.
2. Remove the 4th synchronizer ring from the 3rd-4th synchronizer assembly.



C8756-1A

3. Place the Bearing Collets T87T-7025-FH or equivalent on either side of the mainshaft front bearing. Position the Puller Tube T77J-7025-B in the collets. Pass the Collet Retaining Ring T75L-7025-G over the Puller and into the collets so they clamp firmly to the bearing. Pull the bearing from the mainshaft.

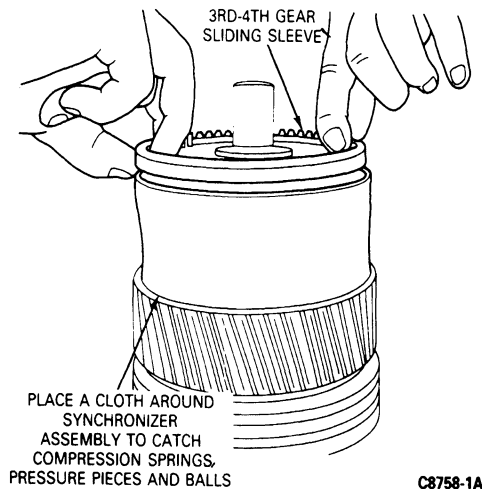


C8757-B

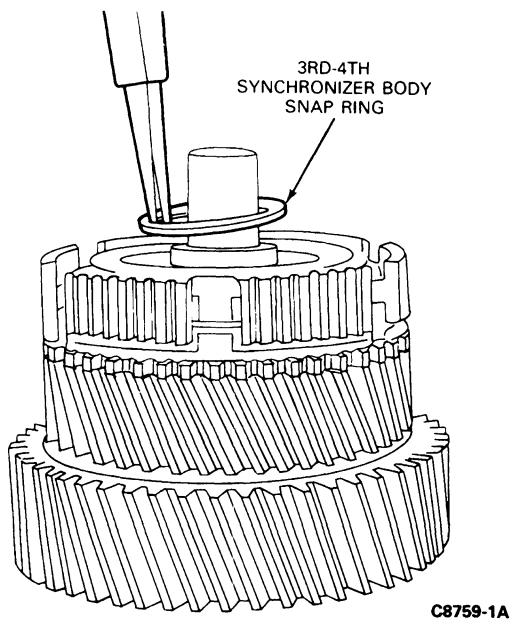
DISASSEMBLY AND ASSEMBLY (Continued)

4. Remove the 3rd-4th gear sliding sleeve from the mainshaft.

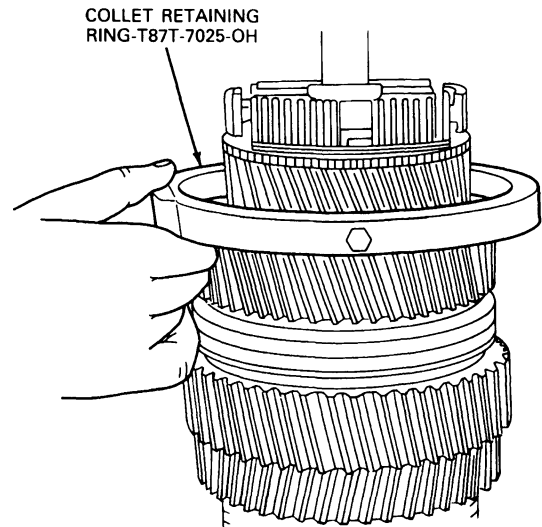
CAUTION: Place a cloth around the synchronizer assembly to catch the compression springs, pressure pieces and balls that will be released when the sliding sleeves are removed.



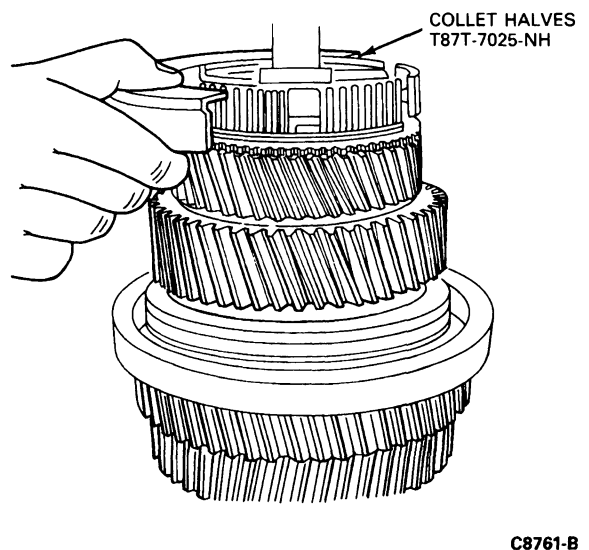
5. Remove the snap ring that retains the 3rd-4th synchronizer body to the mainshaft.



6. Place the Collet Retaining Ring T87T-7025-OH over the mainshaft and let it rest on the mainshaft 1st gear.

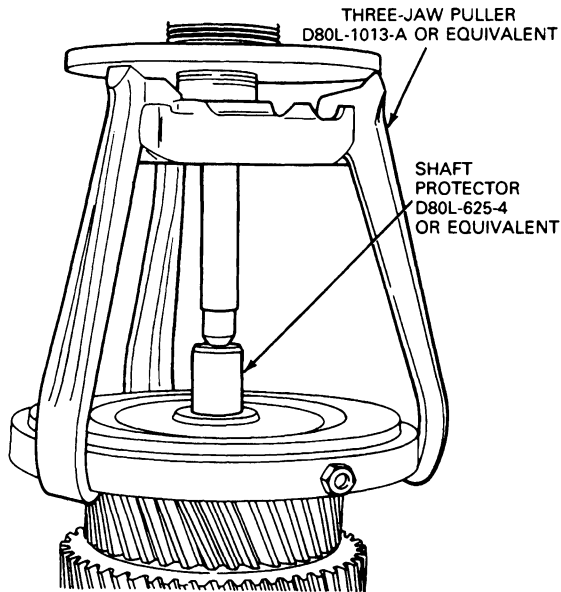


7. Position the two Collet Halves T87T-7025-NH on the 3rd-4th synchronizer body and slide the collet retaining ring over the collet halves to hold them in place on the synchronizer body.



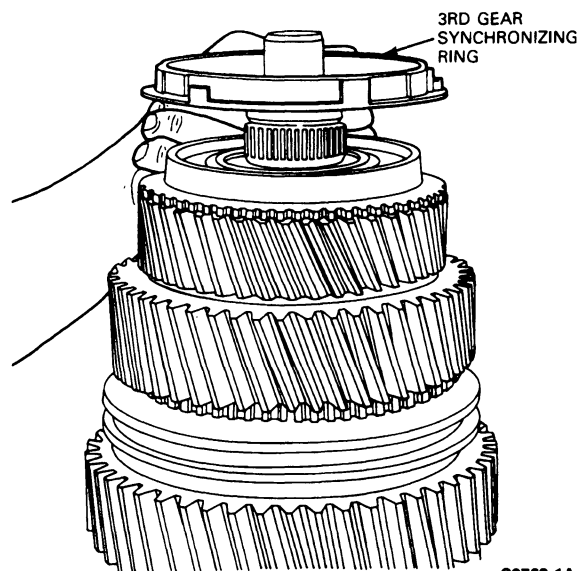
DISASSEMBLY AND ASSEMBLY (Continued)

8. Place the Shaft Protector D80L-625-4 or equivalent on the end of the mainshaft. Place the Three-Jaw Puller D80L-1013-A or equivalent on the assembled collet halves and retaining ring and pull the synchronizer body from the mainshaft.



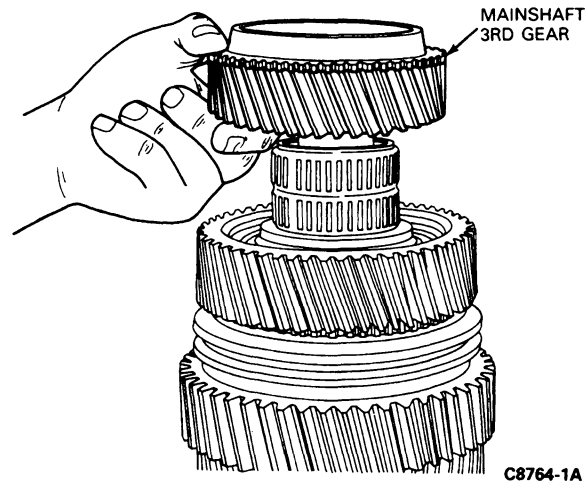
C8762-1A

9. Remove the synchronizer ring from the mainshaft 3rd gear.



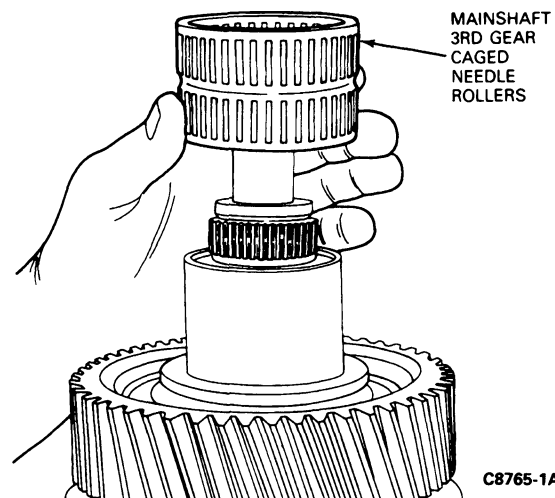
C8763-1A

10. Remove the 3rd gear from the mainshaft.



C8764-1A

11. Remove the 3rd gear caged needle rollers from the mainshaft.



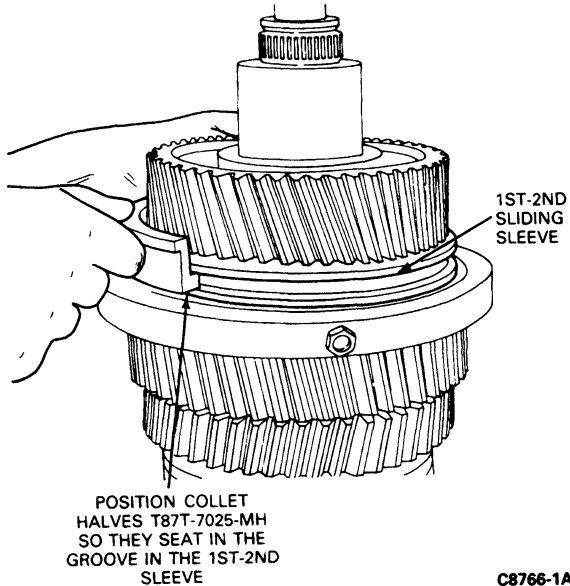
C8765-1A

12. Lift the 1st-2nd gear sliding sleeve up as far as it will slide.

13. Position the Collet Retaining Ring T87T-7025-OH over the mainshaft and let it rest on the 1st gear.

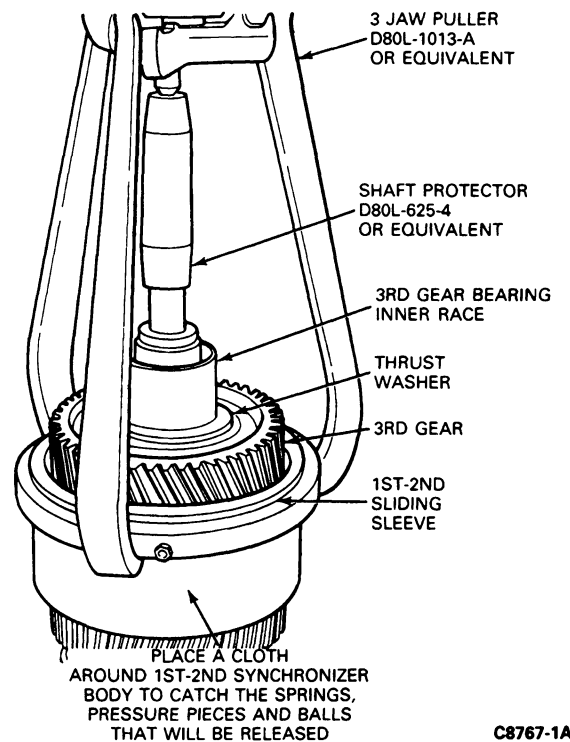
DISASSEMBLY AND ASSEMBLY (Continued)

14. Position the two Collet Halves T87T-7025-MH so they seat in the groove in the 1st-2nd sliding sleeve. Pass the retaining ring from below over the two halves and secure them to the sliding sleeve.

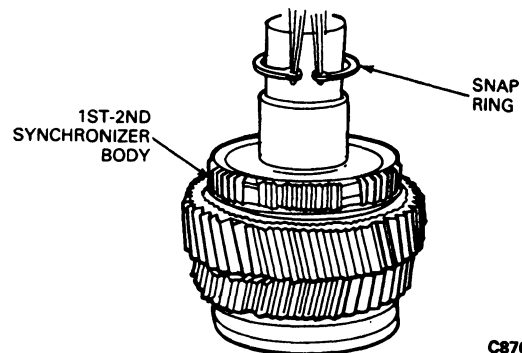


15. Position Shaft Protector D80L-625-4 or equivalent on the end of the mainshaft. Position the Three-Jaw Puller D80L-1013-A or equivalent on the collet retaining ring and pull the 1st-2nd sliding sleeve, 2nd gear, thrust washer, and 3rd gear bearing inner race from the mainshaft.

CAUTION: Position a cloth around the 1st-2nd synchronizer body to catch the springs, pressure pieces and balls that will be released when the sliding sleeve clears the 1st-2nd synchronizer body.



16. Remove the snap ring retaining the 1st-2nd synchronizer body to the mainshaft.



17. Reposition the mainshaft in the vise so that the output end of the shaft is now facing up.

NOTE: Use brass pads or equivalent to prevent damage.

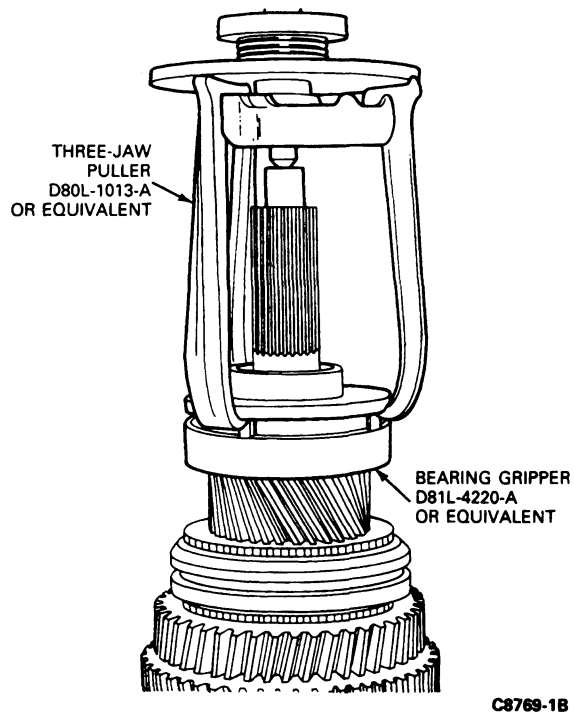
NOTE: On 4x4 versions and F-Super Duty versions, a snap ring retaining the taper roller bearing inner race must be removed.

18. Position a bearing gripper such as D81L-4220-A on the mainshaft rear tapered roller bearing. The gripper used must pull the bearing assembly by the shoulder of the tapered rollers, not from the bearing cage.

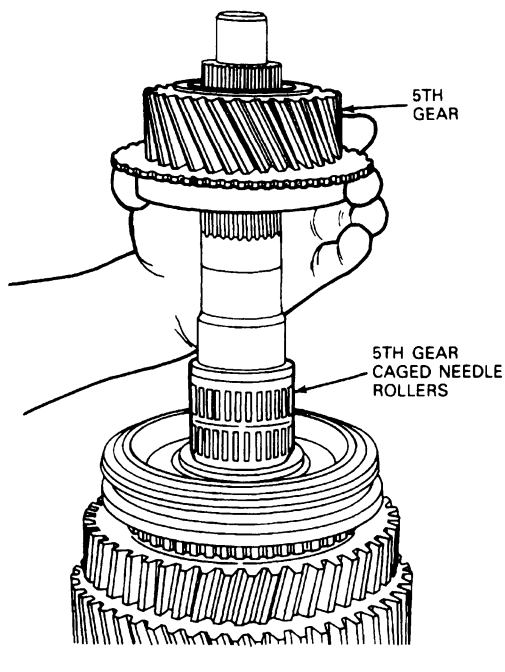
CAUTION: Failure to use a bearing gripper will destroy the bearing.

DISASSEMBLY AND ASSEMBLY (Continued)

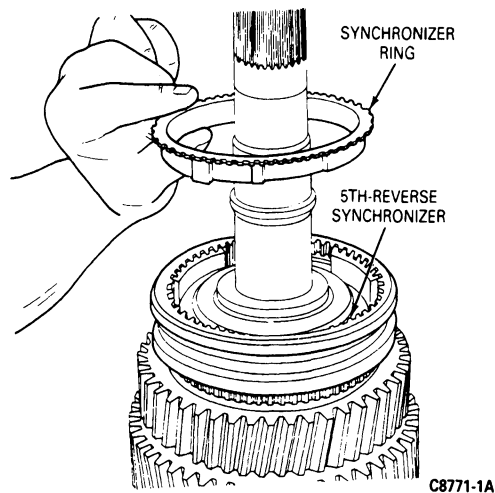
19. Position Three-Jaw Puller D80L-1013-A or equivalent on the bearing gripper and pull the mainshaft rear tapered roller bearing from the mainshaft.



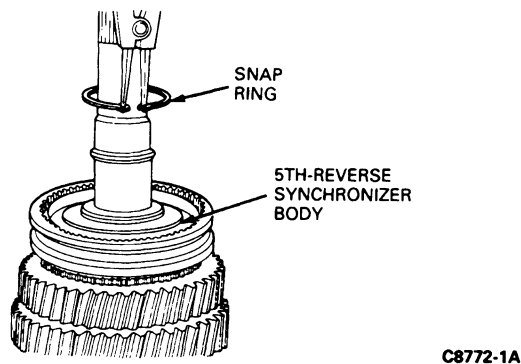
20. Remove the 5th gear from the mainshaft.
21. Remove the 5th gear caged needle rollers from the mainshaft.



22. Remove the synchronizer ring from the 5th-reverse synchronizer.



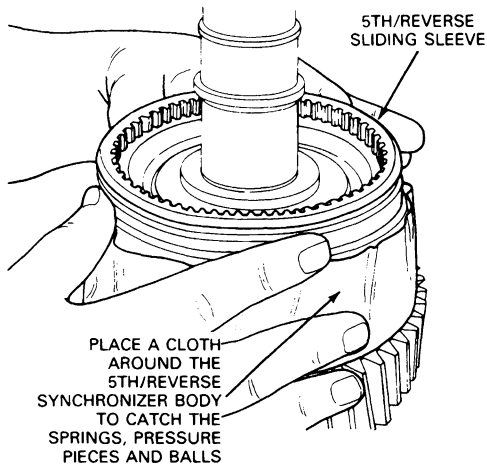
23. Remove the snap ring retaining the 5th-reverse synchronizer body to the mainshaft.



DISASSEMBLY AND ASSEMBLY (Continued)

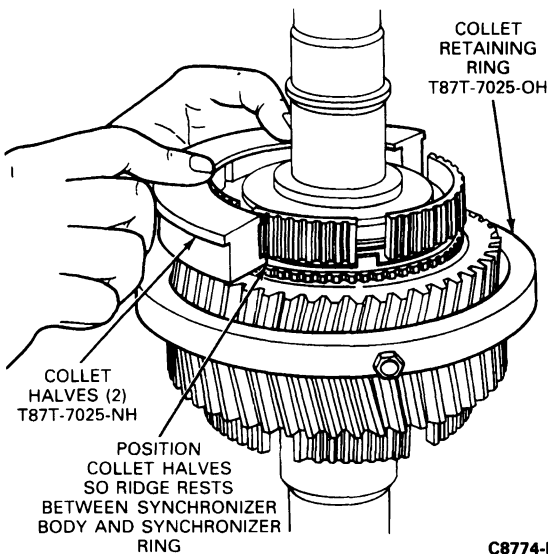
24. Remove the 5th-reverse sliding sleeve.

CAUTION: Position a cloth around the 5th-rev synchronizer body to catch the springs, pressure pieces and balls that will be released when the sliding sleeve clears the 5th-rev synchronizer body.



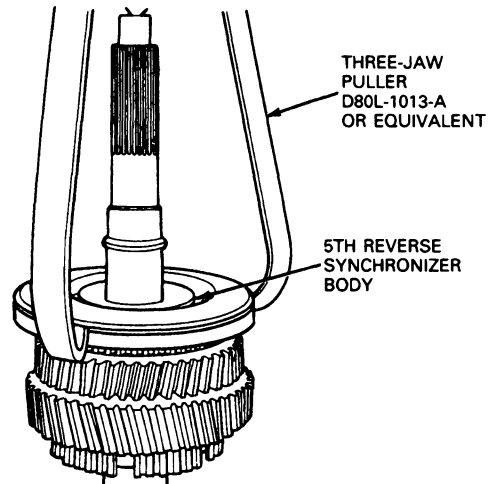
C8773-1A

25. Place the Collet Retaining Ring T87T-7025-OH over the mainshaft and let it rest on the 1st gear. Position the Collet Halves T87T-7025-NH so the ridge rests between the synchronizer body and the synchronizer ring. Slide the retaining ring upwards around the collets to secure them in position.



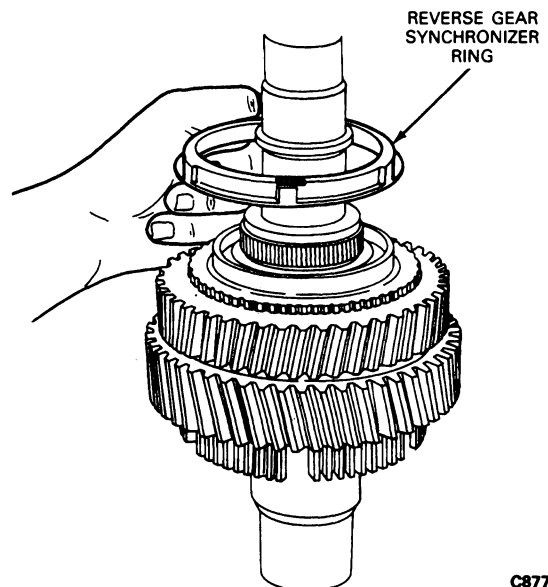
C8774-B

26. Position a Three-Jaw Puller D80L-1013-A or equivalent on the collet retaining ring and pull the 5th-Reverse synchronizer body from the mainshaft.



C8775-1A

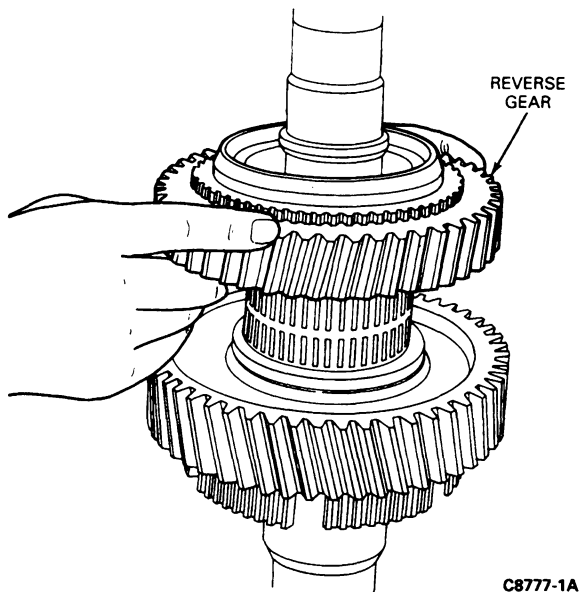
27. Remove the synchronizer ring from the reverse gear.



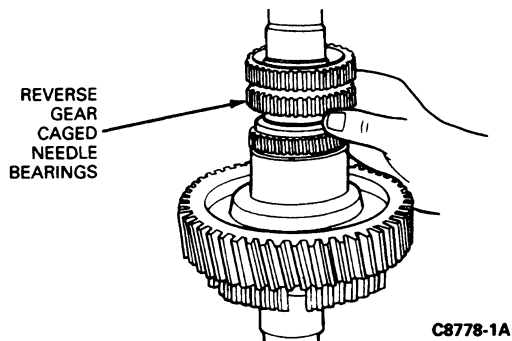
C8776-1A

DISASSEMBLY AND ASSEMBLY (Continued)

28. Remove the reverse gear from the mainshaft.

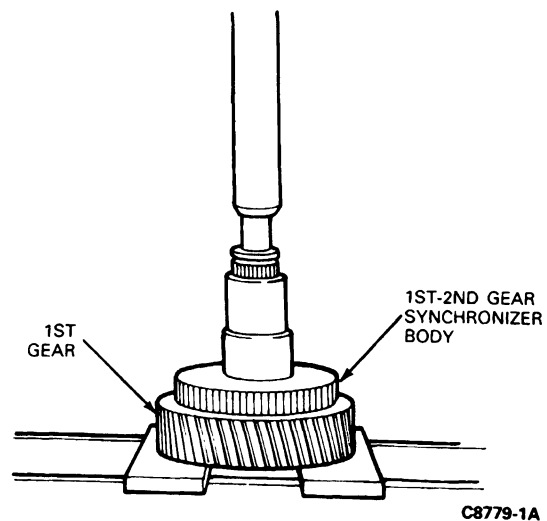


29. Remove the reverse gear caged needle bearings from the mainshaft.

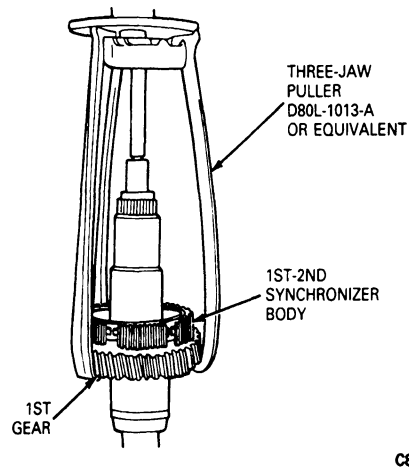


30. Remove the mainshaft from the vise. Position the mainshaft in a press as shown in the illustration and press the 1st gear and the 1st-2nd gear synchronizer body from the mainshaft.

CAUTION: Make sure mainshaft is properly supported.

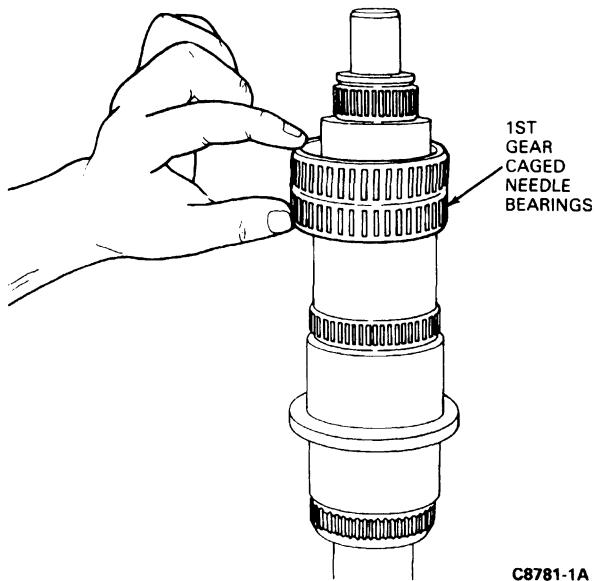


31. An alternate method is to turn the mainshaft over and clamp it at the output end. Position the jaws of Puller D80L-1013-A or equivalent on the 1st gear and pull the 1st gear and the 1st-2nd synchronizer body from the mainshaft.



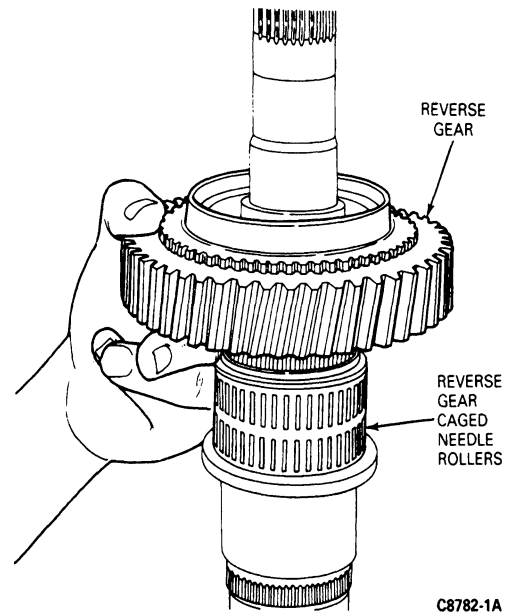
DISASSEMBLY AND ASSEMBLY (Continued)

32. Remove the 1st gear caged needle rollers from the mainshaft.

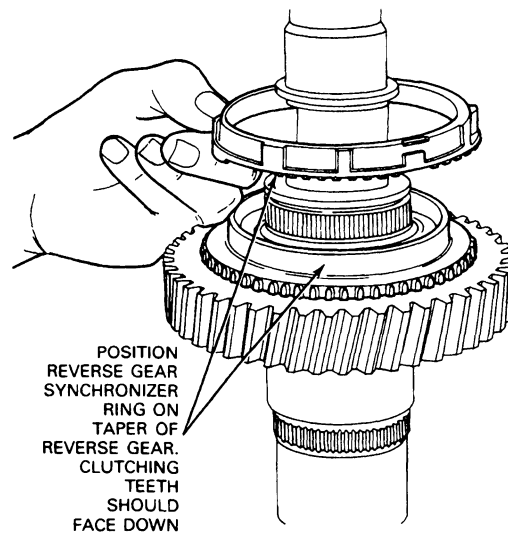
**Assembly**

1. Clamp the input end of the mainshaft in a vise.
NOTE: Use brass pads or equivalent to prevent damage.
2. Place the reverse gear caged needle rollers on the mainshaft.
3. Place the reverse gear on the mainshaft over the caged needle rollers. The clutching teeth on the reverse gear must face upwards.

CAUTION: Before installing original synchronizer ring and synchronizer body, check for excessive wear. Refer to synchronizer ring/synchronizer body wear check under inspection in this section for procedure.



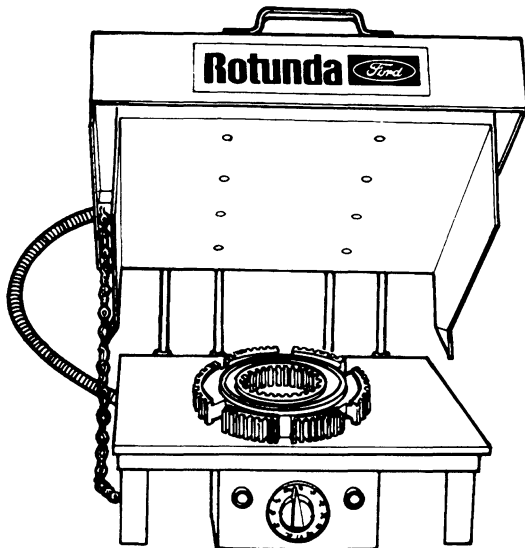
4. Position the reverse gear synchronizer ring on the taper of the reverse gear.



DISASSEMBLY AND ASSEMBLY (Continued)

5. Heat the 5th-reverse synchronizer body with a Rotunda Gear Heater 130-00001, Heat Gun 107-00300 or equivalent to 160°C (320°F).

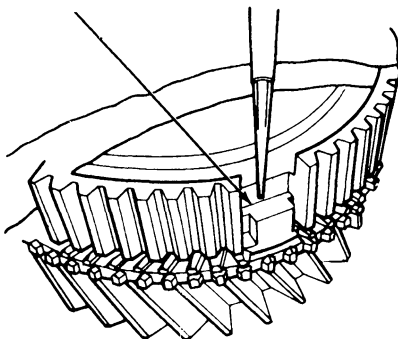
CAUTION: Do not heat synchronizer body for more than 15 minutes.



C8784-1A

6. Position the synchronizer body on the mainshaft splines so that the side with the deeper hub faces down and the short lugs on the synchronizing ring engage in the shallow gaps in the synchronizer body. Push or lightly tap the synchronizer body down until it stops.

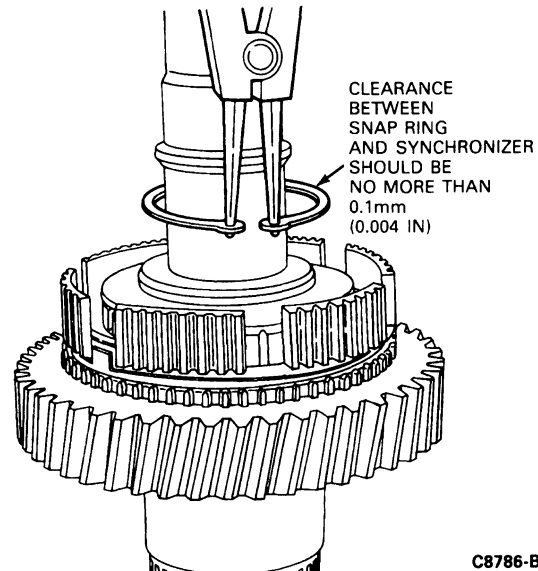
POSITION SYNCHRONIZER
SO DEEPER HUB FACES
DOWN AND SHALLOW GAPS ON
SYNCHRONIZER BODY
LINE UP WITH SHORT
LUGS ON SYNCHRONIZER
RING



C8785-B

7. Install the snap ring on the mainshaft next to the 5th-reverse synchronizer body. The clearance between the snap ring and the synchronizer body should not be more than 0.1mm (0.004 inch) with zero clearance preferable.

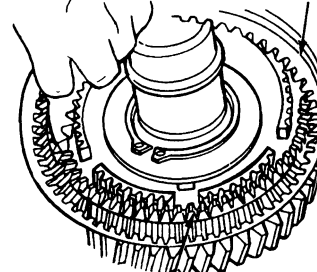
CAUTION: Make sure snap ring is free of burrs before checking clearance.



C8786-B

8. Check the reverse gear end play. End play must be between 0.15-0.35mm (0.006-0.014 inch).
9. There are two grooves on the 5th-reverse sliding sleeve. With the two grooves facing up (toward output end of shaft), position the sliding sleeve over the synchronizer body. In three positions on the sliding sleeve, three teeth have been cut away. Align these three areas with the three shallow gaps in the synchronizer body and the three lugs on the synchronizer ring. Slide the sliding sleeve down until it rests over the reverse gear clutching teeth.

POSITION SLIDING SLEEVE
WITH THE TWO
GROOVES FACING UP



LINE UP AREAS
WHERE TEETH ARE
CUT AWAY ON SLIDING
SLEEVE WITH GAPS ON
SYNCHRONIZER BODY

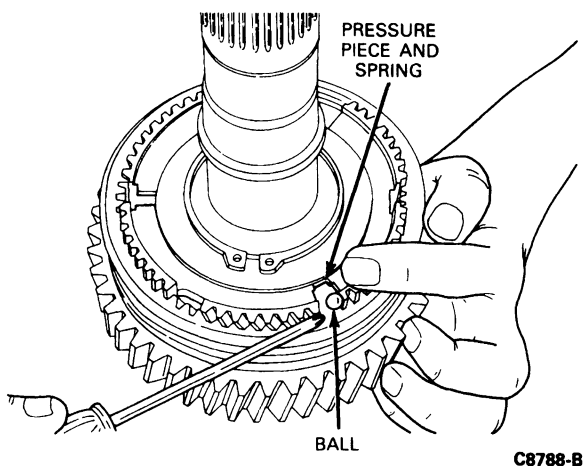
C8787-C

DISASSEMBLY AND ASSEMBLY (Continued)

10. Insert three compression springs with pressure pieces in the recesses of the synchronizer body.

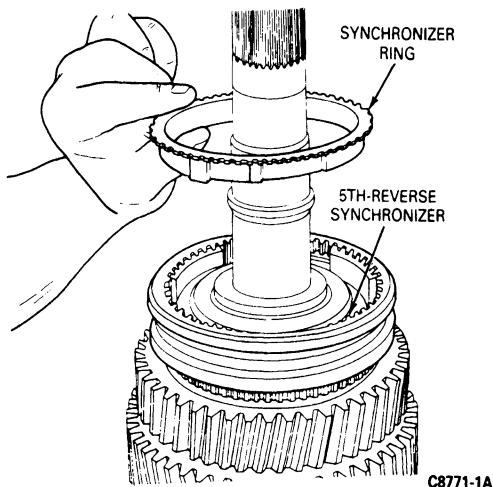
CAUTION: If the original springs are being replaced, inspect them before reuse. Refer to Inspection in this section for procedure.

11. Raise the pressure pieces slightly with a screwdriver. Push in the balls with a screwdriver and slide the pressure piece so that it rests against the ball.

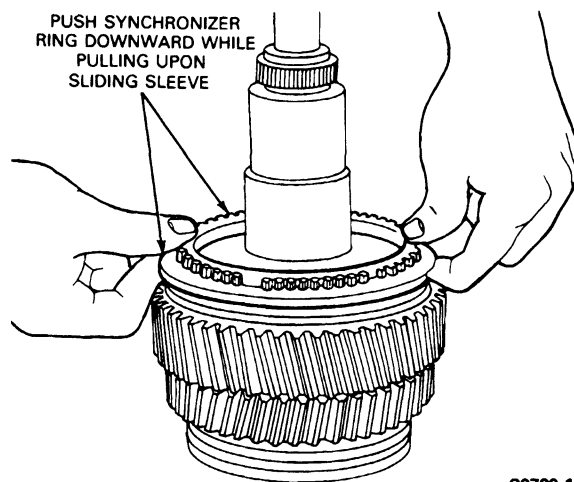


12. Place the 5th gear synchronizer ring on the synchronizer body.

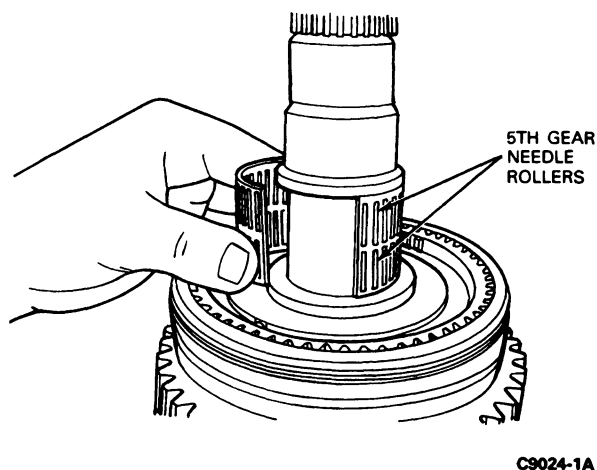
NOTE: The short lugs on the synchronizer ring should be located over the shallow gaps in the 5th-reverse synchronizer body.



13. Push the 5th gear synchronizer ring downwards while pulling the sliding sleeve into the center position.

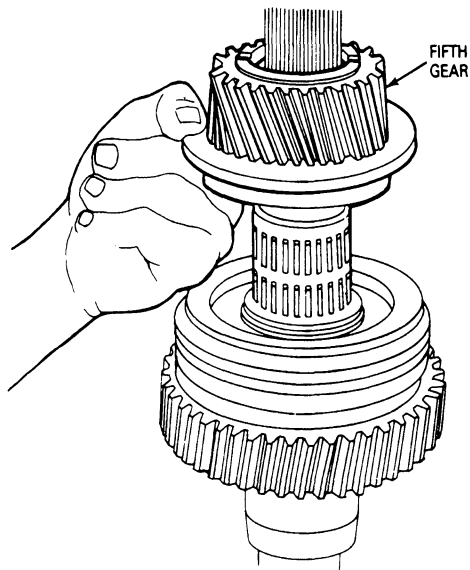


14. Place both 5th gear caged needle rollers on the mainshaft.



DISASSEMBLY AND ASSEMBLY (Continued)

15. Install the 5th gear on the mainshaft over the caged needle rollers.



C8791-1A

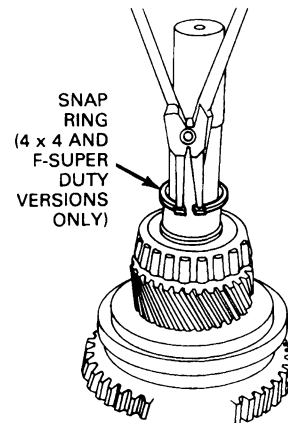
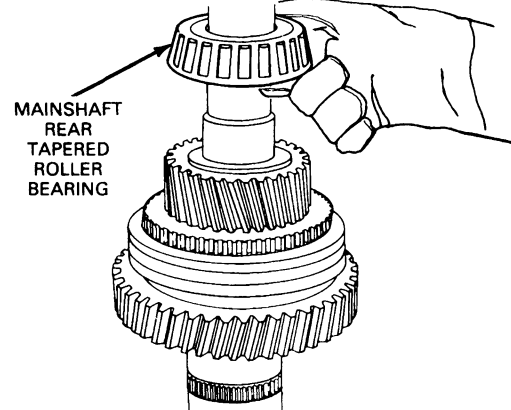
16. Heat the inner race of the mainshaft rear tapered roller bearing to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent. Place it on the mainshaft and drive it on if necessary until it seats against its stop on the mainshaft.

CAUTION: Do not heat the bearing for more than 15 minutes.

CAUTION: If necessary to drive the bearing on, drive against the inner race only. Do not drive against the bearing cone.

17. Check the end play of the 5th gear. End play must be 0.15-0.35mm (0.006-0.014 inch).

NOTE: On 4x4 and F-Super Duty versions, fit an additional retaining ring in the annular groove adjacent to the taper roller bearing inner race. It must have an end play of 0.0-0.1mm (0.0-0.004 inch). 0mm (0.0 inch) should be aimed for.

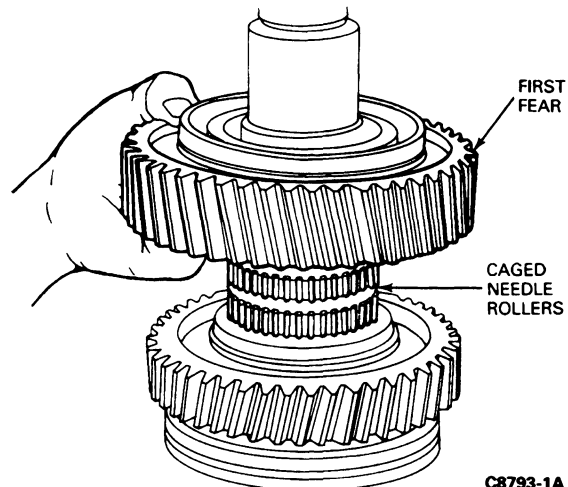


C8792-B

18. Turn the mainshaft over and clamp it at the output end.

NOTE: Use brass pads or equivalent to prevent damage.

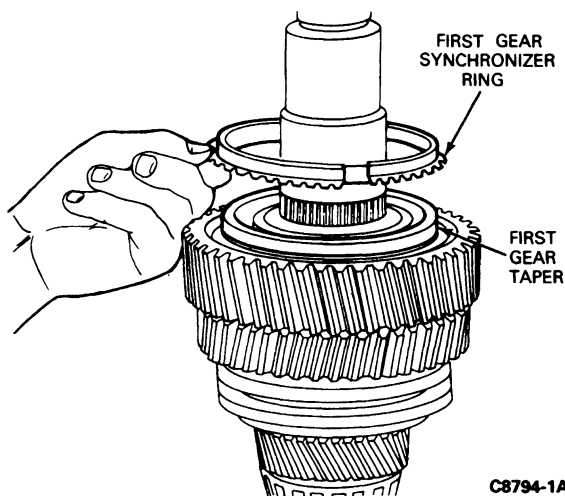
19. Place the caged needle rollers for the 1st gear on the mainshaft.
20. Place the 1st gear over the needle rollers on the mainshaft with the taper facing up.



C8793-1A

DISASSEMBLY AND ASSEMBLY (Continued)

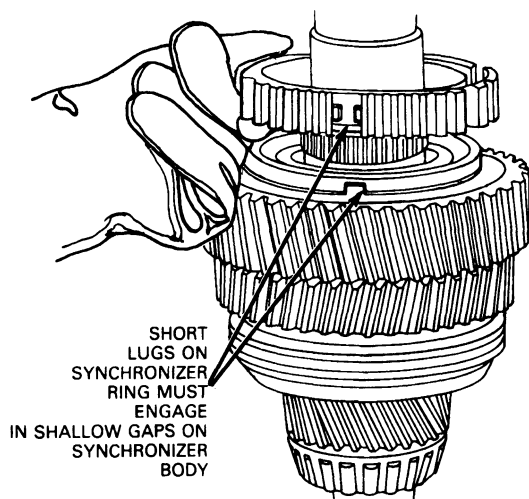
21. Place the 1st gear synchronizer ring on the taper of the 1st gear.



C8794-1A

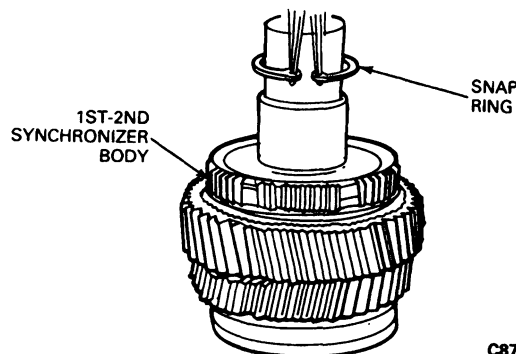
22. Heat the 1st-2nd synchronizer body to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent. Position the synchronizer body on the mainshaft splines so that the short lugs on the synchronizing ring engage in the shallow gaps in the synchronizer body. Lightly tap the synchronizer body down until it stops against the synchronizer ring. When proper installation is made, the word "ENGINE" will be visible on the synchronizer body.

CAUTION: Do not heat the synchronizer body for more than 15 minutes.



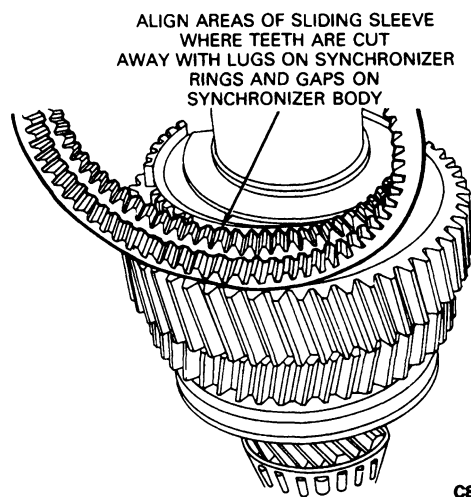
C8795-C

23. Install a new snap ring on the mainshaft next to the 1st-2nd synchronizer body. Clearance between the snap ring and the synchronizer body should not be more than 0.1mm (0.004 inch).



C8768-1A

24. Check the end play of the 1st gear. It must be between 0.15 and 0.35mm (0.006 and 0.014 inch).
25. Position the sliding sleeve over the synchronizer body with its tapered collar facing down (toward the output end of the mainshaft). In three positions on the sliding sleeve, three teeth have been cut away. Align these three areas with the three shallow gaps in the synchronizer body and the three lugs on the synchronizer ring. Slide the sliding sleeve down until it rests against the 1st gear.

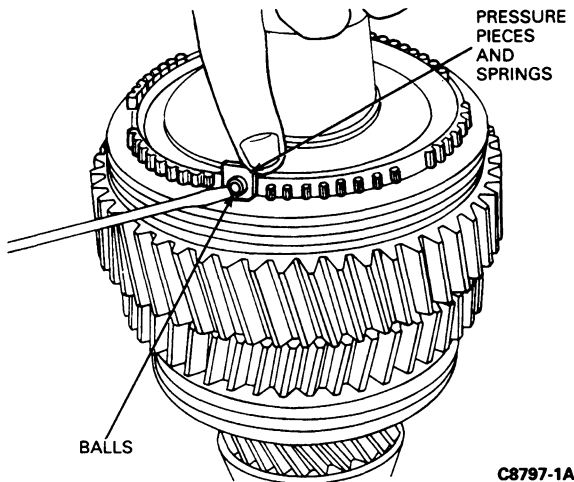


C8796-1A

26. Insert three compression springs with pressure pieces in the recesses of the synchronizer body.
- CAUTION: If the original springs are not being replaced, inspect them before reuse. Refer to Inspection in this section for procedure.**

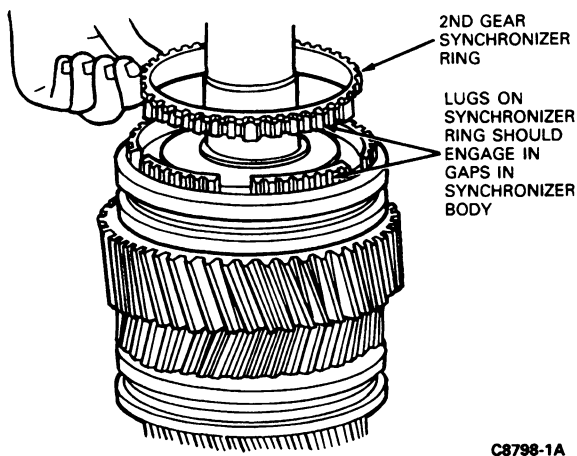
DISASSEMBLY AND ASSEMBLY (Continued)

27. Raise the pressure pieces slightly with a screwdriver. Push in the balls with a screwdriver and slide the pressure piece so that it rests against the ball.



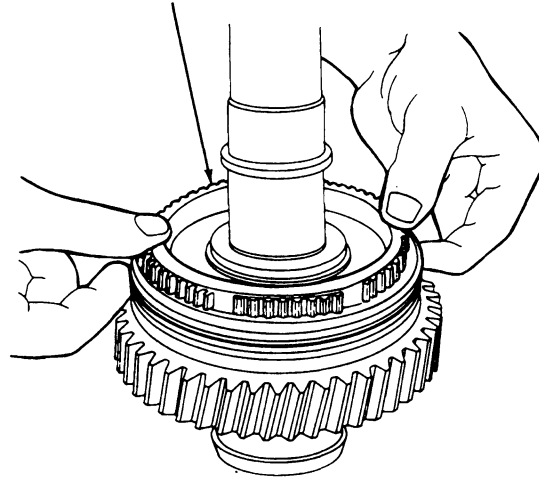
28. Place the 2nd gear synchronizer ring on the 1st-2nd synchronizer body.

NOTE: The short lugs on the synchronizer ring should be located over the gaps in the 1st-2nd synchronizer body.



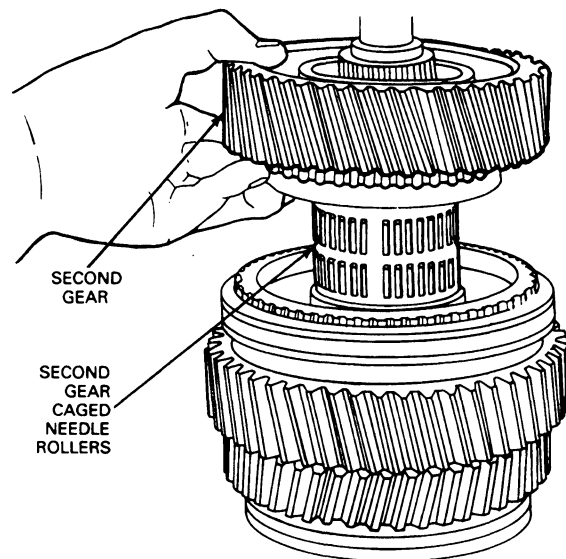
29. Push the synchronizer ring downwards while pulling the sliding sleeve into the center position.

PUSH DOWN ON
SECOND GEAR SYNCHRONIZER
RING WHILE PULLING UP
ON FIRST-SECOND SLIDING SLEEVE



30. Place the caged needle rollers for the 2nd gear on the mainshaft.

31. Place the 2nd gear over the needle bearings on the mainshaft. The taper of the 2nd gear must face down on the mainshaft.

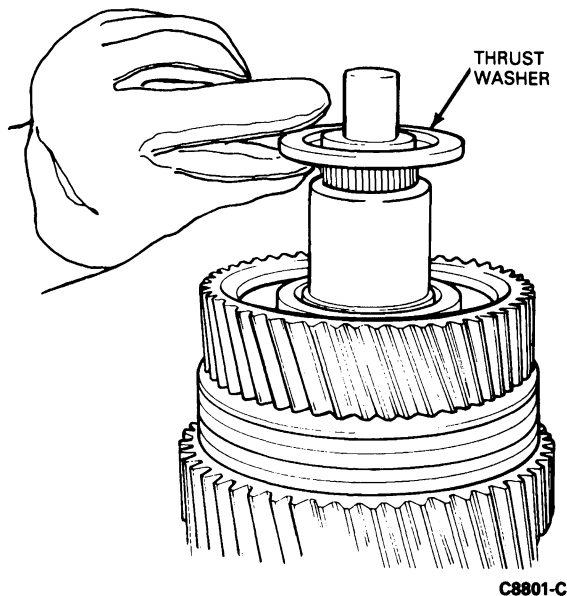


32. Heat the thrust washer to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent.

CAUTION: Do not heat the washer for more than 15 minutes.

DISASSEMBLY AND ASSEMBLY (Continued)

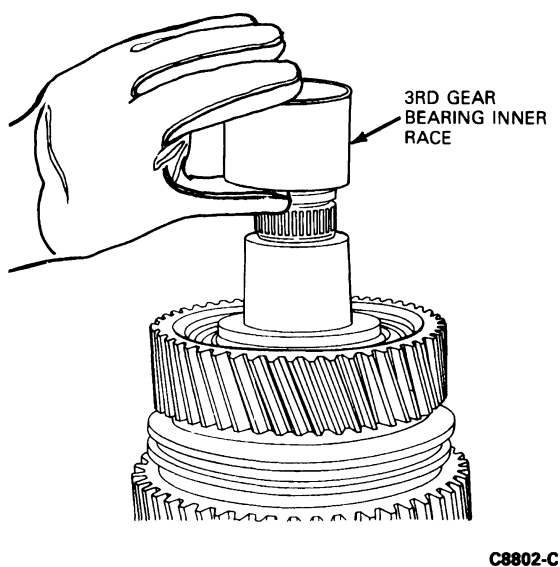
33. Position the thrust washer on the mainshaft and tap it down until it seats against its stop on the shaft. If necessary, gently tap the washer to fully seat it.



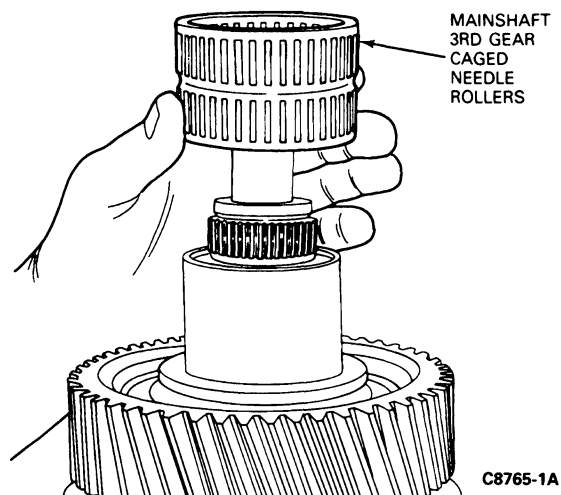
34. Heat the 3rd gear bearing inner race to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent.

CAUTION: Do not heat the race for more than 15 minutes.

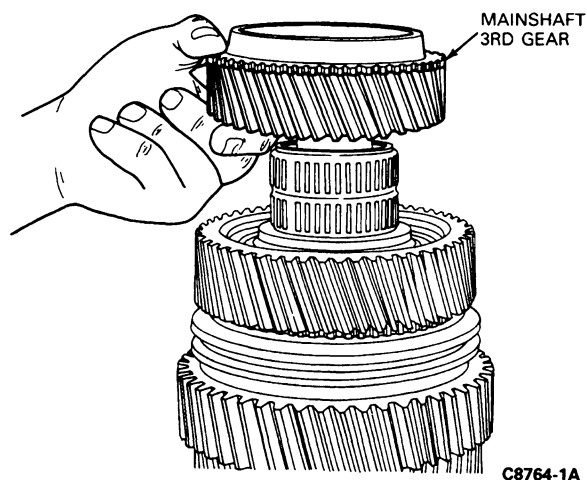
35. Position the race on the mainshaft and tap it down until it seats against its stop on the shaft. If necessary, gently tap the race to fully seat it.



36. Check the end play of the 2nd gear. It must be between 0.15-0.45mm (0.006-0.017 inch).
37. After the 3rd gear bearing inner race has fully cooled, place the 3rd gear caged needle rollers over it.

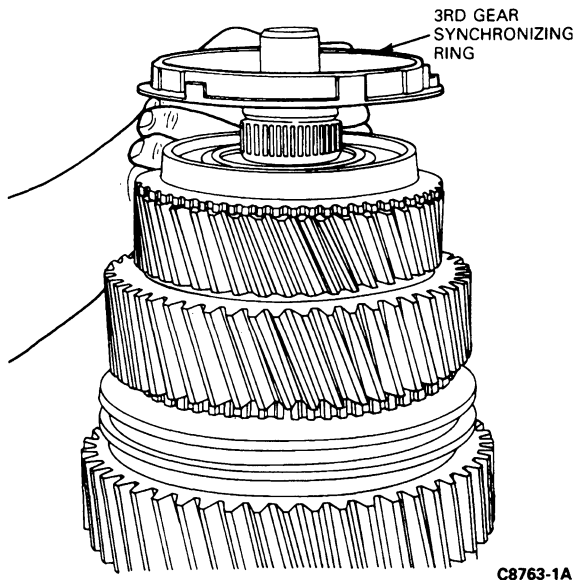


38. Place the 3rd gear over the needle rollers on the mainshaft. The taper of the 3rd gear must face up.



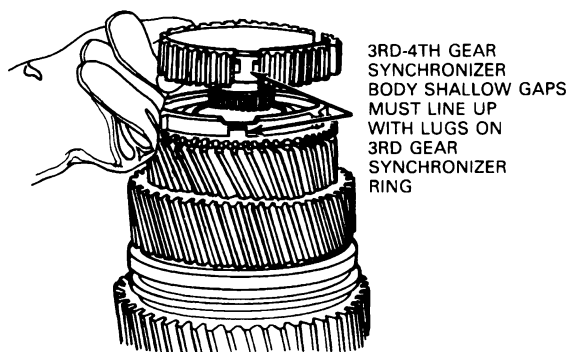
DISASSEMBLY AND ASSEMBLY (Continued)

39. Place the 3rd gear synchronizer ring on the taper of the 3rd gear.

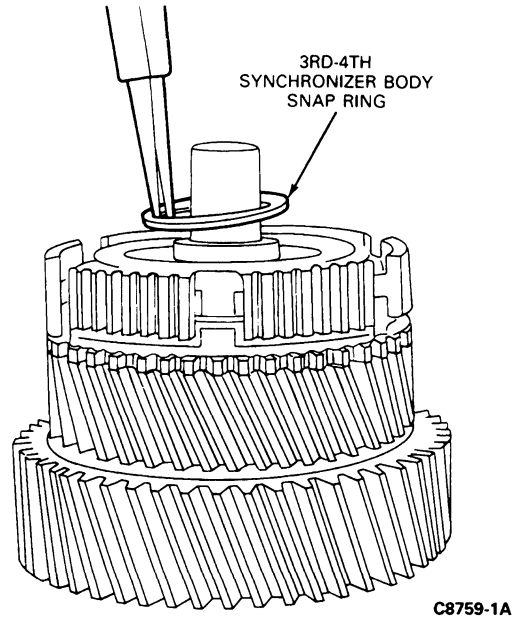


40. Heat the 3rd-4th synchronizer body with Rotunda Gear Heater 130-00001 or equivalent to max. 160°C (320°F). Position the synchronizer body on the mainshaft splines so that the short lugs on the synchronizing ring engage in the shallow gaps in the synchronizer body. Lightly tap the synchronizer body down until it stops against the synchronizer ring. The recess in the synchronizer body must face upwards.

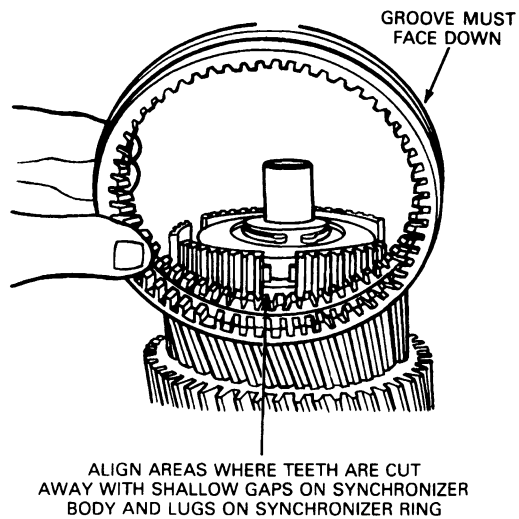
CAUTION: Do not heat the synchronizer body for more than 15 minutes.



41. Install a new snap ring on the mainshaft next to the 3rd-4th synchronizer body. Clearance between the snap ring and the synchronizer body should not be more than 0.1mm (0.004 inch).
42. Check the end play of the 3rd gear. It must be between 0.15 and 0.35mm (0.006 and 0.014 inch).



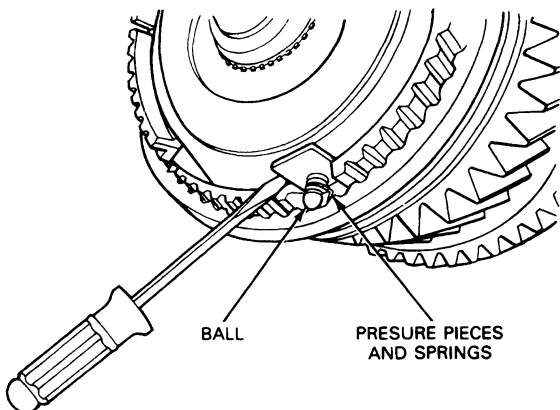
43. Position the sliding sleeve over the synchronizer body with the smaller of the two grooves facing down. In three positions on the sliding sleeve, three teeth have been cut away. Align these three areas with the three shallow gaps in the synchronizer body and the three lugs on the synchronizer ring. Slide the sliding sleeve down until it rests against the 3rd gear.



44. Insert three compression springs with pressure pieces in the recesses of the synchronizer body.
- CAUTION: If the original springs are being replaced, inspect them before reuse. Refer to Inspection in this section for procedure.**

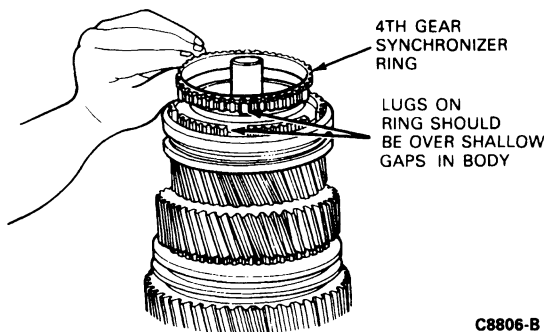
DISASSEMBLY AND ASSEMBLY (Continued)

45. Raise the pressure pieces slightly with a screwdriver. Push in the balls with a screwdriver and slide the pressure piece so that it rests against the ball.



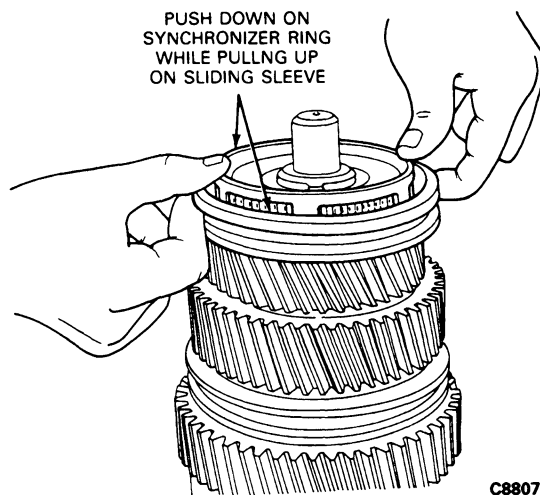
C8805-1A

46. Place the 4th gear synchronizer ring on the synchronizer body.
- NOTE: The short lugs on the synchronizer ring should be located over the shallow gaps in the 3rd-4th synchronizer body.



C8806-B

47. Push the synchronizer ring downwards while pulling the sliding sleeve into the center position.



C8807-1A

48. Heat the inner race of the mainshaft front taper roller bearing to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent. Position it on the mainshaft and drive it on if necessary until it seats against its stop on the mainshaft.

CAUTION: Do not heat the bearing for more than 15 minutes.

CAUTION: If necessary to drive the bearing on, drive against the inner race only. Do not drive against the bearing cone.

An alternate method is to press the bearing on using Bearing Cone Replacer T85T-4621-AH.



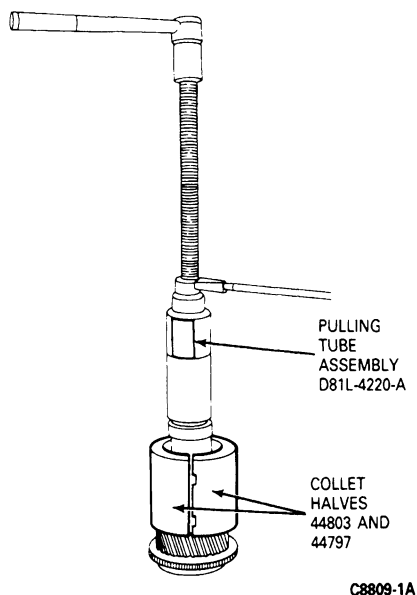
C8808-C

DISASSEMBLY AND ASSEMBLY (Continued)

Input Shaft

Disassembly

1. Position the two Collet Halves (44803 and 44797) of the Transmission Puller Set D81L-4220-A or equivalent around the input shaft bearing cone. Install the Pulling Tube Assembly on the collet halves and pull the input shaft bearing from the input shaft.



Assembly

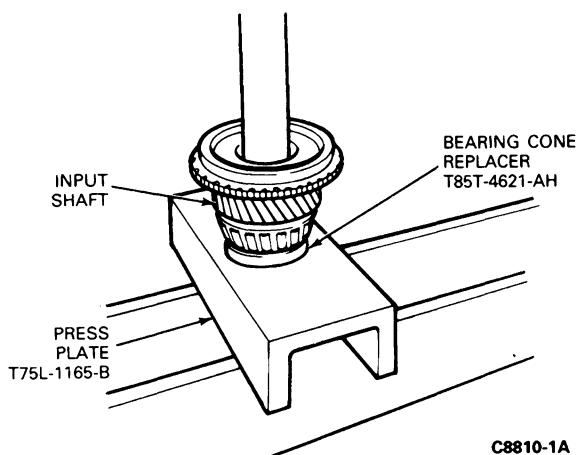
CAUTION: Inspect the surface of the input shaft in the area of the bearing race to make sure it is smooth and free of burrs. Also inspect the condition of the guide splines, pilot bearing inner race, pocket bearing outer race and oil dam.

1. Place the bearing on the input shaft.
2. Place Bearing Cone Replacer T85T-4621-AH over the bearing.
3. Position the shaft, bearing, and bearing cone replacer in Press Plate T75L-1165-B as shown in the illustration.

CAUTION: Make sure that the pocket bearing oil baffle is fully installed and not damaged.

4. Press the bearing on until it seats against its stop on the shaft.

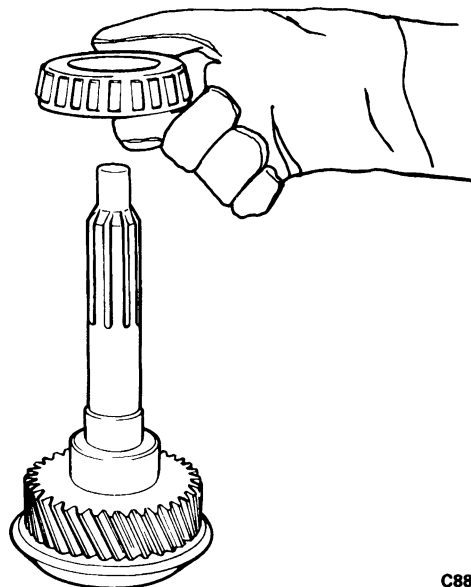
CAUTION: Press plunger must not contact pocket bearing outer race.



5. An alternate method is to heat the inner race of the input shaft tapered roller bearing to 160°C (320°F) with Rotunda Gear Heater 130-00001, Heat Gun 107-00300 or equivalent and position it on the input shaft. Use a suitable tool to seat the bearing against its stop.

CAUTION: Do not heat the bearing for more than 15 minutes.

CAUTION: Do not drive against the bearing cone. Drive against the inner race only.



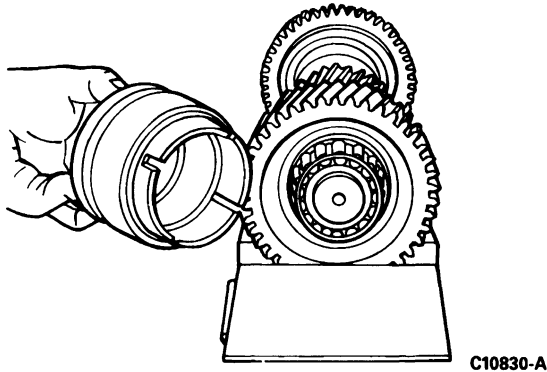
Countershaft

Disassembly

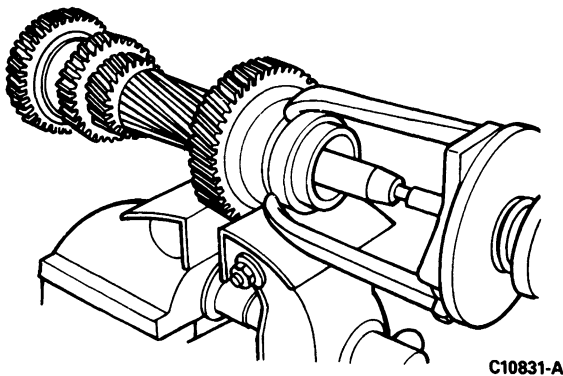
NOTE: Do not attempt service procedures on the countershaft gears. Only the countershaft bearings can be serviced.

DISASSEMBLY AND ASSEMBLY (Continued)

1. Position countershaft in a vise clamping onto 5th gear.
NOTE: Use brass pads or equivalent to prevent damage.
2. Place puller device, such as D81L-4220-A or equivalent over the inner ring of the tapered roller bearing located at the output end of the countershaft. Turn the knurled ring on the tool to secure it to the ring on the bearing.



3. Position Puller D80L-1013-A or equivalent over the gripper tool and remove the bearing from the countershaft.

**Assembly**

1. Using Rotunda Heat Gun 107-00300 or equivalent, heat the tapered roller bearing not to exceed 160°C (320°F). **Maximum heating time is 15 minutes.**

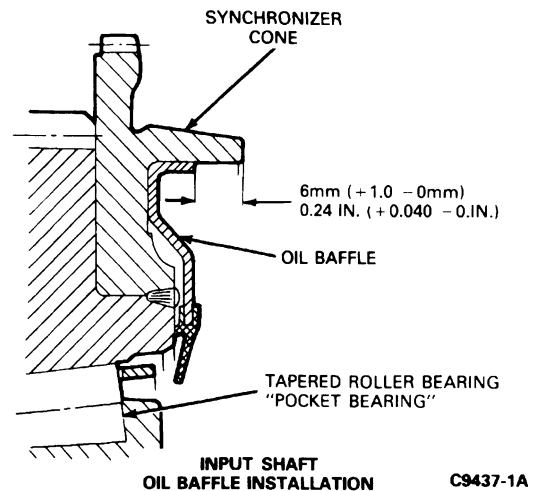
2. Install bearing on end of shaft and drive it to its axial stop.

NOTE: This procedure can also be used to replace the front countershaft bearing.

Any time the transmission is serviced check the following items:

- Confirm that the oil dam is installed in the input shaft synchronizer cone recess.
- Visually inspect the oil dam for tears or damage.
- The oil dam lip is recessed 6mm (+1 -0) (0.24 inch [+0.04 -0]) below the synchronizer cone edge.

- The oil dam fits tight and cannot be moved by hand.
- The three lubrication holes in the input shaft are free of any obstruction.
- The oil channel (in the main case) to the input shaft bearing is free of any obstruction.
- The oil retainer ring (part of the shim pack) behind the outer race of the input bearing is free of damage.
- The synchronizer body snap ring forward of the 3/4 synchronizer package on the mainshaft is in position.

**ADJUSTMENTS****Bearing Preload Adjustment**

Measurement and adjustment of the tapered roller bearings is necessary if a housing, countershaft, mainshaft or input shaft has been replaced or if a tapered roller bearing per shaft has been replaced. The mainshaft, input shaft, and countershaft should be adjusted to provide a preload of 0.02-0.11mm (0.00079-0.00434 inch). After adjusting the two shafts, each should be rotated a few times to center the rollers in the bearings involved.

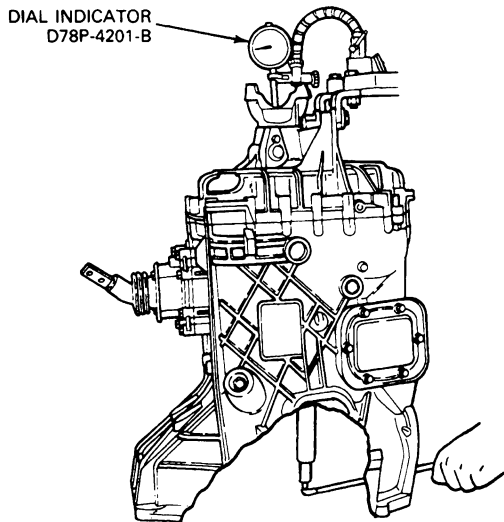
Input Shaft and Mainshaft Tapered Roller Bearing Preload Measurement

1. With the transmission placed on a bench with the output flange facing upward, attach a dial indicator gauge with a magnetic base, such as Dial Indicator / Magnetic Base D78P-4201-B or equivalent to the output flange in such a manner that the measurement bar will rest on the output end of the mainshaft as shown in the illustration.
2. Zero the dial indicator and, using a pry bar, gently pry up the input shaft and mainshaft.

ADJUSTMENTS (Continued)

- Note the indicator gauge reading. A shim and baffle which is to be fitted later must have a combined thickness equal to the dimension recorded on the dial plus 0.02-0.11mm (0.00079-0.00434 inch). This will result in obtaining the specified preload after installation of the shims and baffle, and mainshaft and countershaft.

NOTE: Shims and baffle must be removed prior to preload measurement. The baffle is part of the shim package under the outer bearing race.

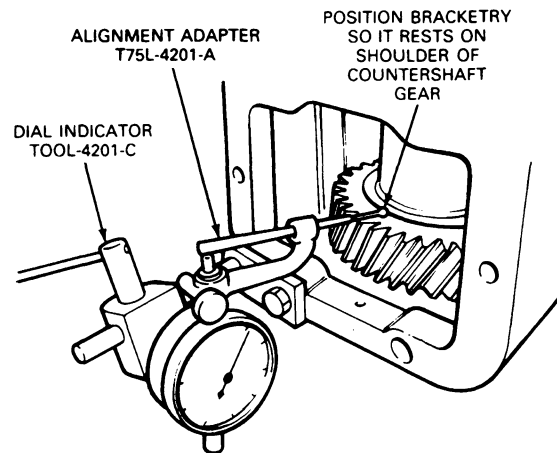


C8721-1B

Countershaft Tapered Roller Bearing Preload Measurement

- Using two 10mm hex screws, attach Dial Indicator with Bracketry TOOL-4201-C and Alignment Adapter T75L-4201-A to the PTO opening in the front case as shown in the illustration. Position the dial indicator gauge to the support in such a way that the measurement bar rests against the flat face of the fourth speed helical gear on the countershaft.
- Set the dial indicator needle to zero.
- Insert pry bars through each of the two power take-off openings and position them beneath the 4th speed helical gear on the countershaft. Pry up on the countershaft.
- Like the preceding shaft check, the preload should be 0.02 to 0.11mm (0.00079 to 0.00434 inch) after installing the shim.

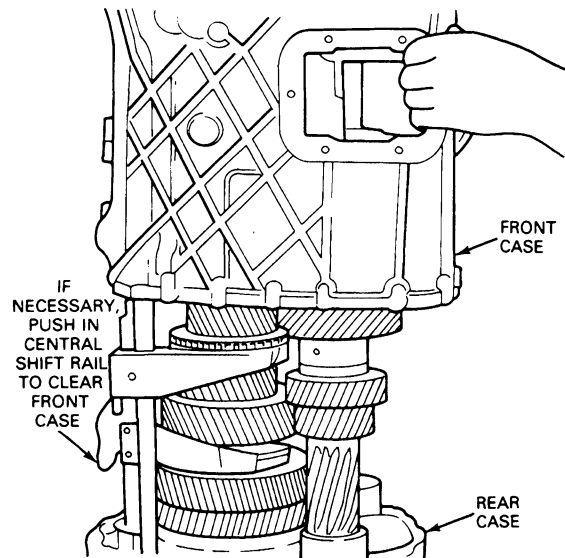
NOTE: Countershaft shim under front bearing race must be removed prior to preload measurement.



C8722-1B

Mainshaft and Input Shaft Tapered Roller Bearing Preload Adjustment

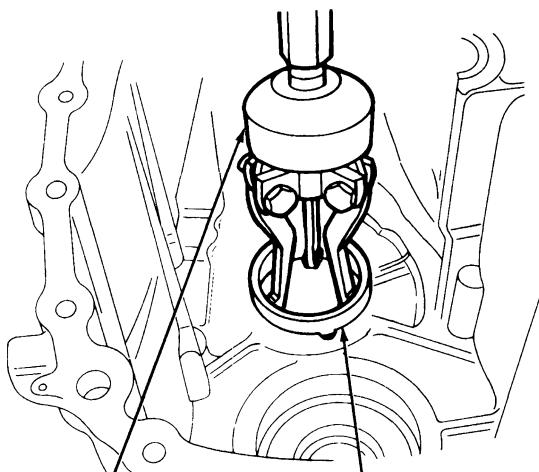
- After completing the tapered roller bearing preload measurements described previously, place the transmission in an upright position with the input shaft pointing upwards.
- Drive the two dowel pins out of their holes in the front and rear cases and lift the front case off the rear case.



C8688-1A

ADJUSTMENTS (Continued)

3. Using Slide Hammer T50T-100-A and Internal Puller D80L-943-A or equivalent, remove the countershaft and mainshaft tapered roller bearing outer races from the front case.



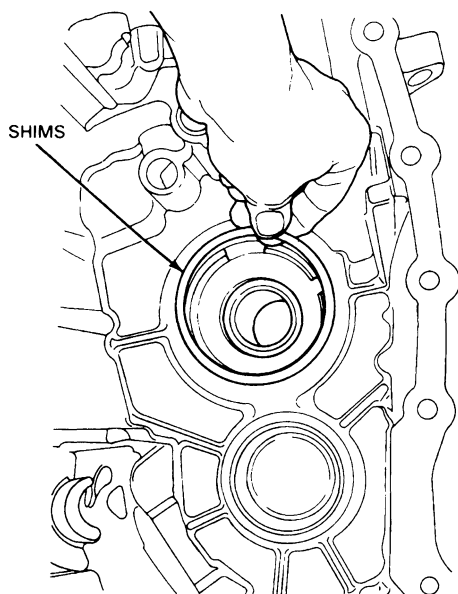
SLIDE HAMMER
T50T-100-A
AND INTERNAL PULLER
D80L-943-A OR EQUIVALENT

COUNTERSHAFT
FRONT BEARING
OUTER RACE

C8723-B

4. Fit each race with a shim washer or shim washer and baffle plate to obtain the required preload determined previously. Countershaft preload is established by using shims alone; input shaft and mainshaft preload is established by using shims and a baffle. In both cases the parts are installed beneath the outer race of the tapered roller bearing which seats in the front case.

NOTE: Always replace the baffle plate with a new one when removed.



C8724-1A

5. Apply Gasket Maker E2AZ-19562-B (ESE-M4G234-A2) or equivalent to the mating surfaces of the front and rear cases.

CAUTION: Do not use silicon.

6. Position the front case on the rear case. Install all of the screws that secure the two front and rear cases and tighten to 22 N·m (16 ft-lbs).

NOTE: Input and output shaft should turn freely by hand after preload adjustment.

7. Proceed with assembly continuing from Step 17 of the transmission assembly procedure.

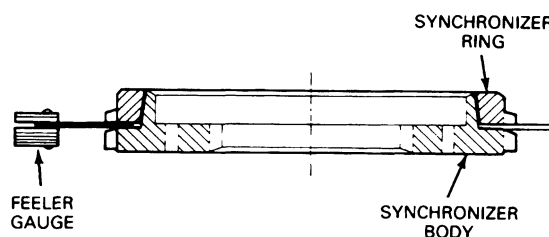
INSPECTION

For cleaning and inspection procedures other than that listed below, refer to Section 07-00B, Transmission, Manual, General.

Synchronizer Ring / Synchronizer Body Wear Check

Inspect the internal surface for contact pattern. The contact pattern should be the same on the entire internal circumference of the ring.

Position the synchronizer ring on the synchronizer body as shown in the illustration. Insert a feeler gauge and measure clearance at two opposite points. If clearance is less than 0.6mm (0.024 inch) for the 3rd-4th, 1st-2nd and 5th synchronizer assemblies and 0.4mm (0.016 inch) for the reverse synchronizer assemblies, replace the synchronizer assembly, affected mainshaft gear, or both if required to bring to within specification.



GEARS	CLEARANCE
1	0.6 mm (0.024 inch)
2	0.6 mm (0.024 inch)
3	0.6 mm (0.024 inch)
4	0.6 mm (0.024 inch)
5	0.6 mm (0.024 inch)
Reverse	0.4 mm (0.016 inch)

C8725-1B

Synchronizer Compression Spring Tension Check

Check the length of all compression springs of synchronizers.

INSPECTION (Continued)

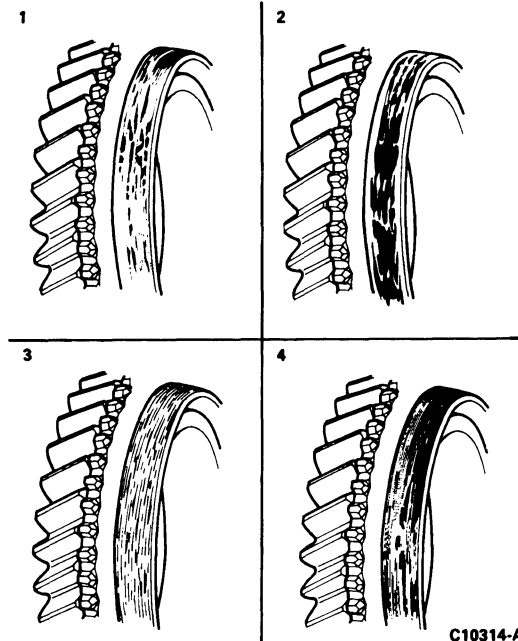
SPRING SPECIFICATIONS

Unloaded Length	O.D.	Wire Diameter
14.8mm (min) (0.583 in.)	5.960mm (0.235 in.)	0.95mm (0.037 in.)

TC8726A

Mainshaft and Input Shaft Gears

1. Inspect the friction taper cone on the gears and check for the following wear patterns.
 - a. Sporadic slightly darkened patches on otherwise evenly smoothed circumference is acceptable. The patches will appear to be blackish in color and will vary in degree and surface area depending on the synchronizer ring contact area.
 - b. Signs of excessive heat will appear to be burnt to a reddish-blue color, mainly on the edges of the cone. This is a result of excessive overloading, operating failure or perhaps a malfunctioning clutch system.
2. Replace gears showing excessively burnt spots (reddish-blue) on the friction taper cone edges. In this case the selector teeth will be damaged as well.
3. Reuse the gears if sufficient synchronizer reserve allowance is available and the teeth (dog teeth) are in good condition. The following illustration shows acceptable wear patterns.



C10314-A

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
Filler Plug / Drain Plug (Straight Threads with Sealing Ring)	50	37
Extension Adapter to Main Case	22	16
End Yoke to Mainshaft	250	184
Shift Tower Cover to Main Case	22	16
P.T.O. Cover Plate	38	28
Idler Shaft Retention	22	16
Shift Rail Plate	10	7
Shift Cover to Tower Cover	10	7
Reverse Switch	20	15
Upper Shift Lever	22-33	16-24

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Transmission to Engine Bolts	54-68	40-50
Shift Rail Interlock	10	7
Front Case to Rear Case	22	16
Upper Gusset (F-250 4x4)	58-77	43-57
Crossmember to Frame (F-250)	58-77	43-57
Transmission Support Plate to Crossmember (F-250)	81-109	60-81
Transmission Support Plate to Transmission	64-71	47-52
Crossmember to Frame (F-350)	43-57	32-42
Gusset (F-350)	43-57	32-42
Crossmember to Transmission (F-350)	81-109	60-81

CLEARANCE SPECIFICATIONS

Description	mm	inches
Countershaft (Preload)	0.02-0.11	0.00079-0.00434
Input Shaft and Main Shaft (Preload)	0.02-0.11	0.00079-0.00434
Mainshaft Reverse Gear	0.15-0.35	0.00591-0.01378
Mainshaft 1st Gear	0.15-0.35	0.00591-0.01378
Mainshaft 2nd Gear	0.15-0.45	0.00591-0.01717

(Continued)

SPECIFICATIONS (Continued)

CLEARANCE SPECIFICATIONS (Cont'd)

Description	mm	inches
Mainshaft 3rd Gear	0.15-0.35	0.00591-0.01378
Mainshaft 5th Gear	0.15-0.35	0.00591-0.01378
Mainshaft Synchronizer Body Retention Rings	0-0.1	0-0.00394

TC8825A

TRANSMISSION LUBRICANT

Description	Liters	U.S. Qts.	Imp. Qts.
Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX or equivalent.	3.2	3.5	3.0

TC9018A

SPRING SPECIFICATIONS

	Length	Outer Diameter	Wire Diameter
Detent Springs	44.1mm (1.736 in.) min.	7.880mm (0.310 in.)	1.250mm (0.049 in.)
Reverse Gear Stop Plate Spring	35.5mm (1.398 in.) min.	9.040mm (0.356 in.)	1.000mm (0.039 in.)
Synchronizer Spring	14.8mm (0.583 in.) min.	5.960mm (0.235 in.)	0.950mm (0.037 in.)

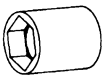
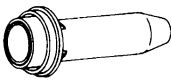
TC8829A

MOUNTING TEMPERATURES



	Temperature	
	C	F
Taper Roller Bearing Inner Race	160	320
Synchronizer Bodies	160	320
Thrust Washer	160	320
Needle Bearing Inner Race	160	320
Bearing Outer Race in Cover	160	320
Ball Bearing Sleeve in Cover	160	320

TC8830A

SPECIAL SERVICE TOOLS / EQUIPMENT




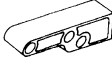





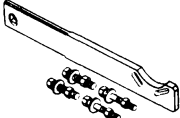
Tool Number / Description	Illustration
T87T-7025-AH Locknut Socket	 T87T-7025-AH
T87T-7025-BH Rear Seal Replacer	 T87T-7025-BH

(Continued)



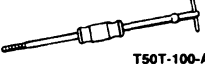
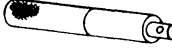
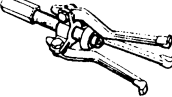
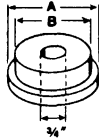

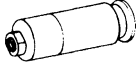

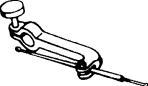
Tool Number / Description	Illustration
T87T-7025-CH Rear Seal Remover	 T87T-7025-CH
T87T-7025-DH Needle Bearing Replacer	 T87T-7025-DH

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT **(Continued)**

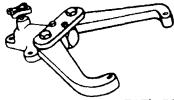

Tool Number / Description	Illustration
T87T-7025-EH Front Seal Replacer	 T87T-7025-EH
T87T-7025-FH Bearing Collets Pair	 T87T-7025-FH
T87T-7025-HH Gear Pack Holding Fixture	 T87T-7025-HH
T87T-7025-JH Shift Rod Support	 T87T-7025-JH
T87T-7025-LH Output Seal Replacer	 T87T-7025-LH
T87T-7025-MH Puller Collets	 T87T-7025-MH
T87T-7025-NH Puller Collets	 T87T-7025-NH
T87T-7025-OH Collet Retaining Ring	 T87T-7025-OH
T87T-7025-PH Mainshaft Front Bearing Cup Replacer	 T87T-7025-PH
T78P-4851-A Companion Flange Holder	 T78P-4851-A

(Continued)

Tool Number / Description	Illustration
T75L-1165-B Press Plate	 T75L-1165-B
T85T-4621-AH Bearing Cone Replacer	 T85T-4621-AH
T50T-100-A Slide Hammer	 T50T-100-A
T80T-4000-W Handle	 T80T-4000-W
T77F-1102-A Bearing Cup Puller	 T77F-1102-A
T73T-4222-A Bearing Cup Replacer	 T73T-4222-A
T84T-7025-B Forcing Screw	 T84T-7025-B
T77J-7025-B Puller / Installer Tube	 T77J-7025-B
T75L-7025-G Collet Retaining Ring	 T75L-7025-G
T75L-4201-A Alignment Adapter	 T75L-4201-A

(Continued)

SPECIAL SERVICE TOOLS / EQUIPMENT (Continued)

Tool Number / Description	Illustration
T57L-500-B Bench Mounted Holding Fixture	 T57L-500-B
TOOL-4201-C Dial Indicator	 TOOL-4201-C
Tool Number	Description
D81L-4220-A	Transmission Puller Set
D78P-4201-B	Dial Indicator

(Continued)

Tool Number	Description
D80L-943-A	Internal Puller
D80L-100-Q	Blind Hole Puller
D80L-1013-A	Three Way Puller
D80L-625-4	Shaft Protector
ROTUNDA EQUIPMENT	
Tool Number	Description
077-00008	Transmission Jack
107-00300	Heat Gun
130-00001	Gear Heater

SECTION 07-05 Shift Controls, Automatic Transmission

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION	
Automatic Transmission Manual Linkage		Manual Shift Linkage Grommet, Motorhome and Commercial Stripped Chassis Only.....	07-05-2
Adjustments, Motorhome and Commercial Stripped Chassis Only	07-05-5	Park Neutral Position Switch, AOD and E4OD	07-05-4
Automatic Transmission Shift Cable		Park/Neutral Position Switch (PNP), C6	07-05-4
Adjustment	07-05-7	Shift Cable, E-150-250-350, F-150-250-350, Bronco and F-Super Duty.....	07-05-2
Park/Neutral Position Switch Adjustment, C6	07-05-10	SPECIAL SERVICE TOOLS	07-05-11
DESCRIPTION AND OPERATION		SPECIFICATIONS	07-05-10
E4OD Lock Out Switch	07-05-1	VEHICLE APPLICATION	07-05-1
DIAGNOSIS AND TESTING	07-05-2		

VEHICLE APPLICATION

Bronco, E-150-250-350, F-150-250-350 4x2 and 4x4, F-Super Duty Chassis Cab, Motorhome and Commercial Chassis Vehicles Equipped with Automatic Transmissions

DESCRIPTION AND OPERATION

The transmission shift control linkage or cable transfers the transmission operating mode from the selector lever to the transmission. The indicated transmission position on the steering column is transferred to a shift lever on the bottom of the steering column. On vehicles equipped with cable-operated shift systems, the indicated position of the transmission selector lever is transferred to the transmission through the shift cane, then to the cable, and down to the transmission manual shift lever at the transmission. On vehicles equipped with shift rod assemblies, the rod transfers the indicated transmission selector level position through a bell crank assembly to a control rod. The control rod transfers the indicated position to the transmission assembly.

For information on the steering column, refer to Section 11-04A.

E4OD Lock Out Switch

Vehicles equipped with E4OD Automatic Transmissions have an overdrive lock out switch located on the end of the transmission shift select lever. Pushing the lock out button will either disengage or engage the overdrive function of the transmission. If the overdrive function is disengaged, the word "OFF" will illuminate on the shift lever.

NOTE: The Motorhome and Commercial Chassis vehicles utilize an overdrive lockout switch located near the instrument cluster.

Refer to Section 11-05 for diagnosis and repair procedures.

DIAGNOSIS AND TESTING

For diagnosis and testing procedures, refer to the appropriate section in this manual, or refer to the Powertrain/Control Emissions Diagnosis Manual¹.

REMOVAL AND INSTALLATION

Shift Cable, E-150-250-350, F-150-250-350, Bronco and F-Super Duty

Removal and Installation

1. From inside the vehicle, use a screwdriver to remove grommet at the floor pan.
2. Remove the cable from the dash panel attaching clip. (F-Series and Bronco only)
3. Pry the cable end fitting from the shift lever ball stud at the bottom of the steering column.
4. Bend back the retaining tab and push the cable upward to disengage cable from the column bracket.
5. Raise vehicle on hoist and position suitable safety stands under vehicle.
6. Using a screwdriver, pry the cable end fitting from the transmission lever ball stud.
7. Compress the ears of the shift cable body and pull forward on the cable to disengage from the transmission bracket.

8. Remove the cable from the underbody attaching clip by pushing outward on the cable. (E-Series only)

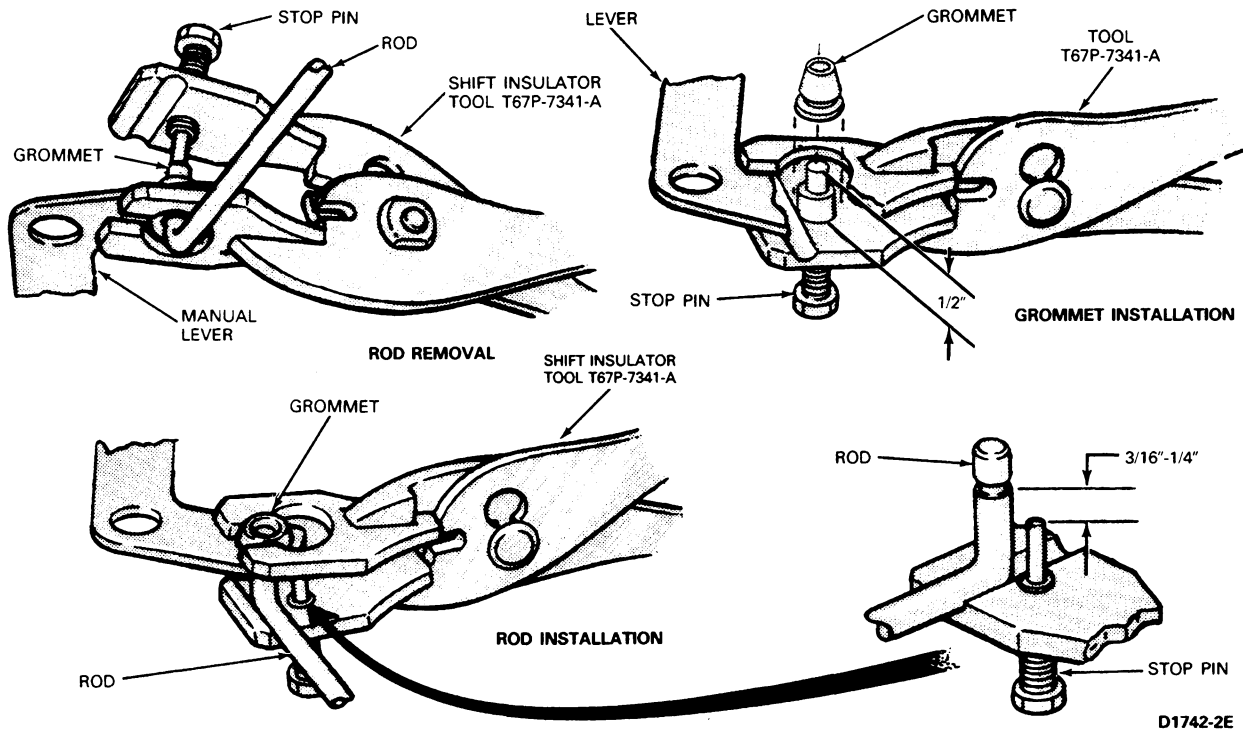
For installation, follow the removal procedures in reverse order. Adjust shift cable as outlined.

Manual Shift Linkage Grommet, Motorhome and Commercial Stripped Chassis Only

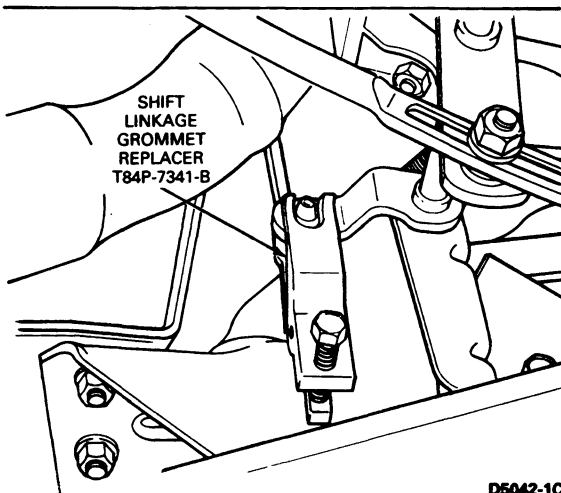
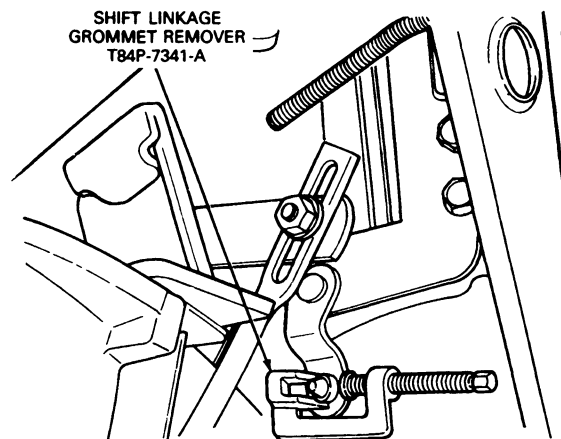
The automatic transmission linkage systems make use of a polyurethane plastic grommet to connect the various rods, levers and adjusting stud. **Whenever a rod is disconnected from a grommet-type connector, the old grommet must be removed and a new one installed.** Remove and install the grommet as follows:

1. Place the lower jaw of Shift Linkage Insulator Tool T67P-734 1-A between the lever and the rod. For areas with limited space, use Shift Linkage Grommet Remover T84P-734 1-A for removal of the grommet. Position the stop pin against the end of the control rod and force the rod out of the grommet. Remove the grommet from the lever by cutting off the large shoulder with a sharp knife. **The grommet must be removed from the lever and a new one installed each time the rod is disconnected.**

¹ Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)**Removing or Installing Shift Linkage Grommet**

REMOVAL AND INSTALLATION (Continued)

Removing or Installing Shift Linkage Grommet
(Limited Space Situations)

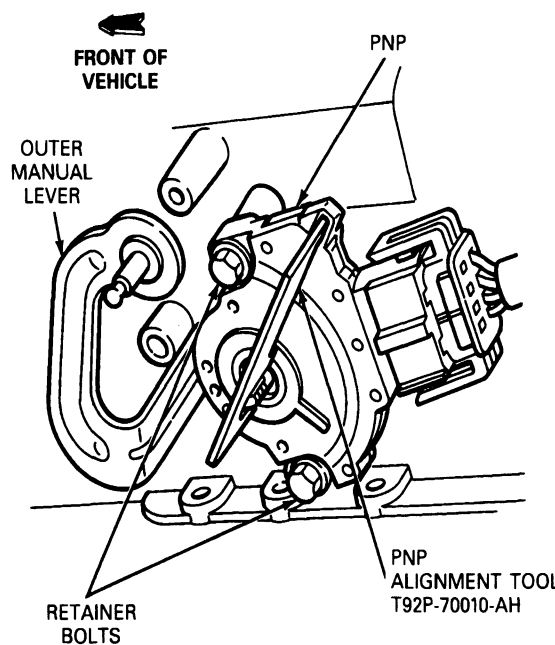
D5042-1C

2. Adjust the stop pin to 12.70mm (1/2 inch) and coat the outside of the grommet with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Place a new grommet on the stop pin and force it into the lever hole. Turn the grommet several times to be sure it is properly seated.
 3. Readjust the stop pin to the height shown in the illustration. The pin height is determined by the length of the rod end which is to be installed into the grommet. If the pin height is not adjusted, the rod may be pushed too far through the grommet causing damage to the grommet retaining lip.
- NOTE:** Coat ends of rods with Steering Linkage Lube D4AZ-19590-A or equivalent before installing in new grommet.
4. With the pin height properly adjusted, position the rod on the tool and force the rod into the grommet until the groove in the rod seats on the inner retaining lip of the grommet. For areas with limited space, use Shift Linkage Grommet Replacer T84P-7341-B for grommet installation.

Park/Neutral Position Switch (PNP), C6

Removal and Installation

1. Raise vehicle on hoist and position suitable safety stands under vehicle.
2. Remove the downshift linkage rod from the downshift lever at the transmission.
3. Remove the two switch retaining bolts.
4. Disconnect the wiring harness from the sensor.
5. Position the new PNP to the transmission and insert suitable PNP alignment tool into the aligning notches in the switch. Adjust the PNP alignment tool until all three notches are in alignment.
6. Proceed to bolt the sensor into place to the case. The tool should remain engaged until switch is securely bolted in place. Tighten bolts to 6-8 N-m (53-70 in-lb)
7. Remove the adjusting tool and connect the wiring harness to the switch.
8. Confirm proper alignment visually. The line etched in the actuator should be in a straight line with the line etched in the housing when the switch is centered in the neutral position.
9. Remove safety stands and lower the vehicle.



D4823-D



Park Neutral Position Switch, AOD and E4OD

For neutral start switch removal and installation procedures, refer to Section 07-01C or Section 07-01A.




ADJUSTMENTS

Perform the transmission control linkage or cable adjustments in the order in which they appear in this section. Before the linkage or cable is adjusted, the shift lever indicator flag must be checked as detailed in Section 11-04A or Section 11-04B. Be sure the engine idle speed is within specification.

Automatic Transmission Manual Linkage Adjustments, Motorhome and Commercial Stripped Chassis Only

1. With the engine stopped and the parking brake applied, place the transmission selector lever at the steering column in the  (OVERDRIVE position) E4OD applications, and hold against the  stop by applying a three-pound force to the selector lever knob.

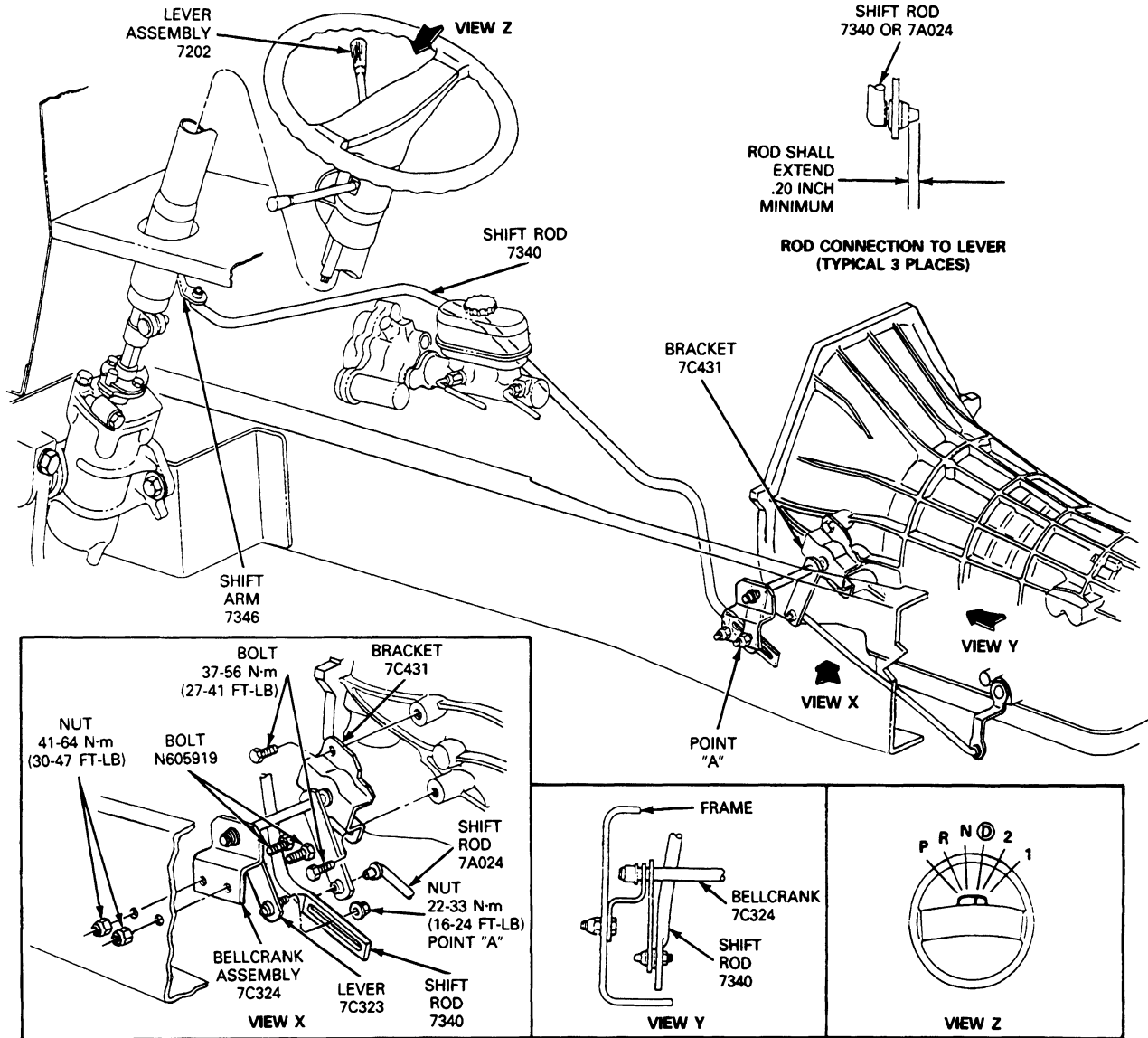
NOTE: Motorhome and Commercial Chassis vehicle columns are almost vertical so hanging a weight on the shift select lever would have little to no effect while making the adjustments. Application of a three-pound force can be accomplished by the use of an elastic strap such as a bungy cord.

2. Loosen the shift rod adjusting nut at point A. Refer to the following illustrations.
3. Shift the manual lever at the transmission into the  (overdrive) position for E4OD, by moving the lever all the way rearward, then forward two detents.
4. With the selector lever and transmission manual lever in the  position, tighten the nut at point A to 17-24 N·m (12-18 ft-lb) torque. Use care to prevent motion between the stud and rod.
5. Remove the three-pound force from the steering column selector lever knob.
6. Operate the shift lever in all positions to make certain that the manual lever at the transmission is in full detent in all gear ranges. Re-adjust the linkage if required.
7. On F-Super Duty Motorhome and Commercial Chassis vehicles recheck for correct operation of the automatic transmission selector indicator (PRN21). Refer to Section 11-04A.

CAUTION: Under no circumstances will it be permissible to adjust linkage in any position other than the  position for E4OD applications.

ADJUSTMENTS (Continued)

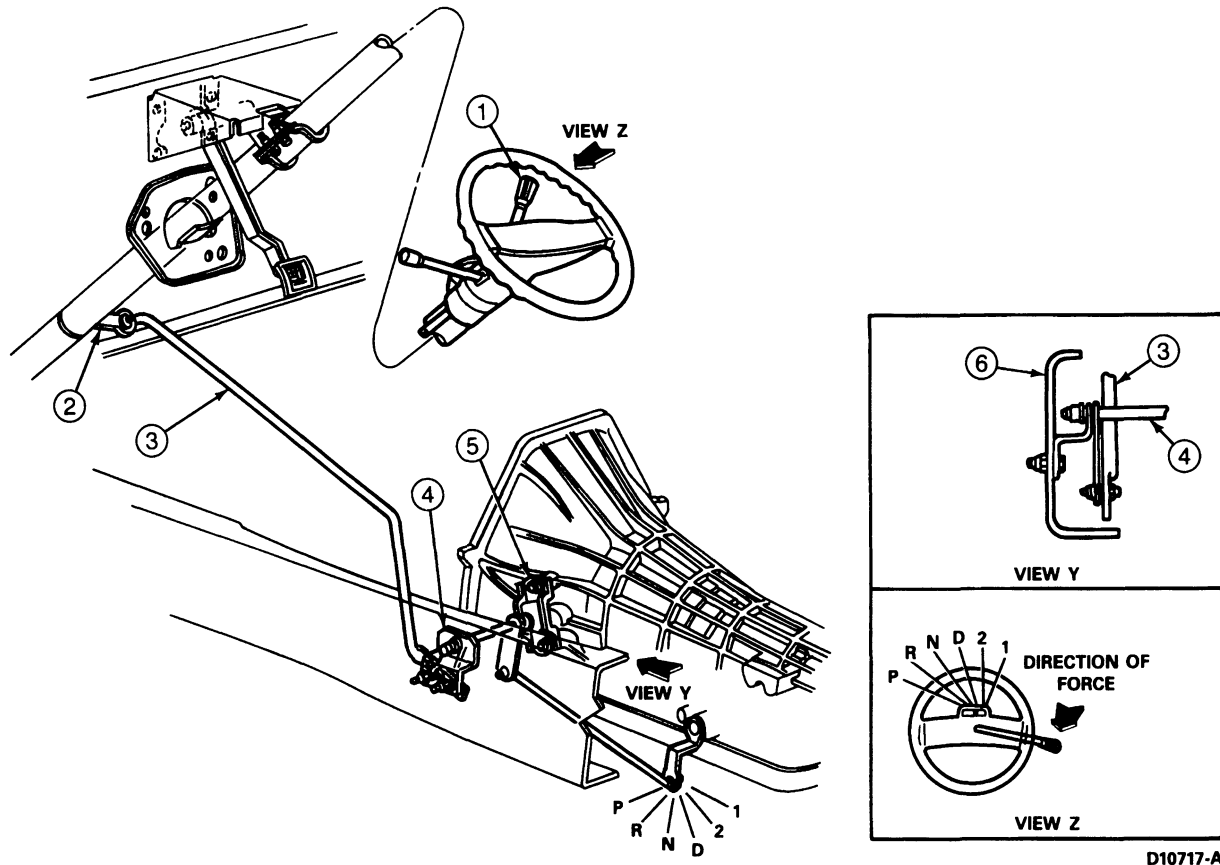
Shift Linkage Adjustment, F-Super Duty Motorhome, E4OD Automatic Transmission, 7.5L



D7881-28

ADJUSTMENTS (Continued)

Shift Linkage Adjustment, F-Super Duty Commercial Chassis, E40D Automatic Transmission and 7.3L Diesel



D10717-A

Item	Part Number	Description
1	7202	Lever Assembly
2	7346	Shift Arm
3	7340	Rod, Transmission Gearshift
4	7C324	Bell Crank Assembly, Transmission Shift

(Continued)

Item	Part Number	Description
5	7C431	Bracket Assembly, Transmission Shift Bell Crank
6	5005	Frame Assembly (Reference)

TD10717A

Automatic Transmission Shift Cable Adjustment

- From inside the vehicle, place the column shift select lever in the DRIVE position (C6) or the OVERDRIVE position (AOD and E4OD). Hang a three-pound weight on the selector lever.
- Raise vehicle on a hoist and position suitable safety stands under vehicle.
- Remove the shift cable from the transmission lever ball stud.
- Pull down the lock tab on the shift cable body.

- Position the transmission shift lever in the DRIVE position (C6) or the OVERDRIVE position (AOD and E4OD). This is three detents from the front-most lever position with the first position counting as one.
- Connect the cable end fitting to the transmission lever ball stud.
- Push up on the lock tab to lock the cable in the correctly adjusted position.
- Remove safety stands and lower vehicle from hoist. Remove the three-pound weight from the column shift select lever.

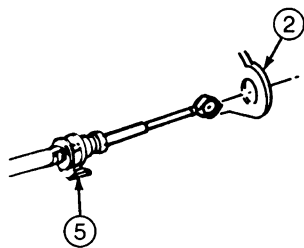
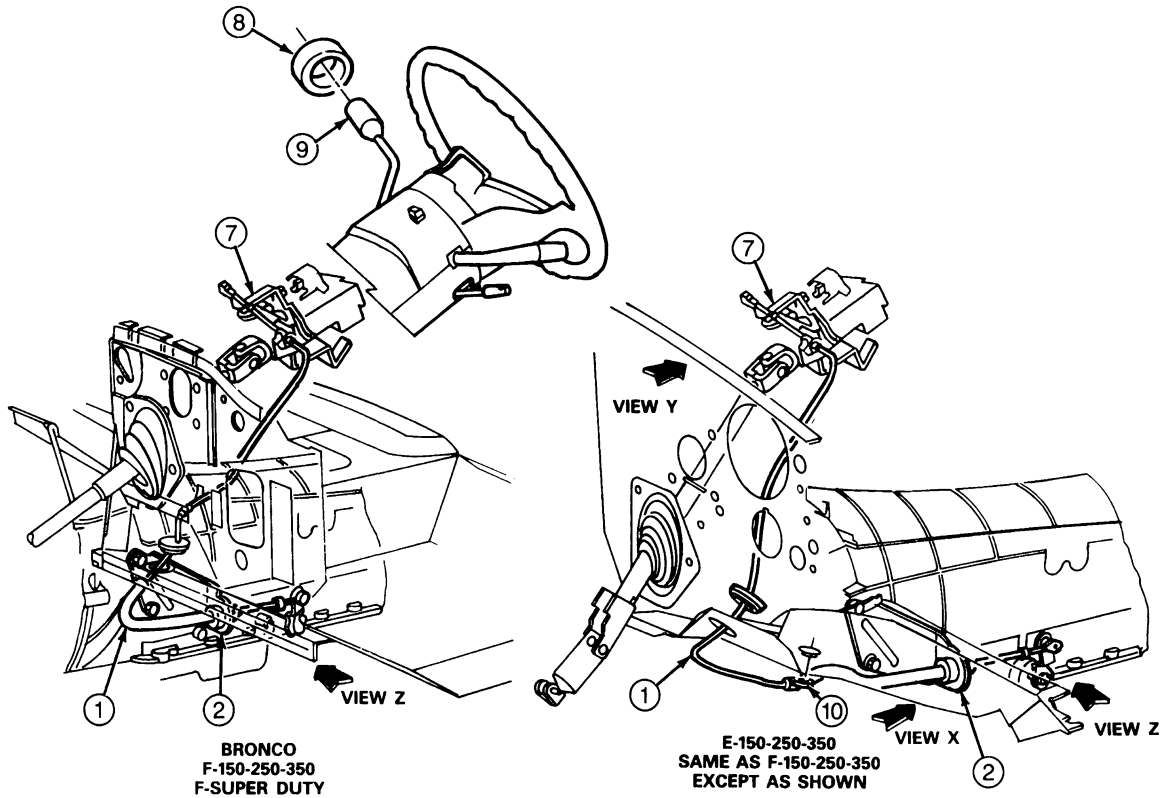
ADJUSTMENTS (Continued)

9. After making the adjustment, check for park engagement. Check the transmission control lever in all detent positions with the engine running to make sure correct detent / transmission actions. Readjust if necessary.

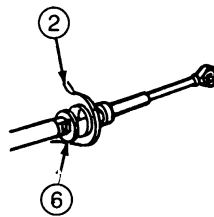
CAUTION: Under no circumstances will it be permissible to adjust the cable in any position other than D (drive) for the C6 transmission or Ⓞ (overdrive) for the E4OD transmission.

ADJUSTMENTS (Continued)

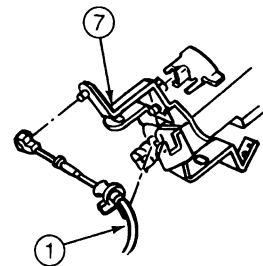
Shift Cable, Automatic Transmission, F-150-250-350, F-Super Duty Except Motorhome and Commercial Stripped Chassis, E-150-250-350 and Bronco



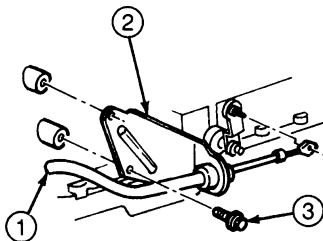
UNLOCKED
VIEW X



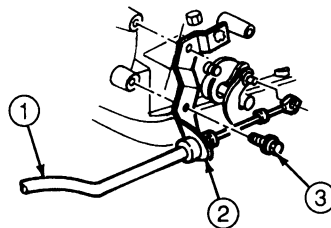
LOCKED
VIEW X



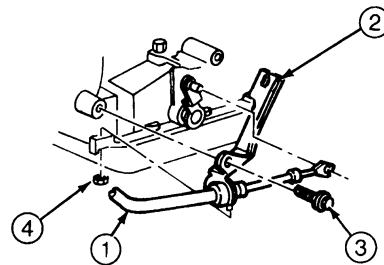
VIEW Y



W/E40D AUTO TRANS
VIEW Z



W/C6 AUTO TRANS
VIEW Z



W/AOD AUTO TRANS
VIEW Z

D9966-B

ADJUSTMENTS (Continued)

Item	Part Number	Description
1	7E395	Cable Assembly, Transmission Shift
2	7B229	Bracket, Transmission Control Cable
3	56137-S100	Bolt 3 / 16-16 x .62 Hex Flange Head
4	N801555-S2	Nut and Washer M8-1.25 Hex (Attaches 7B229 to Transmission)
5	—	Lock Mechanism (Part of 7E395 Cable) Shown Unlocked

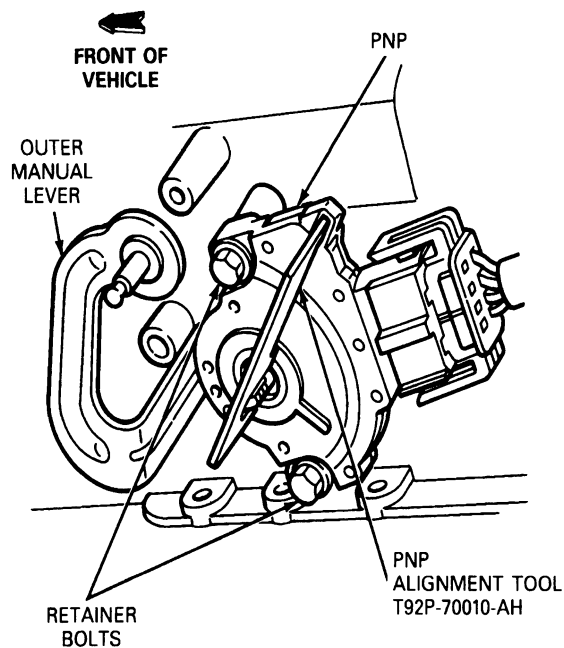
(Continued)

Item	Part Number	Description
6	—	Lock Mechanism (Part of 7E385 Cable) Shown Locked
7	3C529	Lever Assembly (Part of Steering Column Assembly)
8	—	Three Pound Weight (To Be Improvised in Shop)
9	7202	Lever, Gear Shift Selector
10	—	Clip (E-Series with 7.3L or 7.5L and Auxiliary Air Conditioning Only)

TD9966A

Park / Neutral Position Switch Adjustment, C6

1. Apply the parking brake.
2. With the automatic transmission linkage properly adjusted, loosen the two switch attaching bolts.
3. Place the transmission selector lever in neutral. Rotate the switch and insert switch T92P-70010-AH into the three notches in the PNP Alignment Tool. Rotate PNP if required to align all three notches. Tool should remain engaged while tightening retainer bolts.
4. Tighten the two PNP switch attaching bolts to 6-8 N·m (53-70 in-lb). Remove the alignment tool from the switch.
5. Check the operation of the switch. The backup lamps should come on when the transmission is in reverse. The vehicle should start only with the transmission lever in "PARK" or "NEUTRAL".

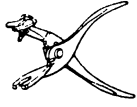




D4823-D

SPECIFICATIONS**TORQUE LIMITS**

Description	N·m	In-Lb
Park / Neutral Position Switch	6-8	53-70

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T67P-7341-A Shift Linkage Insulator Tool	 T67P-7341-A
T84P-7341-A Shift Linkage Grommet Remover	 T84P-7341-A
T84P-7341-B Shift Linkage Grommet Replacer	 T84P-7341-B

SECTION 07-07 Transfer Case, 4x4 System, General

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS.....	07-07-17	DIAGNOSIS AND TESTING	
DESCRIPTION AND OPERATION		Diagnosis of the Electronic Shift 4x4 Transfer	
Electronic Shift Operation	07-07-7	Case	07-07-13
Mechanical Operation.....	07-07-3	VEHICLE APPLICATION	07-07-1
Operating in 4WD.....	07-07-8		
Transfer Case, Chain-Driven	07-07-1		

VEHICLE APPLICATION

F-150-250-350 (4x4), and Bronco Vehicles with Manual Shift Transfer Case. All Bronco and F-150 4x4 Vehicles with Electronic Shift Transfer Case Only.

DESCRIPTION AND OPERATION

Transfer Case, Chain-Driven

The Borg-Warner 13-56 is a chain-driven transfer case in which the shifts may be activated electrically or mechanically. The basic functions of this system are much the same as any other 4x4 transfer case. With the electronic shift transfer case, by touching the control switch on the instrument panel, the driver can select either 2- or 4-wheel high plus 4-wheel low range, if conditions require. With the manual shift transfer case, speed selection is controlled by a single-lever shift mechanism that provides neutral, 2-high, 4-high and 4-low.

The Borg-Warner 13-56 manual shift transfer case is a three-piece transfer case. The case is magnesium, except for F-350 applications which have an aluminum front case half and an opening for a power take-off (PTO). It is a part-time transfer case for a power take off. The unit is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft and allows towing of the vehicle without disconnecting the rear driveshaft.

The input shaft, front output shaft, four-wheel drive indicator switch, and shift lever are located on the front case half. The rear output shaft, output shaft bearing retainer (or slip yoke-type bearing retainer), and drain and fill plugs are located on the rear case half. Two types of bearing retainers are used: a rear fixed output circular flange and a slip-yoke type.

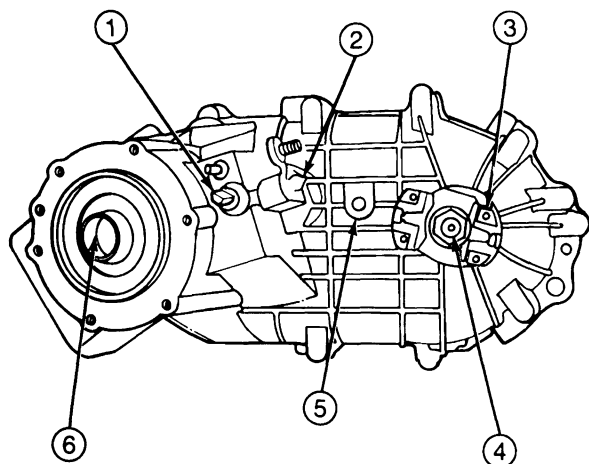
The Borg-Warner 13-56 electronic shift transfer case is used on Bronco and F-150 4x4 vehicles as an option. The transfer case transfers power from the transmission to the rear axle, and also to the front axle when electronically actuated.

The Borg Warner 13-56 electronic shift transfer case is a three-piece magnesium part-time transfer case. It transfers power from the transmission to the rear axle and, when actuated, also the front drive axle. The unit is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft and allows towing of the vehicle at maximum legal road speeds for extended distances without disconnecting the front and/or rear driveshaft.

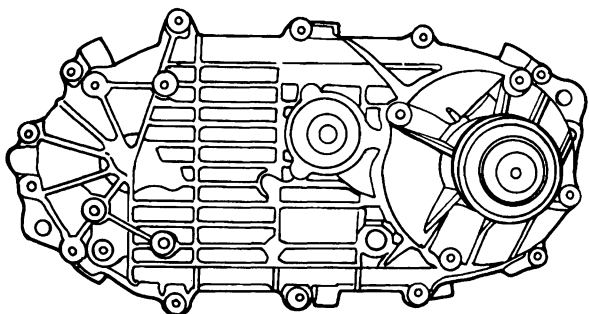
NOTE: It is important to consult the vehicle owner's guide before towing any 4x4. There are speed and distance restrictions that vary from vehicle to vehicle.

DESCRIPTION AND OPERATION (Continued)

Borg-Warner 13-56 Manual Shift Transfer Case



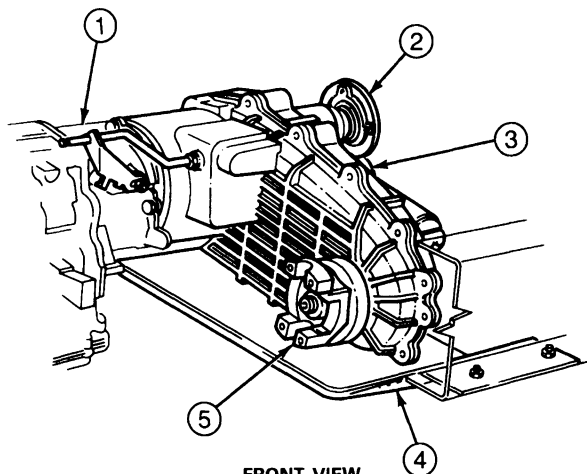
FRONT VIEW

BORG-WARNER 13-56 — MANUAL SHIFT
TRANSFER CASE — REAR

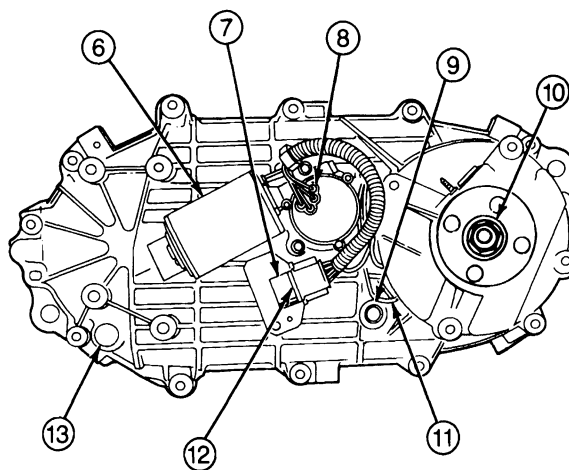
C7860-C

Item	Description
1	Four-Wheel Drive Indicator Switch
2	Shift Lever
3	Front Output Shaft Yoke
4	Front Output Shaft
5	Fill Plug For PTO Use (F-350 Only)
6	Front Input Shaft

Borg-Warner 13-56 Electronic Shift Transfer Case



FRONT VIEW



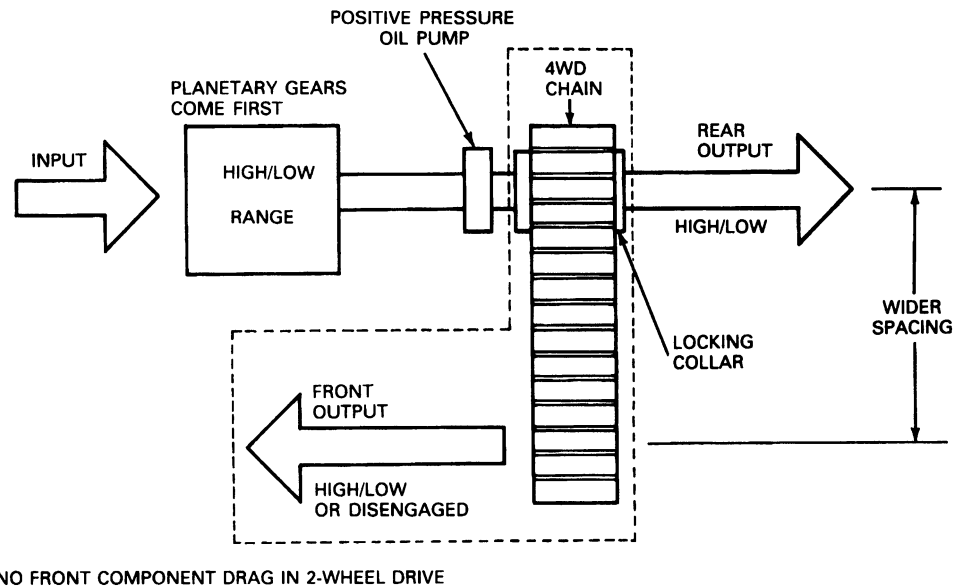
REAR VIEW

C7427-D

Item	Description
1	Transmission and Extension Housing
2	To Rear Axle
3	Transfer Case
4	Skid Plate
5	To Front Axle
6	Electric Shift Motor
7	Wiring Connector Mounting Bracket
8	Shift Position Sensor
9	Fill Plug
10	Rear Output Flange
11	Speed Sensor
12	Wiring Harness Connector
13	Drain Plug

DESCRIPTION AND OPERATION (Continued)

NOTE: It is important to remember that electronic shift transfer cases do not have a selectable neutral position. Because of this, if vehicles equipped with electronic shift are to be towed for long distances, the rear drive shaft should be disconnected. If this is not done, the transfer case (which is protected by positive lubrication) will drive the transmission, which is not lubricated when the vehicle is towed, and may cause damage to the transmission.

Chain-Drive Advantages

C11430-A

Mechanical Operation

In the 4x2 mode, torque from the transmission is transferred to the front input shaft, which in turn drives the output shaft that drives the rear axle.

The 2W-4W shift is accomplished when the 2W-4W shift fork moves the 2W-4W lockup collar to engage the drive sprocket on the rear output shaft splines. The drive sprocket turns the chain which turns the front output shaft driven sprocket on the front output shaft and the front driveshaft.

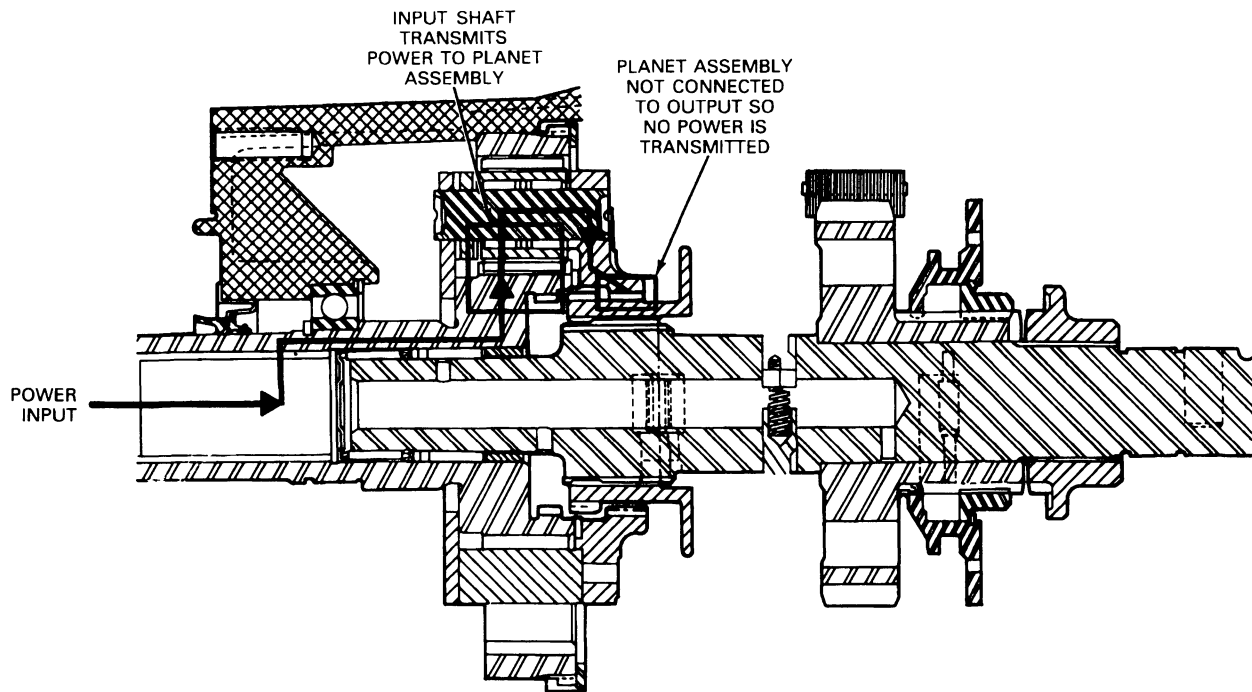
The high-low shift is accomplished when the high-low shift fork moves the high-low lockup collar to engage the planetary gear set assembly to the output shaft. Torque for the input shaft is then transmitted through the sun gear, which then turns the planetary gear set. The planetary gear set, which is now engaged to the output shaft, provides a reduction.

Neutral

With the shift selector in neutral, no power is transmitted to either front or rear. All the planetary gears turn freely with the input shaft, and the chain sprocket floats freely on the output shaft.

DESCRIPTION AND OPERATION (Continued)

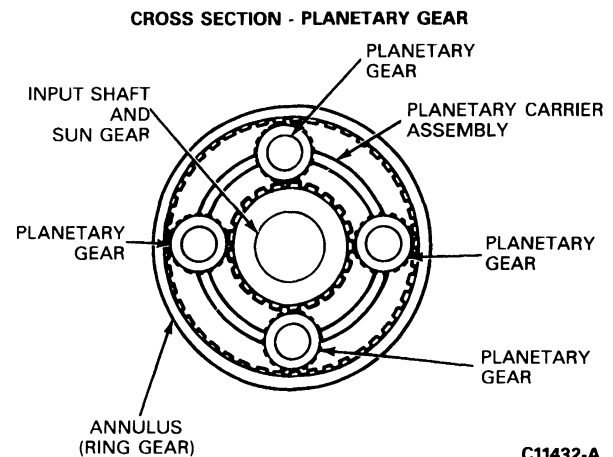
Power Flow in Neutral



C11438-A

The following illustration shows a cross-section of the planetary gear set. At the center, attached to the input shaft, is the sun gear. This gear meshes with four gears that surround it like planets (which is why this component is called a planetary gear). In turn, the four gears mesh with an outer gear called the annulus. (Annulus is another word for ring.)

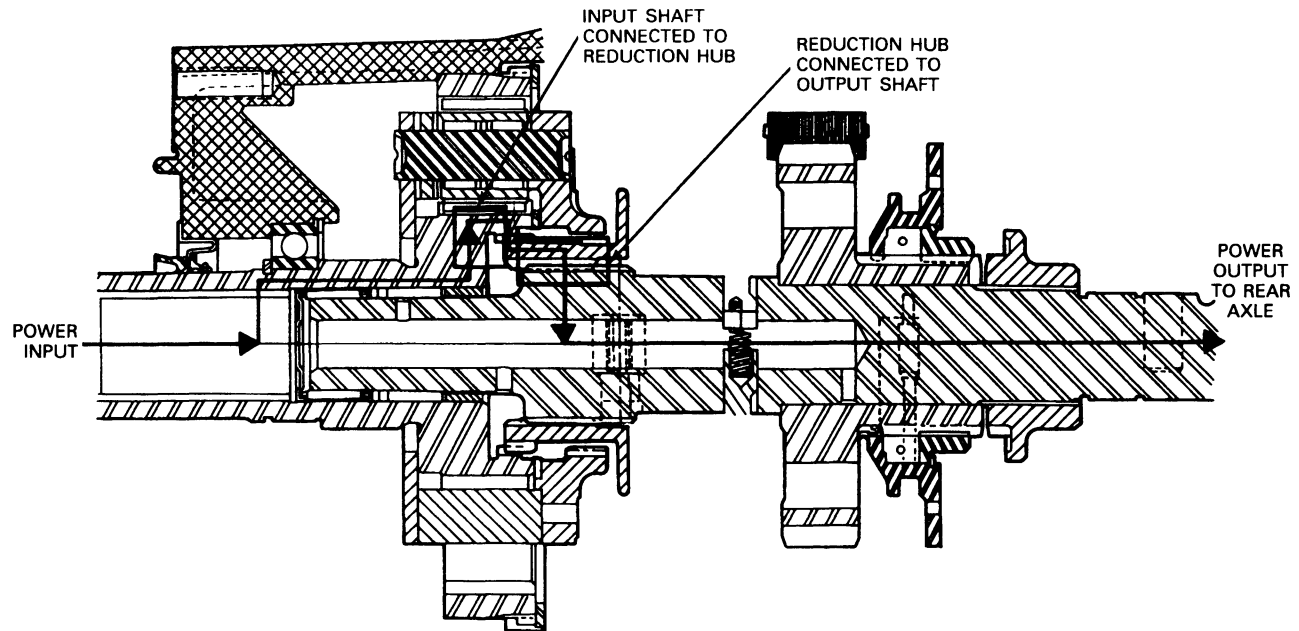
As the sun gear turns, the four planetary gears attempt to rotate. If the output shaft is locked to the planetary gear (as it is in low gear), the planetary gears "walk" around the inside of the annulus providing a gear reduction. If the output shaft is locked to the sun gear (as in high gear), the input and output shafts rotate as a single unit.



C11432-A

2-Wheel Drive — High Range

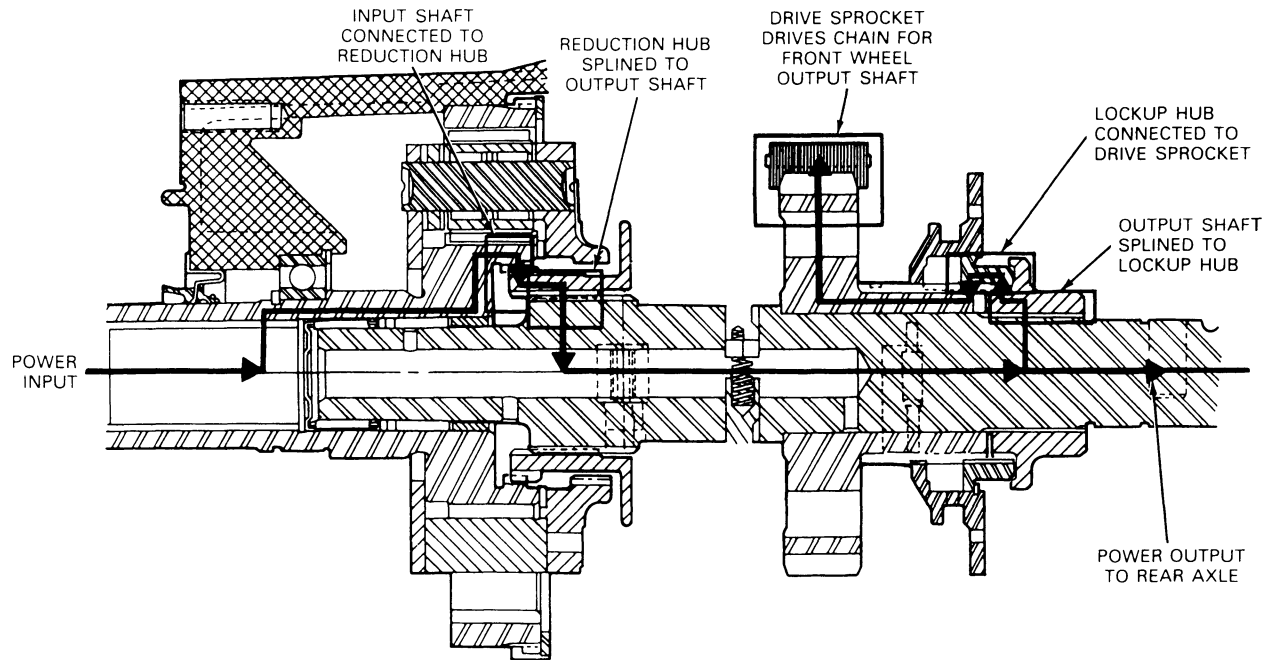
When the driver selects 2H, the reduction hub at the center of the planet carrier assembly slides forward, putting the transfer case into the high speed range (direct drive). The input shaft and the rear output shaft are locked together. This results in direct drive, straight through to the rear driveshaft. In addition, the 4-wheel drive locking collar is disengaged so none of the 4WD components turn.

DESCRIPTION AND OPERATION (Continued)**Power Flow in 2H**

C11439-A

4-Wheel Drive — High Range

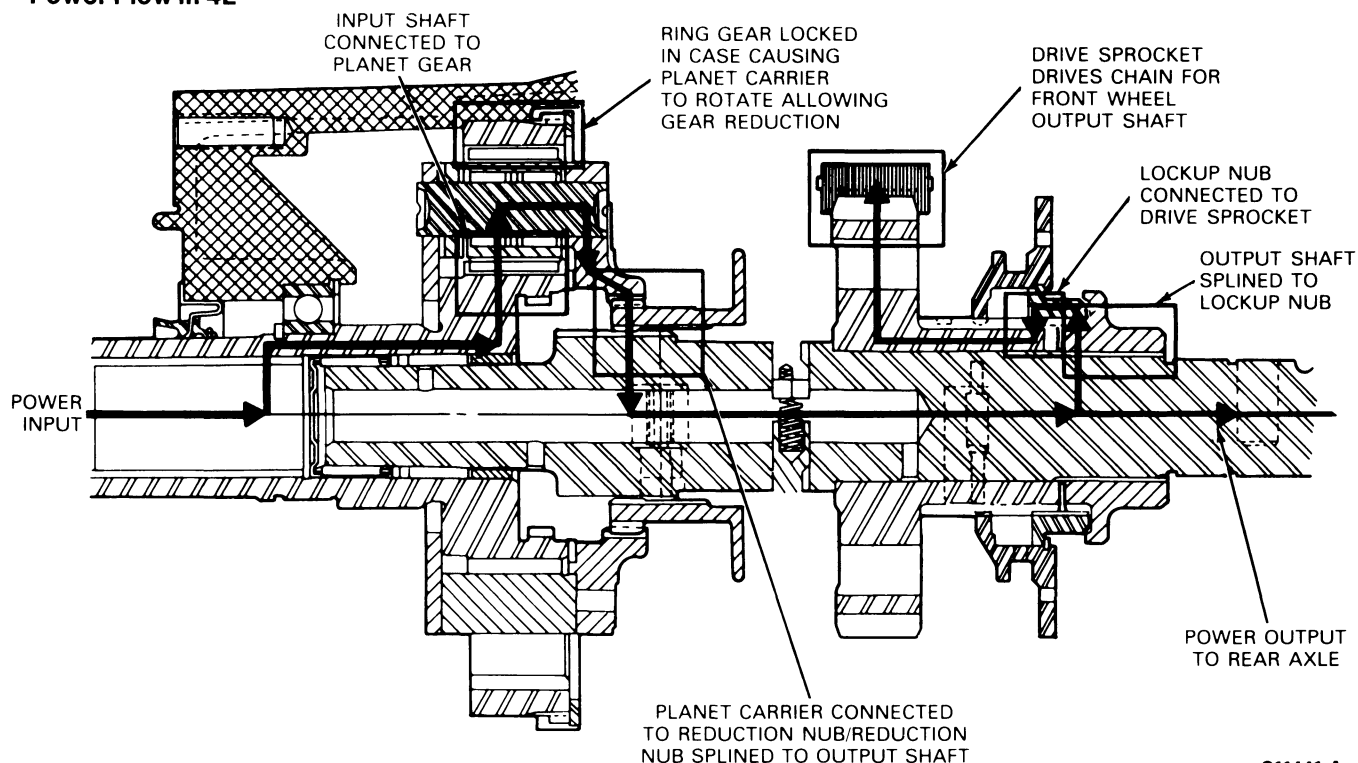
In 4-wheel drive — high range (4H), the planet carrier assembly stays where it was in the 2H shift. The action of the shift lever causes the 4-wheel drive lockup hub to move rearward, locking the chain sprocket to the rear output shaft. Now, both the rear and the front wheels are being driven in the high range.

DESCRIPTION AND OPERATION (Continued)**Power Flow in 4H**

C11440-A

4-Wheel Drive — Low Range

To get maximum pulling power, the driver selects 4L. When this happens, the reduction hub moves rearward, and the planet carrier assembly is locked to the output shaft. With the annulus unable to turn, the planetary gears “walk” around the inside. The result is that the planet carrier assembly now turns more slowly than the input shaft. Because the planet carrier assembly is now locked to the output shaft, the output shaft now rotates at a slower speed than the input shaft. This action increases the pulling power available to the wheels. It's like having an additional set of lower gears for extra power.

DESCRIPTION AND OPERATION (Continued)**Power Flow in 4L**

C11441-A

Electronic Shift Operation

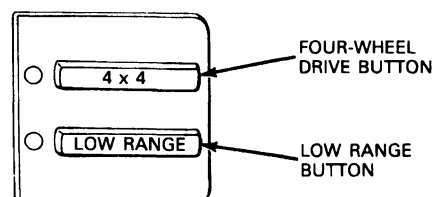
The transfer case is equipped with a magnetic clutch, similar to an air conditioning compressor clutch, which is located inside the transfer case adjacent to the 2W-4W shift collar. The clutch is used to spin up the front drive system from zero to vehicle speed in milliseconds. This spin-up allows the shift between 2-high and 4-high to be made at vehicle speeds listed in the vehicle owner's guide. The spin up engages the front lock hubs. When the transfer case rear and front output shafts reach synchronous speed, the spring-loaded shift collar mechanically engages the mainshaft hub to the chain drive sprocket and the magnetic clutch is then deactivated. Shifts between 4-high and 4-low can only occur with the transmission safety switches closed. The vehicle's speed must also be within specified limits as determined by the transfer case speed sensor (3 mph or under).

Electronic Shift Control System

This system consists of a two-switch control system, an electronic control module, an electric shift motor with an integral shift position sensor, and a speed sensor.

Switch Control System

There are two control switches located on the upper right corner of the instrument panel for fingertip shift control. The two switches are mounted horizontally and are identified as "4x4" and "LOW RANGE". Two indicator bar lamps are located in the instrument cluster.

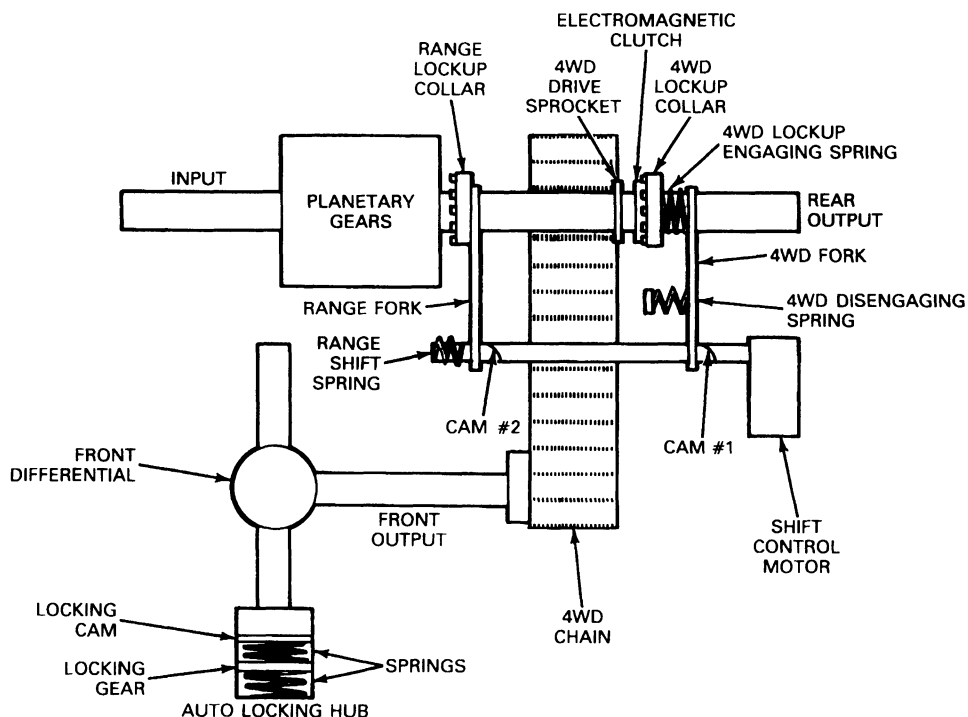


C11148-A

When either of the two switches on the instrument panel control are depressed, the first thing that happens is that the electronic control module receives input from the transfer case shift position sensor to verify what position the transfer case is in (2H, 4H or 4L). Next, the electronic control module looks at the speed sensor and the park / neutral position switch or clutch pedal position switch (depending on transmission type). If all conditions are correct to allow the desired shift, the electronic control module will tell the electric shift motor to execute the shift. After the shift has been made and the electric shift motor is off, the control module again looks at the shift position sensor to make sure the proper shift has been accomplished. Finally, the dash indicator light and the pushbutton light on the control panel will be illuminated by a signal from the electronic control module indicating the desired function has been completed.

DESCRIPTION AND OPERATION (Continued)

Electronic Shift Transfer Case



C11461-A

Electronic Control Module

The electronic control module, located on the right cowl side, controls the operation of the transfer case in response to inputs to the pushbutton control by the vehicle operator, the speed sensor, shift position sensor and the park / neutral position switch.

Speed Sensor

The speed sensor, mounted on the rear of the transfer case, tells the electronic control module the speed of the vehicle to allow range shifts (in or out of 4L) to occur.

Shift Position Sensor

The shift position sensor, an integral part of the electric shift motor, tells the electronic control module the shift position of the transfer case.

Electric Shift Motor

The electric shift motor, mounted externally at the rear of the transfer case, drives a rotary helical cam which moves the 2W-4W shift fork and 4H-4L reduction shift fork to the selected vehicle drive position.

Operating in 4WD

Locking Hubs

There are two types of front hubs available for 4x4 vehicles.

- Manual (or free-running) that require the driver to get out of the cab to either lock or unlock them.
- Automatic locking (which lock automatically when the axle shaft begins to turn).

Manual (free-running) hubs feature seals that prevent entry of dirt and moisture and are very simple to operate. Automatic locking hubs use the front axle shaft rotation to actuate a cam that locks and unlocks the hub. Locking hubs may be locked at any time, and can be left in the locked position all the time, if desired.

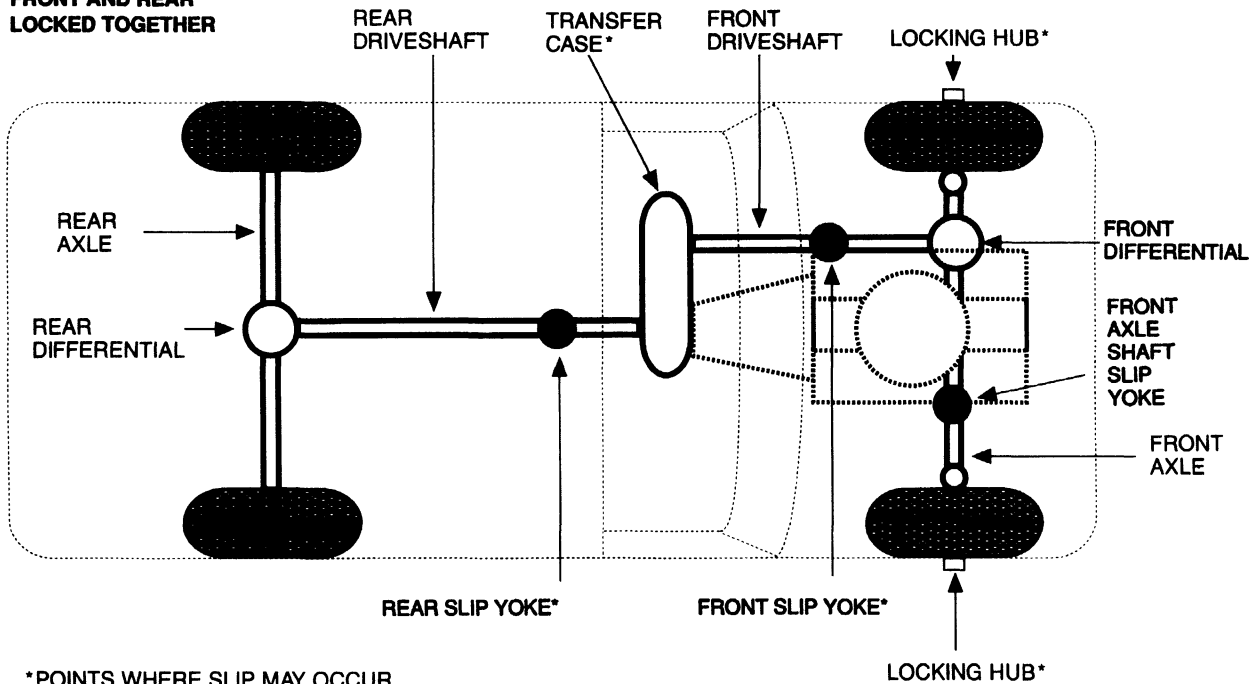
On vehicles equipped with a manual shift transfer case and manual locking hubs, low range can be selected when the vehicle's front hubs are unlocked. This is useful for short distances if very low, creeper gearing (but not 4WD) is needed. Refer to Section 04-01B for diagnosis, testing and repair procedures.

In 4WD, the front hubs are locked (either automatically or manually). As a result, the front wheels are **no longer free to turn independently**. The front and rear driveshafts are also now locked together and must turn as one. What's going to happen when the vehicle turns? That's a very important question.

In 4WD, just as in 2WD, each front wheel travels further than the rear wheel on its side. But this time, the front wheels aren't free to turn independently of the rear wheels. They are linked to the drivetrain by the transfer case and front driveshaft.

DESCRIPTION AND OPERATION (Continued)

Points of Possible Slippage, Four-Wheel Drive

FRONT AND REAR
LOCKED TOGETHER

TB-2464-A

Even though difference between the inner and outer front wheels are compensated for by a front differential, torsional windup is still going to occur. Anytime one driveline component travels further than another, there will be driveline or torsional windup that must be released.

4WD in a 4x4 provides increased drive traction and performance in off-road situations and when driving on snow or ice. **It is not** designed for operation on dry surfaces and when traction is good. **It is not** suitable on dry paved roads or dry parking lots. It is this difference, between where 4WD should and shouldn't be used, that gives us the answer to what releases the driveline or torsional windup.

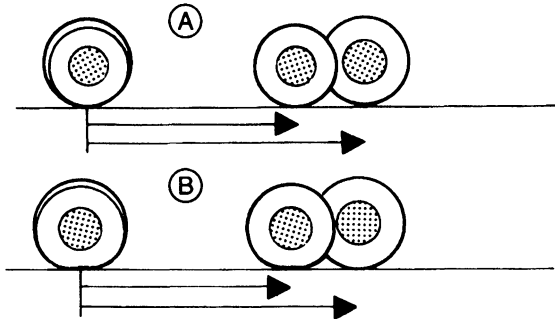
When a 4x4 is driven off-road in 4WD, the wheels are in contact with dirt, sand and sometimes mud. The vehicle is also likely to bounce over bumps and ruts. In turns under these conditions, driveline or torsional windup will occur. If it does, the loose dirt or sand or the slippery mud will allow wheels to slip a little, limiting the windup. Tension is also relieved when the wheel bounces in the air going over a bump. Snow and ice will also allow the wheels to slip and limit the windup.

When operating in 4WD on dry hard pavement, even more torsional windup occurs, and it isn't easily released. When the windup becomes great enough, the driver will feel the vehicle hop, skip or bounce. This is caused by the front or rear wheels slipping as the windup is released. Whichever wheels have the least traction are the ones that will slip. The tighter the turn, or the greater the traction, the greater the hop, skip or bounce. It is this torsional driveline windup that is the cause of many owner complaints concerning the performance of their 4x4.

It is important to remember the effect of tire size, inflation, wear and loading. The following illustration shows that tires of even slightly different sizes roll different distances every revolution. The same effect is true for tires that are the same size but inflated or loaded differently. Operating a 4x4 in 4WD with tires of different size or inflation will produce driveline or torsional windup, even when driving straight ahead. If the vehicle is being driven in 4WD on dry, hard pavement, the driver will notice drag and may experience the hop, skip, bounce effect as the front or rear wheels release the windup.

DESCRIPTION AND OPERATION (Continued)

Tire Rolling Differences Due to Size and Inflation Pressure



C11462-A

4x4 Vehicle — Driveline Windup

Driveline windup does more than just produce hop, skip and bounce. It can also cause delays in shifting out of 4WD. Vehicles with electronic shift transfer case permit shifting from 2WD to 4WD and back on the fly. The vehicle must be stopped and the automatic transmission put in neutral (not park) or the manual transmission clutch depressed in order to shift from 4H to 4L or back.

Windup and Delay — Shifting Out of 4WD

A delay or a failure to shift out of 4WD may be the result of driveline windup or extremely cold temperatures. In 4WD, windup can develop, especially if the vehicle is operated on hard, dry surfaces or in tight turns. The driver may select 2WD, but the shift doesn't take place even though the 4WD light goes out. Also, as long as the transfer case doesn't shift, the hubs remain locked and the vehicle remains in 4WD. If windup in the transfer case is severe, even backing up may not release it.

In order to return to 2WD under these conditions, two things must happen. First, if the transfer case doesn't shift right away, the vehicle will have to be driven in 4WD until the windup is relieved or until the axle warms up. Second, when it does make the shift, the driver will have to stop the vehicle and go straight in the reverse direction for at least ten feet to unlock the hubs.

NOTE: To determine if driveline windup is causing delayed shifts to 2WD, jack the vehicle or lift it on a hoist with the wheels free to rotate. This should release the driveline windup, if it is present, and the transfer case will complete its shift, if windup is the problem.

NOTE: Vehicles vary in terms of how "tight" they are. Some vehicles have a lot of "give" in the system. Softness in suspension and mounts will allow the driveline to absorb more windup before it affects performance. If driveline windup occurs, the system will tighten like a giant rubber band until the tires start slipping. A "tight" vehicle will signal the windup sooner, usually by a lot of chattering noises.

DIAGNOSIS AND TESTING

1. Road test the vehicle to verify the problem, noting road speed, engine speed, speed range where the vehicle problem is evident.

NOTE: Owner driving habits as well as road and weather conditions should be noted.

2. Raise the vehicle on a hoist and position suitable safety floor stands under the vehicle.
3. Run the vehicle at the road speed and in the axle drive mode (4WD / 2WD) where problem exists. Verify problem area:

- Engine
- Clutch / Transmission
- Transfer Case
- Front / Rear Driveline Components
- Front / Rear Drive Axles
- Front / Rear Brake Systems
- Front Axle Locking Hubs
- Front / Rear Wheels and / or Tires

NOTE: If the problem area is indicated to be other than the transfer case, refer to the specific section or sections of the appropriate shop manual.

4. Refer to the appropriate owner's guide for operating data, if the problem is verified to be driveline or torsional windup, before servicing the transfer case assembly.

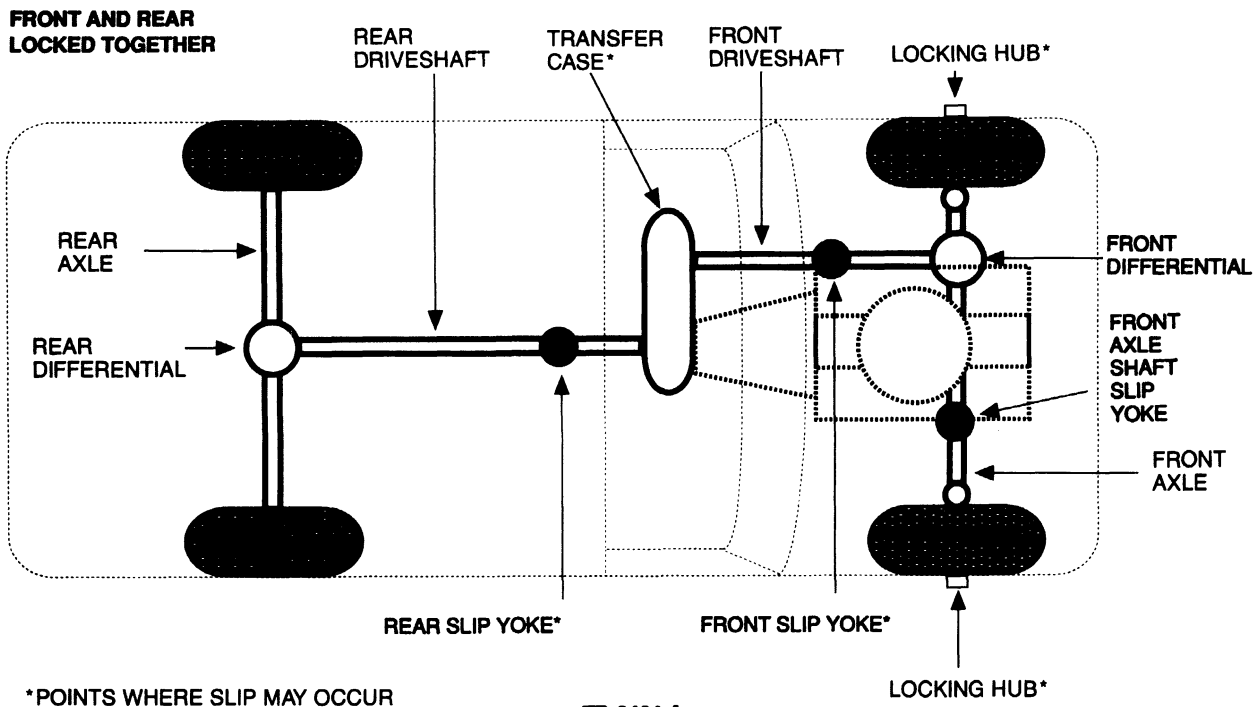
DIAGNOSIS AND TESTING (Continued)

DIAGNOSIS, TRANSFER CASE		
CONDITION	POSSIBLE SOURCE	ACTION
Transfer case makes noise.	<ul style="list-style-type: none"> ● Incorrect tire inflation pressures and/or incorrect size tires and wheels. ● Excessive tire tread wear. ● Internal components. 	<ul style="list-style-type: none"> ● Assure that all tires and wheels are the same size, and that inflation pressures are correct. ● Check tire tread wear to see if there is more than .06 inch difference in tread wear between front and rear. Interchange one front and one rear wheel. Re-inflate tires to specifications. ● Operate vehicle in all transmission gears with transfer case in 2H, or Hi range. ● If there is noise in transmission in neutral gear, or in some gears and not in others, remove and repair transmission. ● If there is noise in all gears, operate vehicle in all transfer case ranges. If noisy in all ranges or Hi range only, disassemble transfer case. Check input gear, intermediate and front output shaft gear for damage. Replace as required. If noisy in LO range only, inspect intermediate gear and sliding gears for damage. Replace as required.
4-wheel drive transfer case jumps out of gear.	<ul style="list-style-type: none"> ● Incomplete shift linkage travel. ● Loose mounting bolts. ● Front and rear driveshaft slip yokes dry or loose. ● Internal components. 	<ul style="list-style-type: none"> ● Adjust linkage to provide complete gear engagement. Adjust shift lever boot. ● Tighten mounting bolts. ● Lubricate and repair slip yokes as required. Tighten flange yoke attaching nut to specifications. ● Disassemble transfer case. Inspect sliding clutch hub and gear clutch teeth for damage. Replace as required.
Locking hubs will not release.	<ul style="list-style-type: none"> ● Driveline / vehicle torsional lockup. ● Extremely cold ambient temperatures. 	<ul style="list-style-type: none"> ● Stop vehicle. Drive vehicle in reverse for 10 feet. ● Drive vehicle 10 miles to warm axle, then try to disengage hub locks.
Driveline / torsional windup. Vehicle hop, wheel / tire bounce, vehicle skip.	<ul style="list-style-type: none"> ● Incorrect tire inflation pressures and/or incorrect size tires and wheels. ● Excessive tire tread wear. ● Driving vehicle on hard surface / dry surface roads or areas. Driving vehicle in tight turns. 	<ul style="list-style-type: none"> ● Assure that all tires and wheels are the same size, and that inflation pressures are correct. ● Refer to vehicle owner's guide for correct usage of vehicle. Advise owner.
Delayed shifts to 2WD.	<ul style="list-style-type: none"> ● Driveline / torsional windup. ● Extremely cold ambient temperatures. 	<ul style="list-style-type: none"> ● Shift transmission into neutral. ● Jack the vehicle or lift on hoist with wheels free to rotate. Windup will be released and transfer case will complete its shift. ● Drive vehicle 10 miles to warm axle, then try to disengage hub locks.

TC11464A

DIAGNOSIS AND TESTING (Continued)

5. If the 4WD system slips under load, find what has broken or is slipping. To locate where slip is taking place, put marks at various possible slip points. Test drive the vehicle, then check to see if marks at different points are still in the same relationship to each other. This will indicate where the slippage is taking place or where to look for broken parts, if any.
 - a. On vehicles with auto hubs, find a suitable place where the vehicle can be tested. Mark the components, then drive vehicle without backing up. Stop and check the marks to see if they are in the same relationship to each other. If the vehicle is backed up before checking these marks, the hubs may re-index and not reveal the problem.

Points of Possible Slippage, Four Wheel Drive

TB-2464-A

6. Check tires and vehicle loading if the problem is clearly driveline windup and not broken parts.
7. If the transfer case shift control motor operates properly and nothing happens, or if a manual shift lever fails to shift the transfer case it will have to be serviced. Be sure driveline windup has been eliminated as a cause.

8. Driveline noise may be experienced if a vehicle is operated in 2WD with the hubs locked. This occurs because the 4WD components are in motion instead of at rest (the normal condition in 2WD with the hubs unlocked). However, it is important to remember that excessive noise may be a sign of a serious problem.

NOTE: A problem can arise if the vehicle is equipped with a limited slip front axle and the front tires are worn differently or are slightly different sizes. In this case, operating in 2WD with hubs locked can result in steering pull like a limited slip rear axle. This will disappear when the hubs are unlocked.

DIAGNOSIS AND TESTING (Continued)

Maintenance of the hubs is important. Easy shifting from one operating position to the other requires smooth movement of the inner clutch ring. This ring slides on splines which must be clean and well lubricated. To prevent dirt and water from entering the hub unit, the oil seals must be very carefully installed. If the vehicle is operated where the hub is constantly submerged in water or mud, the hubs should be serviced more frequently. The important thing is not to run for long periods with dirt and water in the hubs. Start with a short service interval and check for water and dirt. Stretch out the interval as experience shows how dirty they are actually getting.

Diagnosis of the Electronic Shift 4x4 Transfer Case

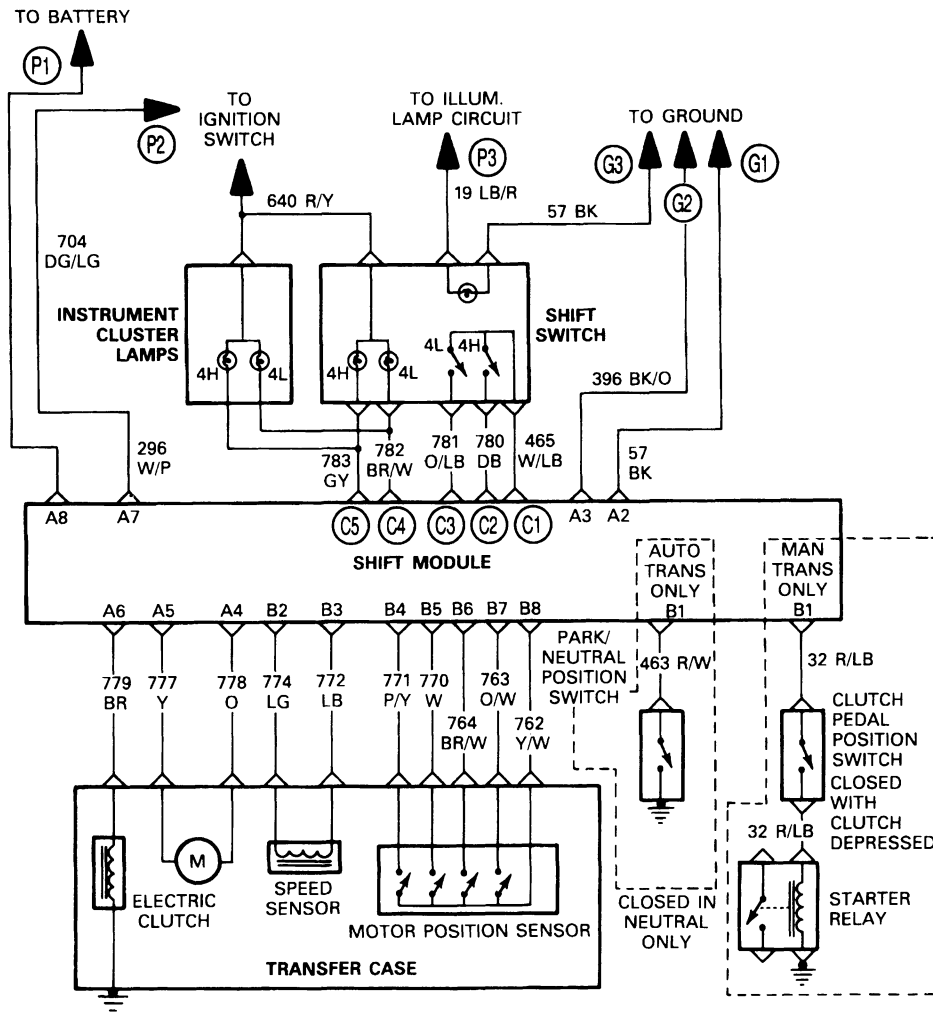
1. Nothing happens (dead system).

2. No range shift.
3. Attempt to shift into 4H from 2H or 4L results in the module clicking and chattering and the system stops in 2H.
4. At start up, the vehicle shifts on its own.
5. Indicator lights don't register the correct information.
6. Shifting on the fly isn't smooth and may require stopping in order to complete the shift.

All these conditions can be best understood by taking a close look at a schematic of the electrical system.

DIAGNOSIS AND TESTING (Continued)

Electronic Shift Transfer Case Schematic



C11442-A

Power In

Power is supplied to the system at three points (P1, P2 and P3 in schematic).

P1. This is a direct connection to the battery. This power drives the electric shift control motor and provides current to the instrument cluster lamps. This circuit goes to ground G1.

P2. The electronic shift control module is tied into the ignition circuit. This circuit provides power to the computer and goes to ground G2.

P3. Nighttime illumination is provided by a connection to the vehicle's nighttime illumination circuit, which goes to ground G3.

The electronic shift control module directs power depending on the position of the control switches. In the schematic, you will notice that inputs and outputs to and from the shift module are labeled A, B or C. A circuits are power circuits, B circuits are data circuits from sensors and C circuits are activating switch and related lamp circuits.

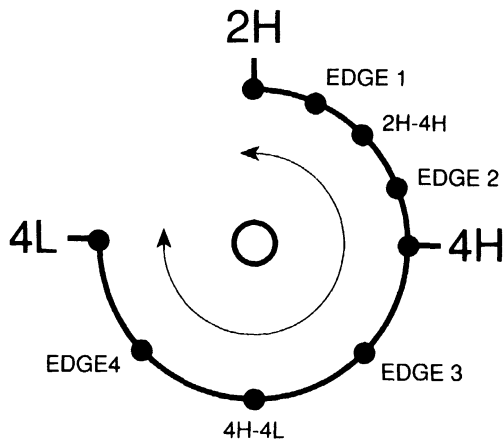
The B circuits supply data from three sources: The speed sensor, the motor position sensor and either a park / neutral position switch (for automatic transmissions) or a clutch pedal position switch (for manual transmissions).

The speed sensor is important because the vehicle must be stopped for a shift into or out of 4L. The shift module won't make the shift if the vehicle is moving. The shift module also won't make a shift to 4L or back unless an automatic transmission is in neutral or the clutch is depressed on a manual transmission.

DIAGNOSIS AND TESTING (Continued)

The motor position sensor indicates the position of the shift motor shaft. This shaft turns through approximately 270° and should stop at three indexed points, 2H, 4H and 4L. The shift control module needs to know where the shaft is before making a new shift. When this sensor isn't functioning properly or the motor stops slightly off location, the shift control module may become "confused."

SHIFT MOTOR ROTATION

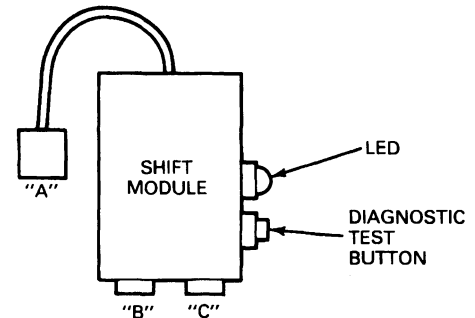


TB-2467-A

The C circuits involve the switches on the vehicle's control panel. When everything is working properly, activating a switch will result in either a shift from 2H to 4H or back, or a shift from 4H to 4L or back. The default operating mode is 2H. This means that in the absence of other instructions, the shift control module will assume that the vehicle should be in 2H. If there is a failure in the system during shifts or engine start up, it will default the vehicle to 2H and permit continued operation.

Nothing Happens (Dead System)

The obvious first step in diagnosing a dead system is to check the power sources, fuses and grounds. If these check out, perform the shift control module diagnostic test. The following illustration shows the module with pigtail A, B and C attachments. The diagnostic test button and diagnostic test LED are located on the side of the shift control module.



C11436-A

Disconnect the B and C connectors, turn on the ignition and allow 4 seconds for the module to power up. Then push the diagnostic test button. If the LED doesn't illuminate, the module is dead and must be replaced. If the LED comes on and stays on for 30 seconds, there is an error condition and the module will have to be replaced. If the module is OK the LED will flash 4 times.

During the test, the vehicle isn't operating, so the shift control module isn't receiving data and initiating shifts. If the unit passes the diagnostic test, it's probably a good module. Check for other probable causes, although the module may need to be replaced even after passing the diagnostic test.

Sensors

Check the three sensors with the ignition on. The transmission sensors (manual or automatic) should be closed with the clutch in, or the automatic shift in neutral. The speed sensor should show 225-275 ohms with the vehicle stopped. Check at the module connection.

Check both the motor position sensors and the wiring harness at B4, B5, B6 and B7 and the input from B8. Make sure the harness is OK, then check the contacts against the following chart. Each valid combination of open and closed switches indicates a different position of the motor. For example, at the 4H position, B7 is closed, B6 is closed, B5 is open and B4 is open. Besides the three main positions (2H, 4H and 4L), intermediate positions are also shown — three between 2H and 4H and three between 4H and 4L. Combinations other than those shown in the chart indicate a defective motor sensor assembly.

DIAGNOSIS AND TESTING (Continued)

Shift Motor Positions

SHIFT MOTOR POSITIONS

MOTOR POSITION	2H	EDGE 1	2H-4H	EDGE 2	4H	EDGE 3	4H-4L	EDGE 4	4L
DASH AND SWITCH LIGHTS	NO	NO	NO	NO	4H ON	4H ON	4H ON	4H ON	4H & 4L ON
MECH. POSITION	2H	2H	2H	4H	4H	4H	NEUTRAL	4L	4L
B7	OPEN	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN
B6	CLOSED	CLOSED	OPEN	CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	OPEN
B5	OPEN	OPEN	OPEN	OPEN	OPEN	CLOSED	CLOSED	CLOSED	CLOSED
B4	CLOSED	CLOSED	CLOSED	CLOSED	OPEN	OPEN	OPEN	CLOSED	CLOSED

1. Three or more open readings in any position means something is wrong with the motor and sensor assembly.

2. In Edge 2, if you push 4H the motor moves to the 4H position and the light comes on.

3. If the motor is in Edge 3, 4H-4L or Edge 4 at start up, it will want to shift to 4H. But this shift requires that the vehicle must be stopped and the clutch depressed or the automatic transmission in neutral. Until these conditions are met and the shift is completed, pushing buttons won't do anything.

CC11437-A

Check Transfer Case Shift Motor

To check if the transfer case shift motor is actually functioning (because it may be hard to hear it in a noisy shop) attach a voltmeter to A4 and A5. Have someone activate a shift and look for a brief (one second) increase in voltage and listen for the relay to click on, then off.

If there is power present, then the control module is trying to run the motor. At this point, unbolt the motor and have someone activate a shift again. If the motor doesn't actually turn, it is malfunctioning and must be replaced.

If there is no power to the motor, check both the power circuits again and the sensors. **If there is incorrect sensor data, the module won't power the motor.**

Check Shift Switches

If the problem isn't in the sensors or the motor, check the control panel switches. Make this check with the ignition on. Disconnect the B and C connections to the sensors, so that their data won't confuse the diagnosis. Now check power at the C1 connection at the module. There should be 5 volts coming from the shift control module to the 4H and 4L switches. Check C1, C2, and C3 for short to ground.

Check the switches themselves by disconnecting C1 and checking continuity across C1 to C2 and C1 to C3. If current passes when the switch buttons are pushed, the switches are OK.

Finally, check for a short between C2 and C3 by bridging between them and activating the 4H and 4L buttons. There are situations where wiring harnesses get crushed in such a way that two wires are crushed together and short, even though there is no short to ground.

Check Lamps

To check the lamps, turn the ignition on and ground C4 and C5. The lamps should light.

No Range Shift

If the vehicle won't shift into 4L, check the speed sensor and the transmission interlocks (neutral or clutch in). Also check the 4L switch (C3) to see if the module is getting a signal. Check for corroded connections.

If the vehicle won't shift back to 4H, follow the proper sequence of being stopped and having the vehicle in neutral (or clutch in) when pushing the switch. Check the 4L switch and the motor position sensor.

Shift From 2H to 4H Results in Chatter and Clicking Noises From the Module, But No Shift

Typically, in this situation the motor hunts for 4H, but overshoots, then hunts back and overshoots the other way. After 7-10 seconds, the module returns to the default, which is 2H. This problem is normally not the sensor input. It is usually the result of the motor running too fast or braking too slowly to allow the module to position it accurately. The motor must be replaced.

DIAGNOSIS AND TESTING (Continued)**At Start Up, the Vehicle Shifts On Its Own**

This can occur when the motor position sensor indicates an intermediate position between 4H and 4L. If the vehicle is started in park instead of neutral, when the driver first moves the transmission shift lever to drive, the transmission passes through neutral. As it passes through neutral, the shift module activates the shift called for by the misinformation from the motor position sensor. On manual transmissions or automatic transmissions started in neutral, the shift occurs immediately.

This may be a one-time only event. However, the motor position sensor should be checked if it happens frequently.

Indicator Lights Don't Register the Correct Information

If the dash lights don't respond, check for no power or a burned-out bulb. If the lights are on all the time, check for a short to ground. Check to see if the shift control module is activating them all as this is a malfunction.

If no lights illuminate as you go through the shifts and ground power and bulbs are good, then the module is at fault or the motor has stopped at an intermediate point.

Shifting on the Fly Isn't Smooth and May Require Stopping in Order to Complete the Shift

Look for problems with the electric magnetic clutch. If the ratcheting or grinding goes on for more than four seconds, there may be a problem with power to the clutch from the shift control module, the clutch ground or the clutch itself. Check the wiring harness as well.

ADJUSTMENTS

Refer to Section 07-00, Section 07-07A, or Section 07-07B for diagnosis and testing of transfer case shifting or operating problem.

SECTION 07-07A Transfer Case, Electronic Shift

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		DIAGNOSIS AND TESTING (Cont'd.)	
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VEHICLE APPLICATION

All Bronco and F-Series 4x4 Vehicles with Automatic Transmissions

DESCRIPTION AND OPERATION

Transfer Case

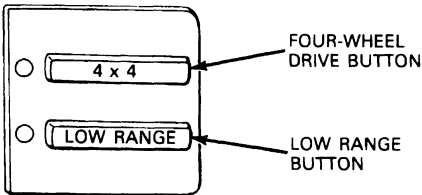
The Borg-Warner 13-56 Electronic Shift Transfer Case is used on Bronco and F-150 4x4 vehicles with automatic transmission. The transfer case transfers power from the transmission to the rear axle, and also to the front axle when electronically actuated.

Electronic Shift Control System

This system consists of a two-switch control system, an electronic control module, an electric shift motor with an integral shift position sensor, and a speed sensor.

Switch Control System

There are two control buttons located on the upper right corner of the instrument panel for fingertip shift control. The two buttons are mounted horizontally and are identified as "4x4" and "LOW RANGE". Two indicator bar lamps are located in the instrument cluster.



C11148-A

Electronic Control Module

The electronic control module, located on the right cowl side, controls the operation of the transfer case in response to inputs to the pushbutton control by the vehicle operator, the speed sensor, shift position sensor and the neutral safety switch.

Speed Sensor

The speed sensor, mounted on the rear of the transfer case, tells the electronic control module the speed of the vehicle to allow range shifts (in or out of 4L) to occur.

Shift Position Sensor

The shift position sensor, an integral part of the electric shift motor, tells the electronic control module the shift position of the transfer case.

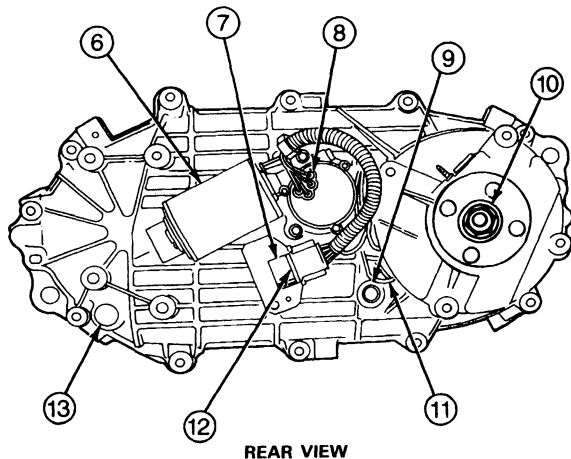
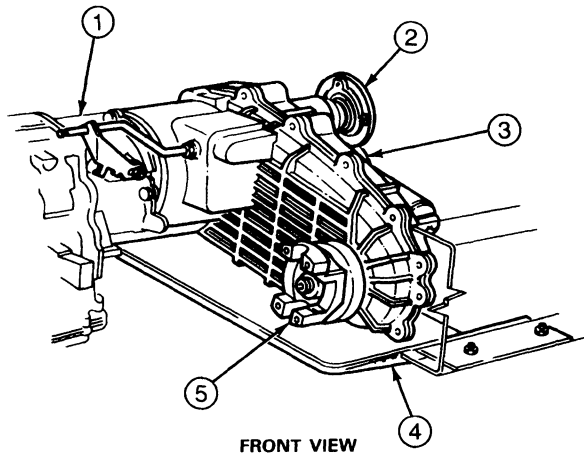
Electric Shift Motor

The electric shift motor, mounted externally at the rear of the transfer case, drives a rotary helical cam which moves the 2W-4W shift fork and 4H-4L reduction shift fork to the selected vehicle drive position.

DESCRIPTION AND OPERATION (Continued)

Neutral Safety Switch

Vehicles equipped with automatic transmissions use a neutral safety switch which is located on the left side of the transmission. Its purpose when dealing with electronic shift transfer cases is to allow range shifting only when the transmission is in the NEUTRAL position.



C7427-D

Item	Description
1	Transmission and Extension Housing
2	To Rear Axle
3	Transfer Case
4	Skid Plate
5	To Front Axle
6	Electric Shift Motor
7	Wiring Connector Mounting Bracket
8	Shift Position Sensor
9	Fill Plug
10	Rear Output Frame
11	Speed Sensor
12	Wiring Harness Connector
13	Drain Plug

Mechanical Operation

In the 4x2 mode, torque from the transmission is transferred to the front input shaft, which in turn drives the rear output shaft that drives the rear axle.

The 2W-4W shift is accomplished when the 2W-4W shift fork moves the 2W-4W lockup collar to engage the front drive sprocket on the output shaft splines. The front drive sprocket turns the chain, which turns the front output shaft driven sprocket on the splined front output shaft and the front driveshaft.

The high-low shift is accomplished when the high-low shift fork moves the high-low lockup collar to engage the planetary gearset assembly to the output shaft. Torque from the input shaft is then transferred through the sun gear, which then turns the planetary gearset. The planetary gearset, which is now engaged to the output shaft, provides the gear reduction.

The unit is lubricated by a positive displacement oil pump that channels oil through the bores in the transfer case output shaft.

Electronic Shift Operation

The transfer case is equipped with a magnetic clutch, similar to an air conditioning compressor clutch, which is located inside the transfer case adjacent to the 2W-4W shift collar. The clutch is used to spin up the front drive system from zero to vehicle speed in milliseconds. This spin-up allows the shift between 2-high and 4-high to be made at any vehicle speed. The spin up engages the front lock hubs. When the transfer case rear and front output shafts reach synchronous speed, the spring-loaded shift collar mechanically engages the mainshaft hub to the chain drive sprocket and the magnetic clutch is then deactivated. Shifts between 4-high and 4-low can only occur with the transmission safety switches closed and the vehicle at a full stop.

When a control switch on the instrument panel is depressed, the electronic control module will analyze certain input information and, if all the design conditions are met, the electronic control module will command the electric shift motor to execute the desired function. The inputs required by the electronic control module are from the:

- transfer case shift position sensor to verify its current position
- speed sensor information to verify the vehicle speed
- neutral safety switch position to verify whether the transmission is in the proper shift range for transfer case shifting to occur

After the shift takes place and the motor is turned off, the electronic control module will again look at the inputs from the shift position sensor to determine if the transfer case is in the position that the operator selected. Finally, the electronic control module will illuminate the shift indication lights located on the electronic switch control and the instrument panel to indicate that the desired function has been completed.

DESCRIPTION AND OPERATION (Continued)

When the operator selects the drive combination through the pushbutton control, an electric motor turns a helical cam, which is linked to the high-low and 2W-4W shift forks through fork-mounted roller bushing assemblies. As the electric motor turns the helical cam, the high-low fork bushing rides in a slotted lobe in the cam to make the low-high or high-low range change; and the 2W-4W fork bushing rides on lobes at the end of the cam to make the 2W-4W or 4W-2W shift.

DIAGNOSIS AND TESTING

Mechanical Operations

For mechanical diagnosis and testing procedures, refer to Section 07-00B.

Electric Shift Operations

If the system operates improperly, or will not operate at all, a problem could exist in a control switch, the electronic control module, the speed sensor, the electric shift motor, the electro-magnetic clutch assembly, neutral safety switch or the interconnecting wiring.

Use the following guidelines and test procedures to assist in locating the cause of a problem.

Circuit Protection

The battery feed circuit, through a circuit breaker, provides memory capability for the electronic control module.

Ignition RUN feed circuit, through a fuse, provides power for the switches and the electric shift motor.

The circuit provides power for nighttime illumination of the switches located in the instrument panel.

Control Module Self-Test

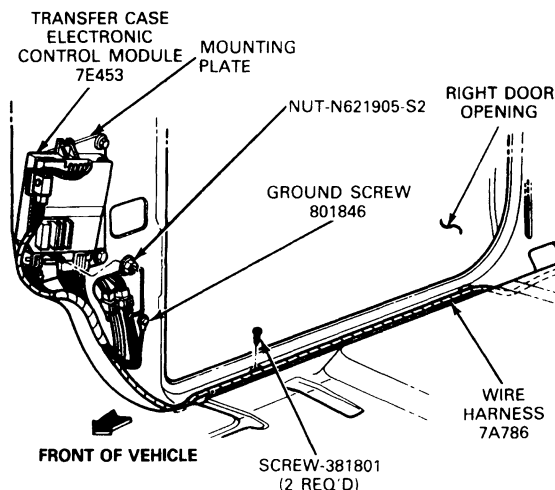
The electronic control module has a diagnostic capability of its own circuitry. The self-test procedure is as follows:

1. Remove the five-wire connector and the eight-wire connector from the bottom of the electronic control module.
2. Turn the ignition switch to the RUN position.
3. Activate the self-test switch located on the module and note the result: a flashing indicator lamp (approximately one flash per second) indicates that the control module is functioning properly. A steady indicator lamp indicates that the control module is inoperative and must be replaced.

Control Module Circuits

There are three wiring harnesses connected to the electronic control module: the eight-wire pigtail harness connector; the five-wire harness connector; and the eight-wire harness connector.

To check the integrity of these circuits, disconnect the harnesses from the electronic control module and perform the following checks.



C7428-C

Eight-Wire Pigtail Harness Connector

1. Connect a voltmeter between terminal 8 and ground. The voltmeter should indicate battery voltage at all times.
2. Connect a voltmeter between terminal 7 and ground. Then turn the ignition switch to the RUN position. The voltmeter should then indicate battery voltage.

CAUTION: In the following sections where the use of an ohmmeter is specified, remember that an ohmmeter should NEVER be connected into a "live" or powered circuit. If the ohmmeter is subjected to a powered circuit, severe damage will be done to the instrument. The vehicle's battery should be disconnected before performing checks on any circuit with an ohmmeter to prevent any accidental damage to the instrument.

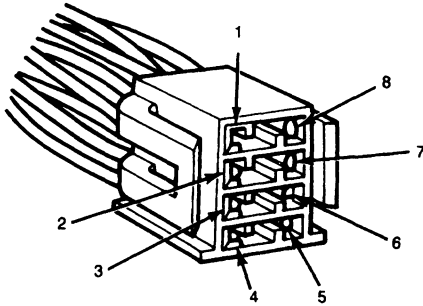
NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

NOTE: When connecting ohmmeter to ground, care must be taken to ensure good contact or false meter readings may result.

3. Connect an ohmmeter Rotunda Number 007-00001 or equivalent between terminal 6 and ground. The ohmmeter should indicate less than 10 ohms.
4. Connect an ohmmeter between terminals 4 and 5 of the wiring harness connector. The ohmmeter should indicate less than 10 ohms.

DIAGNOSIS AND TESTING (Continued)

5. Connect an ohmmeter between terminal 3 and ground. The ohmmeter should indicate 0 ohms.
6. Connect an ohmmeter between terminal 2 and ground. The ohmmeter should indicate 0 ohms.

EIGHT-WIRE PIGTAIL HARNESS CONNECTOR (E25B-14489-GB)

Position	Circuit Number	Color Code	Function
1	OPEN		
2	57	Blk	Ground
3	570	Blk	Logic Ground
4	778	Org	Transfer Case Motor Control (Clockwise) 2H-4H-4L
5	777	Yel	Transfer Case Motor Control (Counterclockwise) 4L-4H-2H
6	779	Brn	Electro-Magnetic Clutch (Feed)
7	296	Wht/Ppl	Ignition Run and Accessory Feed (Fused)
8	517	Blk/Wht	Battery Feed (Circuit Breaker)

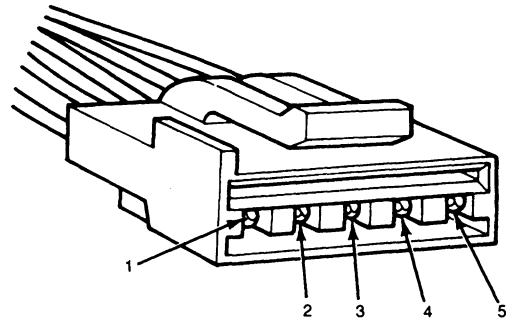
CC6599-B

Five-Wire Harness Connector

1. Connect an ohmmeter between terminals 1 and 2. Then depress the 4x4 (2H-4H) switch in the electronic switch control. The ohmmeter should indicate less than 50 ohms while the switch is being depressed.
2. Connect an ohmmeter between terminals 1 and 3. Then depress the LOW RANGE switch to the right of the steering column. The ohmmeter should indicate less than 50 ohms while the switch is being depressed.

NOTE: The next two checks are to be made with the battery cables connected securely to battery terminals.

3. Connect a test lead between terminal 4 and ground. Turn the ignition switch to the RUN position and observe the electronic switch control. The LOW RANGE indicator light should illuminate.
4. Connect a test lead between terminal 5 and ground. Turn the ignition switch to the RUN position and observe the electronic switch control. The "4x4" indicator light should illuminate.

FIVE-WIRE HARNESS CONNECTOR (D5LB-14489-CA)

Position	Circuit Number	Color Code	Function
1	465	Wht/Lt Blu	Switch Feed
2	780	Dk Blu	4x4 Switch
3	781	Org/Lt Blu	Low Range Switch
4	782	Brn/Wht	Low Range Light
5	783	Gry	4x4 Light

CC6600-1A

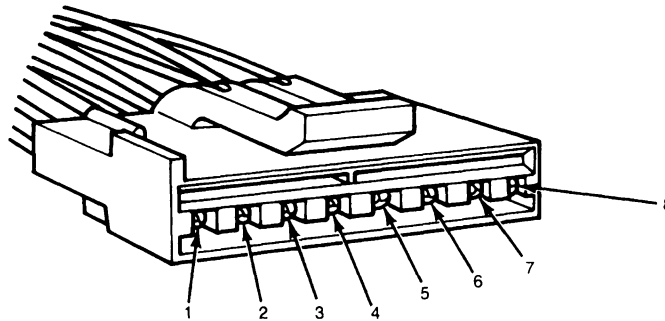
Eight-Wire Harness Connector

1. Connect an ohmmeter between terminal 1 and ground. Shift the transmission into the NEUTRAL position and observe the ohmmeter. The ohmmeter should indicate less than 50 ohms while the transmission selector lever is in the NEUTRAL position.
2. Connect an ohmmeter between terminals 2 and 3. The ohmmeter should indicate 200-350 ohms. This will check the continuity of the speed sensor that is located in the transfer case.

DIAGNOSIS AND TESTING (Continued)

3. Connect an ohmmeter between terminal 8 and terminals 4, 5, 6, and 7, respectively. Refer to the following chart for the appropriate ohmmeter readings in each transfer case position.

**EIGHT-WIRE HARNESS CONNECTOR
(E4EB-14489-SA)**



Position	Circuit Number	Color Code	Function
1	463	Red/Wht	Automatic Transmission Neutral Safety Switch
2	774	Lt Grn	Speed Sensor (Feed)
3	772	Lt Blu	Speed Sensor Return
4	771	Ppl/Yel	Wire #5, Contact Plate Position Sensor in Transfer Case
5	770	Wht	Wire #4, Contact Plate Position Sensor in Transfer Case
6	764	Brn/Wht	Wire #3, Contact Plate Position Sensor in Transfer Case
7	763	Org/Wht	Wire #2, Contact Plate Position Sensor in Transfer Case
8	762	Yel/Wht	Wire #1, Contact Plate Position Sensor in Transfer Case

OHMMETER READINGS FOR SHIFT MOTOR POSITION SENSOR

Ohmmeter Connection	Transfer Case Gear Position		
	2 High	4 High	4 Low
Meter Reading From Terminal #8 to #4	Short	Open	Short
Meter Reading From Terminal #8 to #5	Open	Open	Short
Meter Reading From Terminal #8 to #6	Short	Short	Open
Meter Reading From Terminal #8 to #7	Open	Short	Open
NOTE: SHORT (zero ohms). OPEN (infinity)			

CC6601-C

Main Feed Connector Circuits

The electronic "Touch Drive" four-wheel drive system main feed connector to the instrument panel harness connector is located near the middle of the instrument panel.

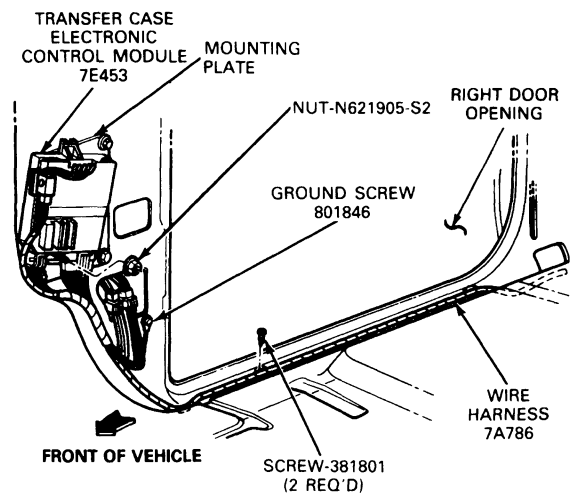
This connector contains the following inputs to the system:

1. The battery feed circuit through a circuit breaker provides memory capability for the electronic control module.
2. Ignition RUN feed circuit provides power through a fuse for the switches and the electric shift motor.

3. The neutral safety switch feed circuit provides input to the control module to help determine whether or not the low range position can be selected.
4. 4x4 indicator lamp to module.
5. 4x4 switch to module.
6. Low range indicator lamp.

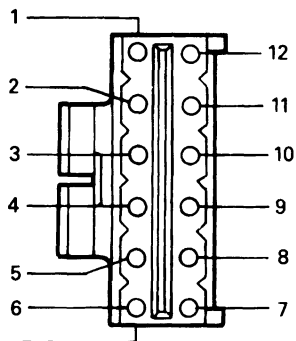
DIAGNOSIS AND TESTING (Continued)

7. The chassis ground circuit provides grounding capability for all of the system components except for the "logic ground" of the control module, which is grounded separately.



C7428-C

**MAIN FEED CONNECTOR
E83B-14489-FA**



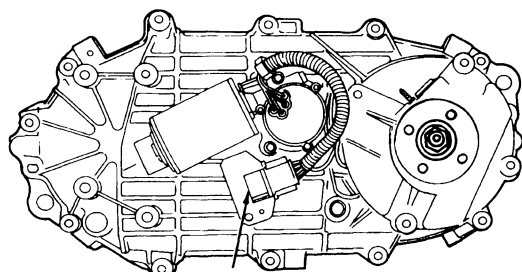
Position	Circuit Number	Color Code	Function
1	570	BK	Logic Ground
2	465	W-LB	Module to Switch
3	781	O-LB	Module to 4 Low Switch
4	782	BR-W	Low Range Indicator Lamp
5	296	W-P	Ignition Run and Accessory Feed
6	57	BK	Ground
7	780	DB	4x4 Switch
8	783	GY	4x4 Indicator Lamp
9	463	R-W	Automatic Transmission Neutral Start Switch
10	517	BK-W	Battery Feed
11	Not Used		
12	Not Used		

CC11149-A

DIAGNOSIS AND TESTING (Continued)

Transfer Case Feed Harness Circuits

The electric transfer case feed harness contains ten wires that carry a variety of signals to and from the electronic control module.



ELECTRONIC
TRANSFER
CASE
FEED
HARNESS

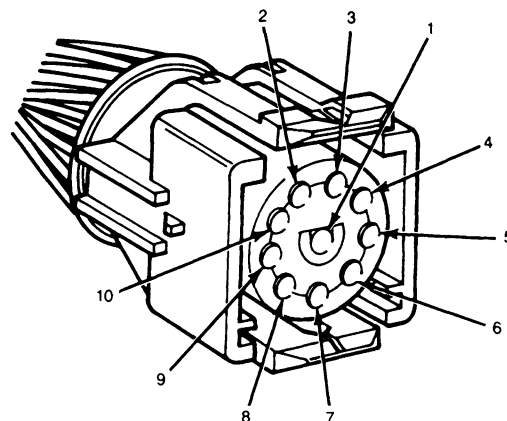
C7430-B

A listing of the transfer case feed harness circuits and their functions follows.

1. The electro-magnetic clutch feed circuit provides a power signal to the clutch coil, from the control module when shifting from 2W to 4W drive.
2. Clockwise rotation of the electric shift motor circuit provides power to drive the shift motor through the 2H-4H-4L sequence. If a position is selected that would require a shift through an intermediate position, the module will respond as if each intermediate position was selected, even if the 4L position was commanded from 2H. It will then fulfill all of the requirements for shifting into and out of each intermediate position.
3. Counterclockwise rotation of the electric shift motor circuit provides power to drive the shift motor through the 4L-4H-2H sequence. Actuation of the low range switch, while in 4L, will cause a shift to 4H. Actuation of the "4x4" switch, after a shift to 4H from 4L, will then cause a shift to 2H.
4. The speed sensor coil feed circuit provides a constant signal from the electronic control module to the speed sensor located in the transfer case.
5. The speed sensor coil return circuit provides a varying signal (while the vehicle is in motion) from the speed sensor to the electronic control module. This signal indicates the vehicle speed to the microprocessor so that it can control the application of the LOW RANGE gear selection in the transfer case.
6. The shift position sensor feed circuit provides a power signal from the electronic control module to the shift position sensor to energize the sensor.

7. Shift position sensor return circuits provide the output information signals from the transfer case to the electronic control module. This information gives the control module the correct position of the shaft that turns the helical cam in the transfer case.

ELECTRONIC TRANSFER CASE FEED HARNESS (E4DB-14489-AA)



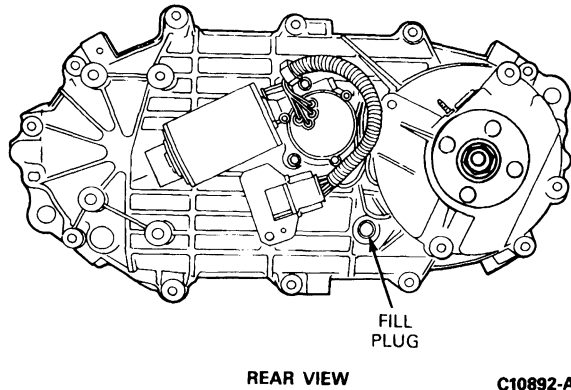
Position	Circuit Number	Color Code	Function
1	779	Brn	Electro-Magnetic Clutch (Feed)
2	778	Org	Transfer Case Motor Control (Clockwise) 2H-4H-4L
3	777	Yel	Transfer Case Motor Control (Counterclockwise) 4L-4H-2H
4	774	Lt Grn	Speed Sensor (Feed)
5	772	Lt Blu	Speed Sensor (Return)
6	771	Violet	Wire #5, Shift Position Sensor in Transfer Case (Output to Module)
7	770	Wht	Wire #4, Shift Position Sensor in Transfer Case (Output to Module)
8	764	Brn/Wht	Wire #3, Shift Position Sensor in Transfer Case (Output to Module)
9	763	Org/Wht	Wire #2, Shift Position Sensor in Transfer Case (Output to Module)
10	762	Yel/Wht	Wire #1, Shift Position Sensor in Transfer Case (Input from Module)

CC6608-1A

ADJUSTMENTS

Fluid Level Check

Remove the fill plug from the rear case. Fluid level should be just below the fill plug hole. If the fluid level is below this level, fill with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent to the correct fill level. Re-install the fill plug and tighten to 9-23 N-m (7-17 ft-lbs).



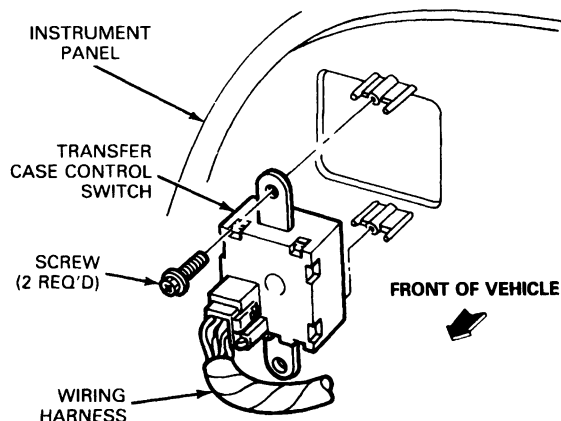
C10892-A

REMOVAL AND INSTALLATION

4x4 Shift Switch

Removal and Installation

1. Remove the instrument panel assembly as described in the Body / Chassis Manual, Section 01-12.
2. Remove the switch mounting screw and remove the switch from the panel and disconnect the switch from the wiring.
3. To install, position the switch in the panel and retain with mounting screw. Then connect harness connector.
4. Install the instrument panel assembly.



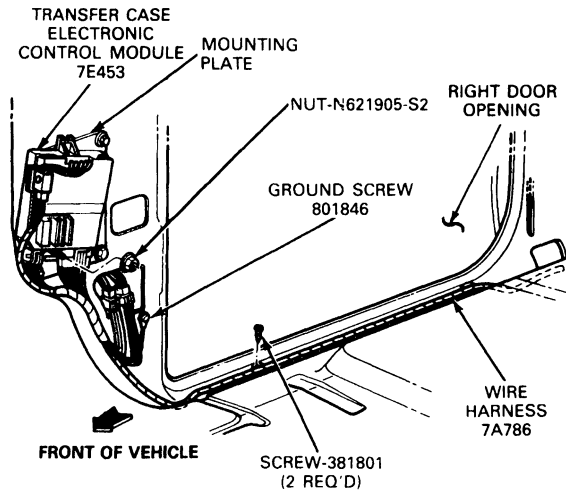
C10884-B

Control Module

Removal and Installation

1. Remove the right cowl panel kick pad.
2. Remove the two module attaching screws.
3. Lift out the module and disconnect the three wiring connectors. Remove module assembly.

For installation, follow removal procedures in reverse order.



C7428-C

Electronic Shift Transfer Case

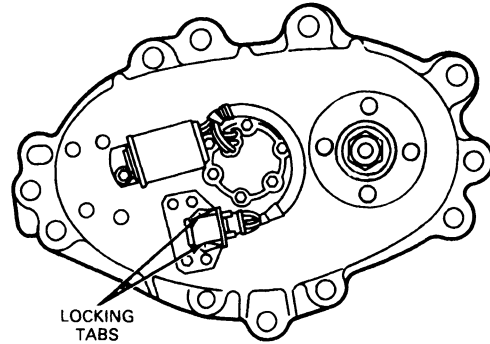
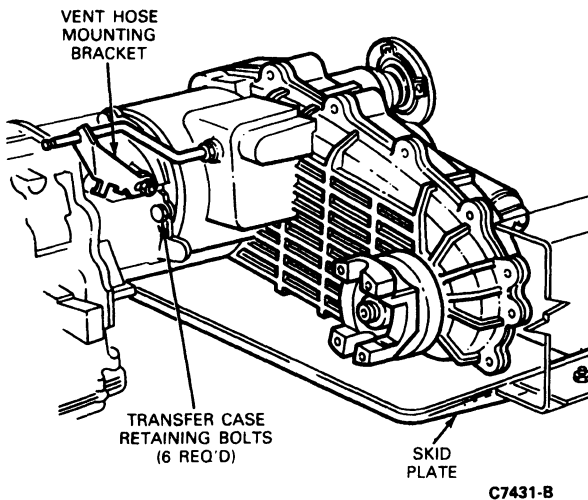
Removal

1. Raise the vehicle on a hoist and position suitable safety stands under vehicle.
2. If so equipped, remove the nuts, bolts and skid plate from the frame.
3. Place a drain pan under the transfer case. Remove the drain plug and drain the fluid from the transfer case.
4. Remove the wire connector from the feed wire harness at the rear of the transfer case. First squeeze the locking tabs, then pull the connectors apart.

CAUTION: Do not pull directly on the wires.

REMOVAL AND INSTALLATION (Continued)

NOTE: For detailed instructions on front and rear driveshaft removal, refer to Section 05-01.



C7432-B

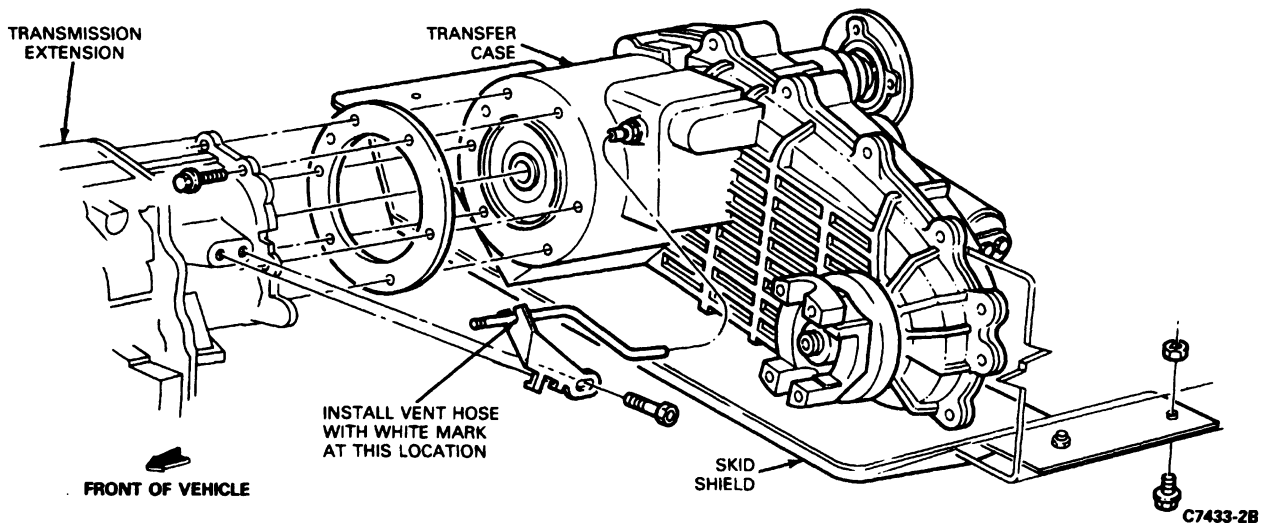
5. Disconnect the front driveshaft from front output shaft flange.
6. Disconnect the rear driveshaft from the transfer case rear output shaft flange.

7. Disconnect the vent hose from the mounting bracket.

CAUTION: The catalytic converter is located beside the transfer case. Be careful when working around the catalytic converter because of the extreme high temperatures generated by the converter.

8. Support the transfer case with a suitable transmission jack such as Rotunda Number 077-00019 or equivalent.
9. Remove the six bolts retaining the transfer case to the transmission and the extension housing.
10. Slide the transfer case rearward off the transmission output shaft and lower the transfer case from the vehicle. Remove the gasket from the transfer case and transmission housing.

Transfer Case Installation



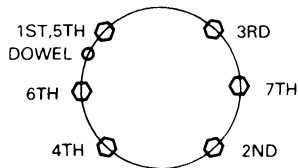
C7433-2B

Installation

1. Place a new gasket between the transfer case and the transmission extension.

REMOVAL AND INSTALLATION (Continued)

2. Raise the transfer case with the transmission jack so that the transmission output shaft aligns with the splined transfer case input shaft. Slide the transfer case forward onto the transmission output shaft and onto the dowel pin. Install the six transfer case retaining bolts to the extension housing. Tighten the bolts to 34-58 N·m (25-43 ft·lb) in the sequence shown.



TIGHTEN CASE TO EXTENSION BOLTS IN THIS SEQUENCE

C7434-1A

3. Remove the transmission jack from the transfer case.
4. Install the vent hose so that the white marking on the hose aligns with the notch in the mounting bracket.
5. Connect the rear driveshaft to the transfer case output shaft yoke. Tighten the bolts to 28-33 N·m (20-28 ft·lb) on Bronco or to 11-20 N·m (8-15 ft·lb) on F-Series vehicles.
6. Connect the front driveshaft to the transfer case front output shaft yoke. Tighten the nuts to 11-20 N·m (8-15 ft·lb).
7. Connect the wire connectors on the rear of the transfer case, making sure that the retaining tabs lock.
8. Install the drain plug and tighten to 9-23 N·m (7-17 ft·lb). Remove the fill plug and install 1.9 Liters (2.0 U.S. Quarts) of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent to the bottom of the fill hole. Install fill plug and tighten to 9-23 N·m (14-22 ft·lb).
9. Install the skid plate, bolts and nuts to the frame and tighten to 20-27 N·m (15-20 ft·lb).
10. Remove safety stands and lower the vehicle.

Rear Or Front Output Shaft Oil Seals**Removal**

1. Raise the vehicle on a hoist and position suitable safety stands under vehicle.

2. Remove the rear or front driveshaft from the transfer case output shaft yokes. Wire the driveshaft(s) out of the way.
3. Remove the output shaft yoke by removing the 30mm locknut, steel washer and rubber seal from the rear or front output shaft and remove the yokes.
4. Remove the oil seal from the front or rear output housing bore with Seal Remover T74P-77248-A and Impact Slide Hammer T50T-100-A.

Installation

1. Make sure the front or rear output shaft output housing bores and faces are free from nicks and burrs. Coat the oil seals with Premium Long-Life Grease XG-1-C or -K (ESA-M1C175-B) or automatic transmission fluid. Position the oil seal into the front or rear output housing bore. Position the oil seal into the front or rear output housing bore, making sure that the oil seal is not cocked in the bore. Drive the oil seal into the bore with Output Shaft Seal Installer T83T-7065-B and Drive Handle T80T-4000-W.
2. Install the yoke, rubber seal, steel washer and locknut on the front or rear output shaft. Tighten the locknut to 203-244 N·m (150-180 ft·lb) front; 162-203 N·m (120-150 ft·lb) rear.
3. Connect the front or rear driveshaft to the transfer case output shaft yokes. Tighten front driveshaft-to-transfer case yoke to 11-20 N·m (8-15 ft·lb), and Bronco rear circular flange bolts to 28-33 N·m (20-28 ft·lb).

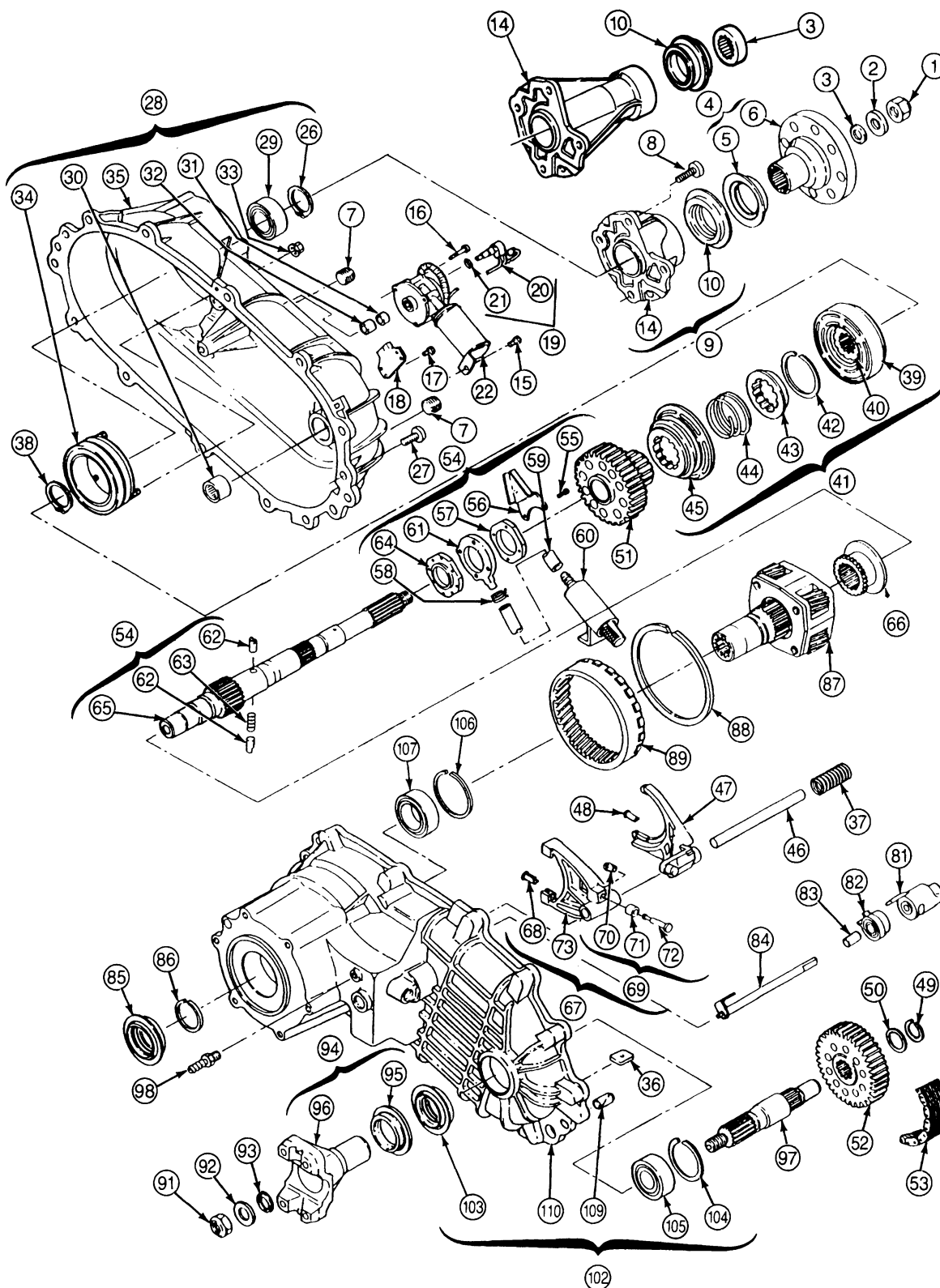
NOTE: F-Series vehicles use a slip-yoke at the rear output of transfer case.
4. Remove safety stands and lower the vehicle from the hoist.

DISASSEMBLY AND ASSEMBLY**Transfer Case****Disassembly**

1. Remove the transfer case from the vehicle as outlined in this section.
2. Remove the front and rear output shaft yokes by removing the 30mm locknut, flat steel washer and rubber seal from the output shafts.

DISASSEMBLY AND ASSEMBLY (Continued)

13-56 Transfer Case, Electronic Shift



C10888-A

DISASSEMBLY AND ASSEMBLY (Continued)

TRANSFER CASE, ELECTRONIC SHIFT (LEGEND)

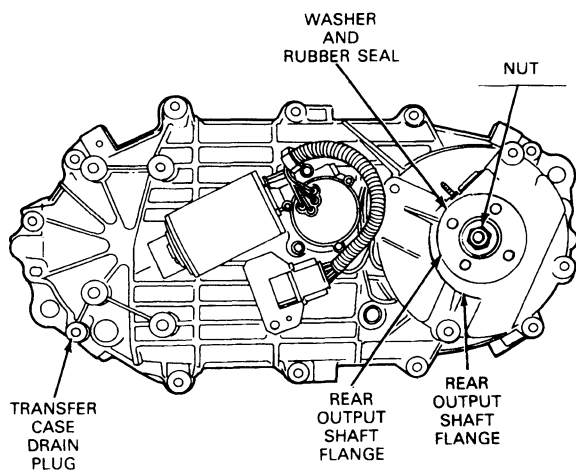
Item No.	Part Number	Description
1	7045	Nut
2	7B363	Washer
3	7052	Seal, Oil
4	7B214	Yoke Assy, Rear (Rear Yoke) Flange Assy, Rear (Rear Flange)
5	—	• Deflector (Serviced as Part of 7B214 Assembly)
6	—	• Yoke (Rear Yoke) (Serviced as Part of 7B214 Assembly) • Flange (Rear Flange) (Serviced as Part of 7B214 Assembly)
7	7A010	Plug, Pipe
8	7A443	Bolt and Washer Assy (1989 and Later)
9	7085	Cap Assy, Bearing
10	7B215	• Seal, Oil
14	—	• Cap, Bearing/Extension (Serviced as Part of 7085 Assembly)
15	—	Bolt
16	—	Bolt
17	—	Bolt
18	14A206	Bracket, Wiring Harness
19	—	Sensor and O-ring Assy
20	7F293	• Sensor, Speed
21	7288	• O-ring
22	7G360	Motor Assy
26	7917	Ring, Snap
27	7A443	Bolt (1989 and Later)
28	7005	Cover Assy, Transfer Case
29	7025	• Bearing, Ball
30	7127	• Bearing, Needle
31	7B216	• Seal, Oil
32	7W073	• Bearing, Sleeve
33	620481-S	• Nut
34	7G361	• Coil Assy, Clutch
35	7005	• Cover, Transfer Case
36	7E290	Magnet
37	7219	Spring, Return
38	7917	Ring, Snap
39	7G363	Housing, Clutch
40	Part of 7G363	Hub, Shift Collar
41	—	Lockup Assy, 2W-4W
42	7917	• Ring, Retaining
43	7D164	• Hub, Lockup
44	7D126	• Spring, Sleeve Return
45	7106	• Collar, Lockup
46	7240	Rail, Shift
47	7289	Fork Assy, Shift, 2W-4W
48	Part of 7289	• Facing, Shift Fork
49	7917	Ring, Retaining
50	7119	Washer
51	7177	Sprocket, Drive
52	7177	Sprocket, Driven
53	7A029	Chain, Drive
54	—	Shaft and Pump Assy (Rear Yoke)

Item No.	Part Number	Description
		Shaft and Pump Assy (Rear Flange)
55	7A291	• Bolt, Hex Head
56	7E215	• Retainer, Pump
57	7A152	• Cover, Pump, Rear
58	382486-S	• Clamp, Hose
59	7A210	• Coupling, Hose
60	7A098	• Filter, Oil
61	7A149	• Housing, Pump
62	7A250	• Pin, Pump
63	7A205	• Spring, Pump Pin
64	7A152	• Cover, Pump, Front
65	7061	• Shaft, Output (Rear)
66	7100	Hub, Reduction
67	7289	Fork Assy, Reduction
68	—	• Facing, Shift Fork (Serviced as Part of 7289 Assembly)
69	—	• Pin, Roller and Retainer Assy. (Serviced as Part of 7289 Assembly)
70	—	• Retainer (Serviced as Part of 7289 Assembly)
71	—	• Roller, Cam (Serviced as Part of 7289 Assembly)
72	—	• Pin (Serviced as Part of 7289 Assembly)
73	—	• Fork, Reduction (Serviced as Part of 7289 Assembly)
81	7F063	Cam, Electric Shift
82	7W074	Spring, Torsion
83	7Z112	Spacer
84	7N095	Shaft, Shift
85	7B215	Seal, Oil
86	7917	Ring, Retaining
87	7A398	Carrier Assy, Complete
88	7C122	Ring, Retaining
89	7A153	Gear, Ring
91	7045	Nut
92	7B368	Washer
93	7052	Seal, Oil
94	7B214	Yoke Assy, Front
95	—	• Deflector (Serviced as Part of 7B214 Assembly)
96	—	• Yoke (Serviced as Part of 7B214 Assembly)
97	7061	Shaft, Output
98	7034	Barb, Breather
102	7005	Case Assy, Transfer
103	7B215	• Seal, Oil
104	7917	• Ring, Retaining
105	7025	• Bearing, Ball
106	7917	• Ring, Retaining
107	7025	• Bearing, Ball
109	—	• Pin Dowel
110	7005	• Case Transfer

CC10889-A

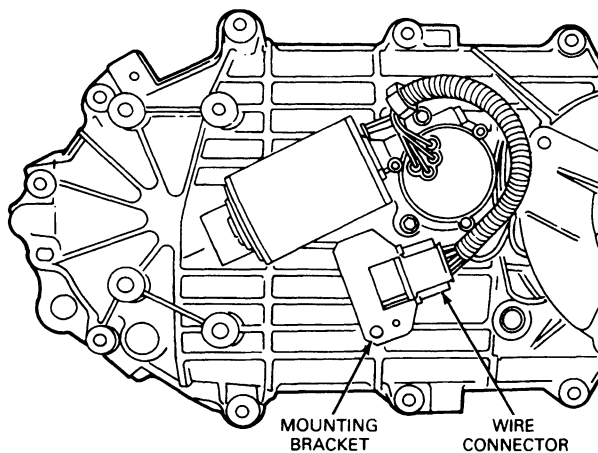
DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove the rear output shaft seal using Seal Remover T74P-77248-A and Slide Hammer T50T-100-A.



C7435-B

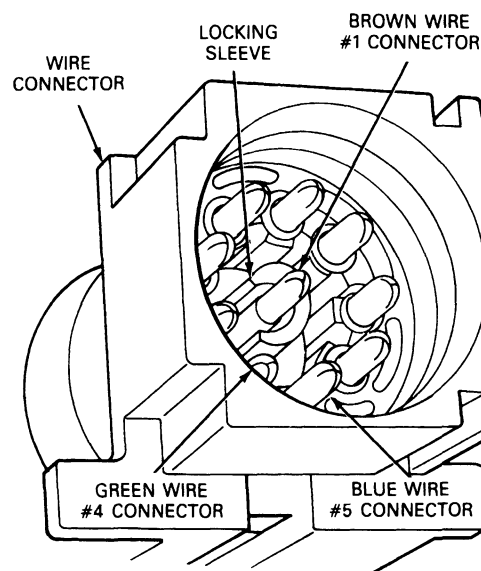
4. Remove the wire connector assembly from the mounting bracket on the rear cover. If required, remove the two bolts and remove the bracket.



C7436-1A

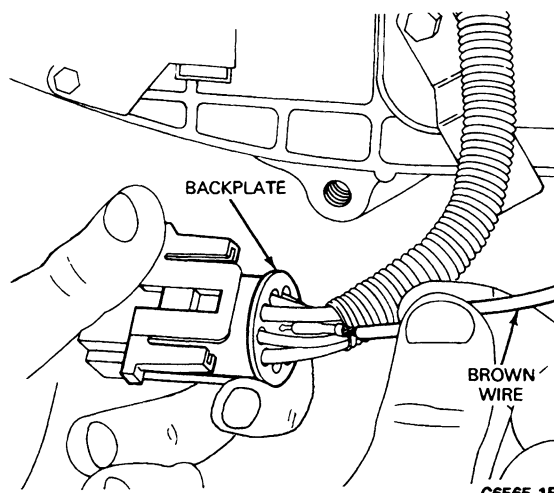
5. Form a small hook at the end of a paper clip or safety pin. Remove the locking sleeve from the wire connector by hooking it with the paper clip or safety pin and pulling it up from the bottom.

CAUTION: Do not damage the wire connector locking sleeve.



C6564-1B

6. Remove the brown wire from the No. 1 center position in the connector. If required, remove the green speed sensor wire from the No. 4 connector position and the blue wire from the No. 5 connector position.



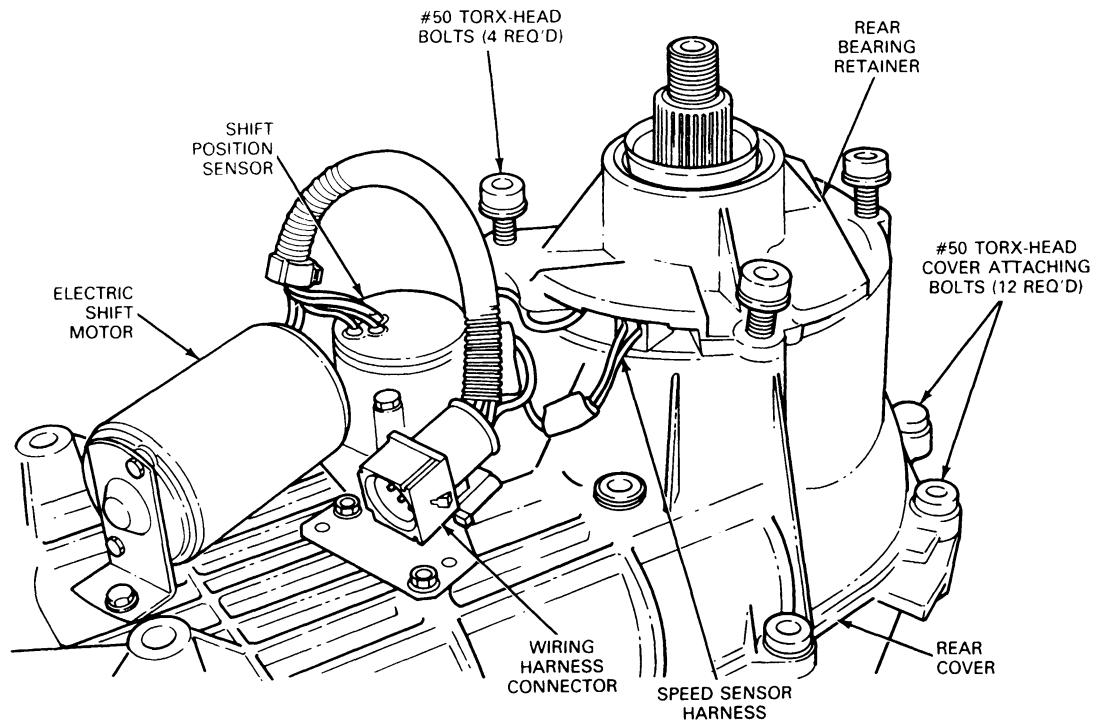
C6565-1B

7. Remove the four No. 50 Torx® head bolts securing the rear bearing retainer to the cover. Pry the rear bearing retainer from the cover using a 1/2 inch drive breaker bar between the pry bosses and separate the bearing retainer from the cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the cover and the bearing retainer.

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium cases.

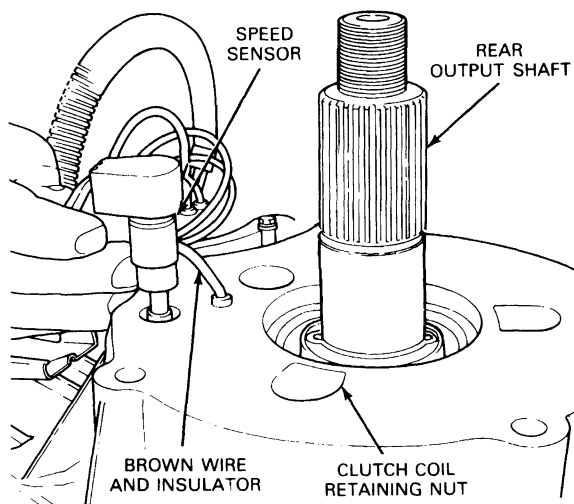
DISASSEMBLY AND ASSEMBLY (Continued)

Transfer Case, Rear View



C7437-2A

8. Remove the speed sensor from the rear cover.



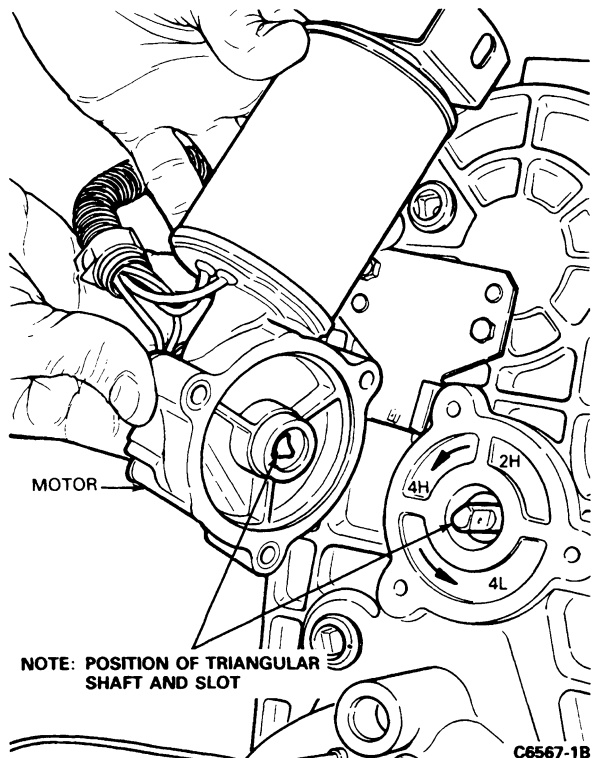
REMOVE SPEED SENSOR

C7438-B

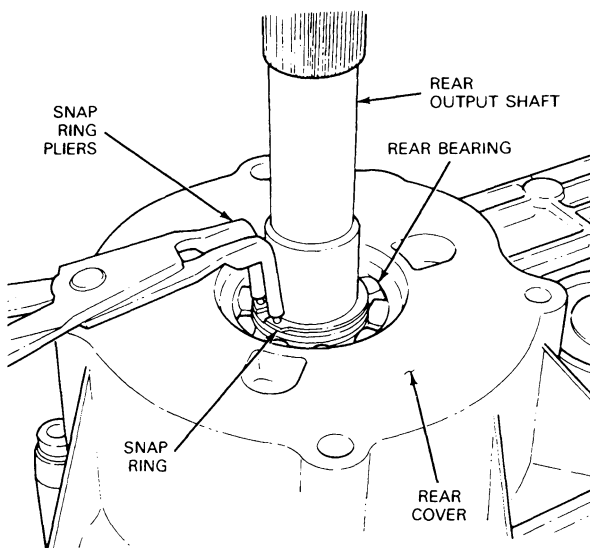
DISASSEMBLY AND ASSEMBLY (Continued)

9. Remove the four bolts attaching the shift motor to the rear cover and remove the shift motor. Note the position of the triangular shaft extending out of the rear cover and the triangular slot in the motor. Do not discard the washer under the motor support bracket, if present.

CAUTION: The motor is serviced as a complete assembly. Do not remove the screws that secure the rear cover to the motor gear housing.



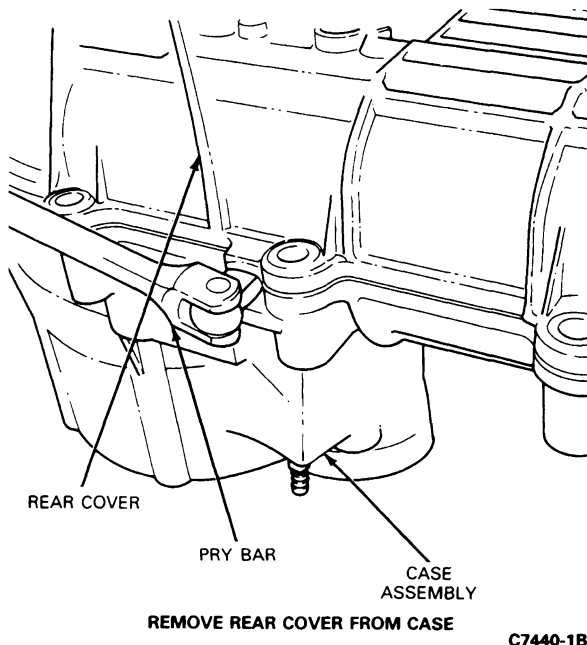
10. Remove the snap ring on the output shaft retaining the upper rear ball bearing using appropriate snap ring pliers as shown.



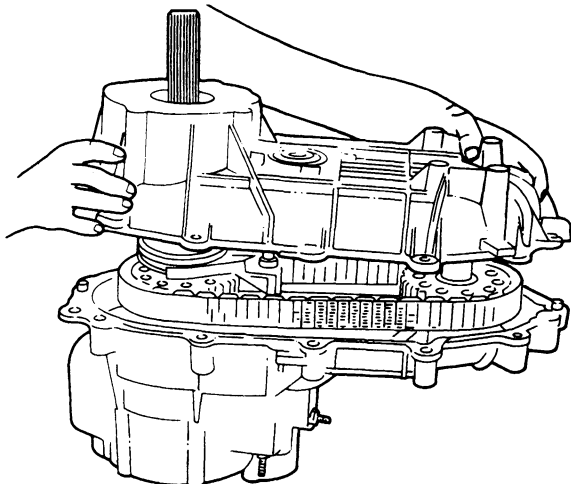
REMOVE REAR BEARING SNAP RING C7439-1C

11. Remove the 12 No. 50 Torx® head bolts that retain the front case of the rear cover. Insert a 1/2-inch drive breaker bar between the pry bosses and separate the front case from the rear cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the front case and the rear cover.

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium housings.

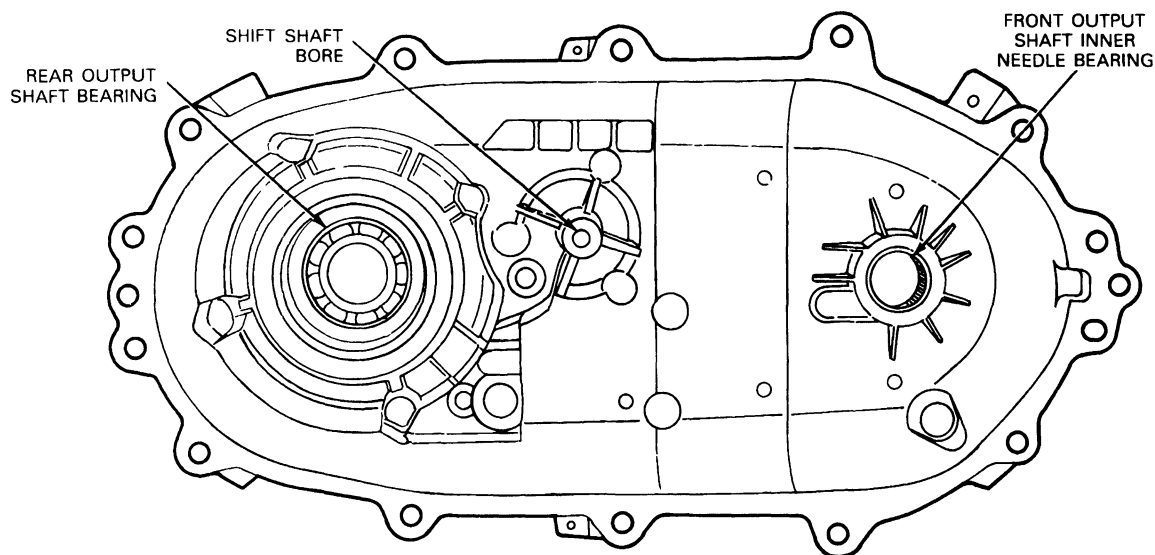


REMOVE REAR COVER FROM CASE C7440-1B

DISASSEMBLY AND ASSEMBLY (Continued)

REMOVE REAR COVER FROM CASE ASSEMBLY C7441-1A

12. Remove the front output shaft caged needle bearing from the rear cover with Collet D80L-100-T and Impact Slide Hammer T50T-100-A.
13. Remove the rear output shaft bearing from the inside of the case using a suitable tool.

Rear Cover Assembly

C7442-B

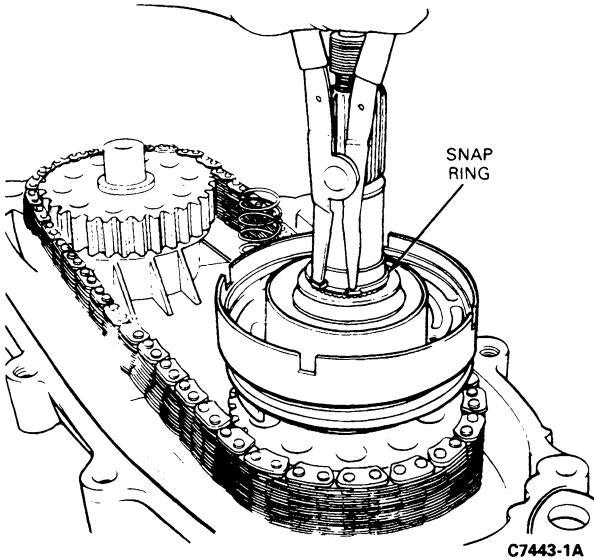
14. Remove the nuts retaining the clutch coil assembly to the rear cover. Pull the assembly along with the O-rings and brown wire, from the cover.

15. Remove the shift shaft bushing and seal from the rear cover using appropriate tools.

DISASSEMBLY AND ASSEMBLY (Continued)

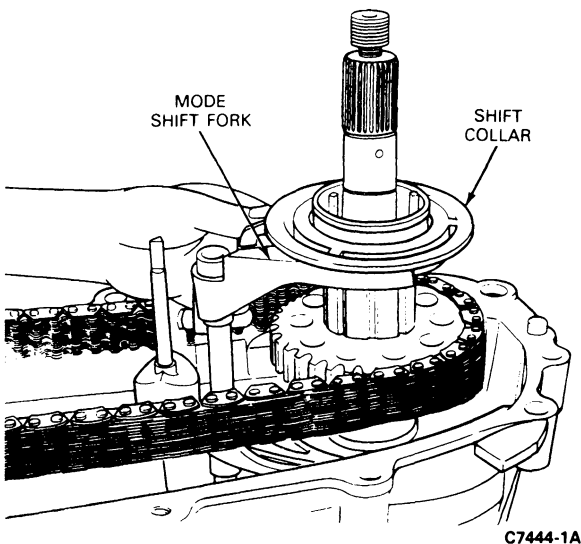
16. Remove the snap ring on the output shaft securing the clutch housing. Slide the clutch housing and the 4WD hub off of the output shaft.

REMOVE CLUTCH HOUSING RETAINING SNAP RING

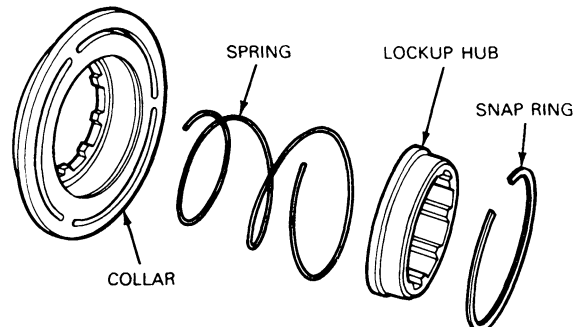


17. Remove the spring from the shift shaft and lift the mode shift fork complete with the shift collar from the upper rear output shaft sprocket splines.

REMOVE MODE SHIFT FORK AND SHIFT COLLAR

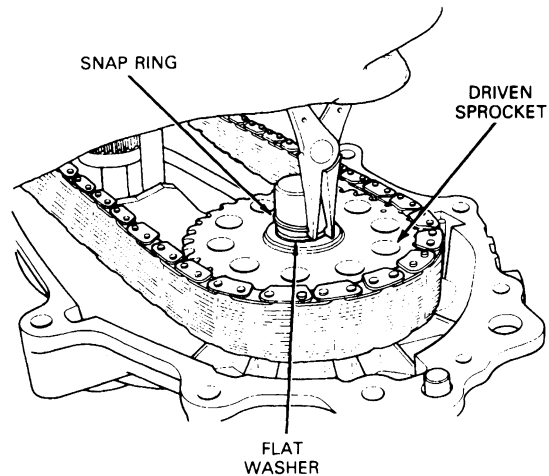


18. Disassemble the 2W-4W lockup assembly by removing the internal snap ring and pull the lockup hub and spring from the collar.



DISASSEMBLY 2W - 4W LOCK-UP ASSEMBLY C7445-1A

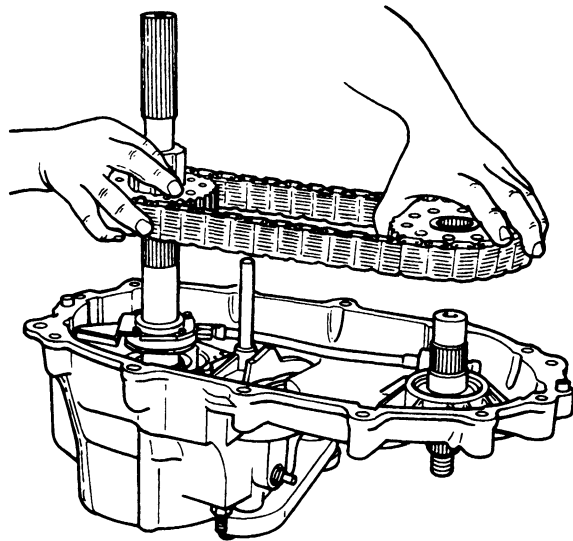
19. Remove the snap ring retaining the front sprocket to the front output shaft. Grasp the rear and front sprocket complete with the chain and lift them at the same time from the rear and front output shafts.



REMOVE SNAP RING — DRIVEN SPROCKET

C7446-C

DISASSEMBLY AND ASSEMBLY (Continued)



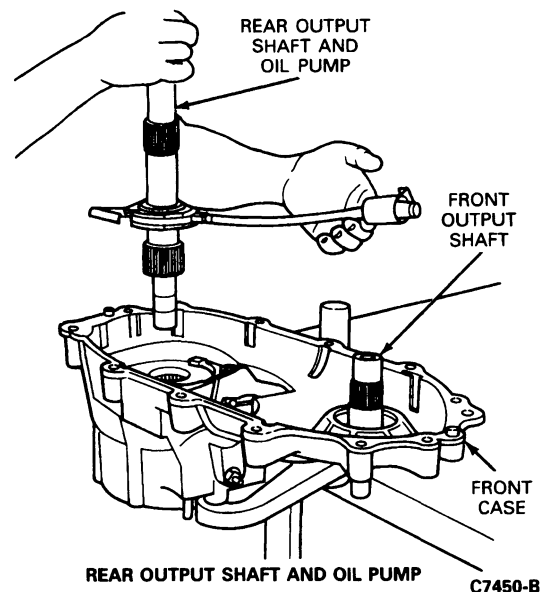
CHAIN REMOVAL

C7447-1A

20. Remove the shift rail by sliding it straight out from the shift fork.
21. Remove the magnet from its slot in the case.

22. Lift out the pump screen and remove the output shaft assembly with the pump assembled on it. If the pump is to be disassembled, remove the four bolts from the pump body. Note the position of the pump front body, pins, spring, rear cover and pump retainer as removed.

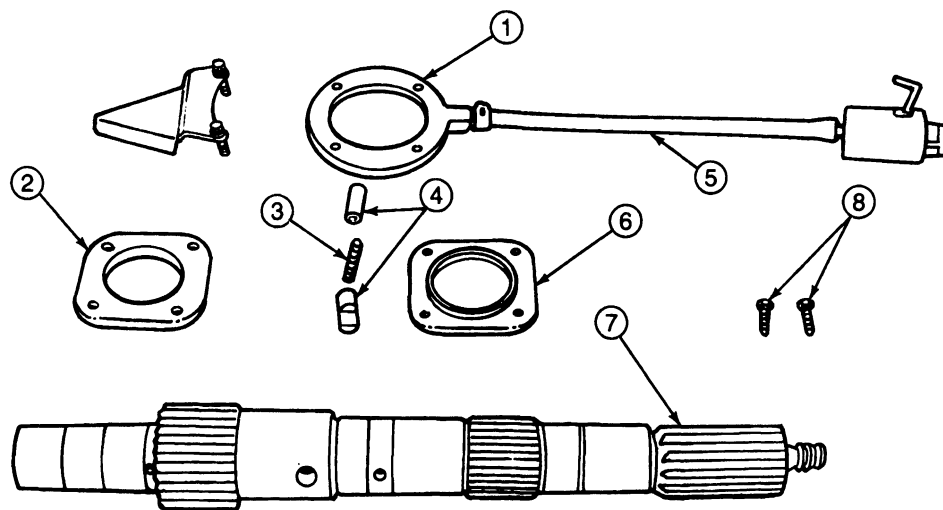
CAUTION: Do not disassemble oil pump unless the oil pump retaining bracket has been bent or broken, or pump damage is indicated. Indications of pump failure are blueing or blackening of the pump, or loosening of the pump bolts.



REAR OUTPUT SHAFT AND OIL PUMP

C7450-B

Rear Output Shaft and Oil Pump Assembly



C7855-D

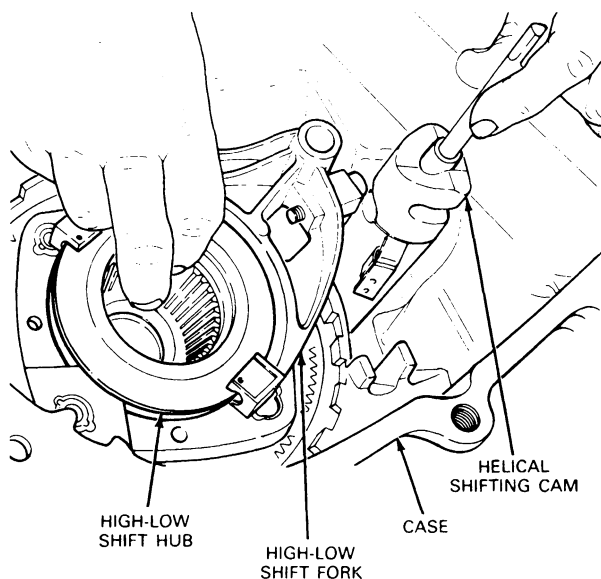
DISASSEMBLY AND ASSEMBLY (Continued)

Item	Description
1	Pump Body
2	Cover
3	Spring

(Continued)

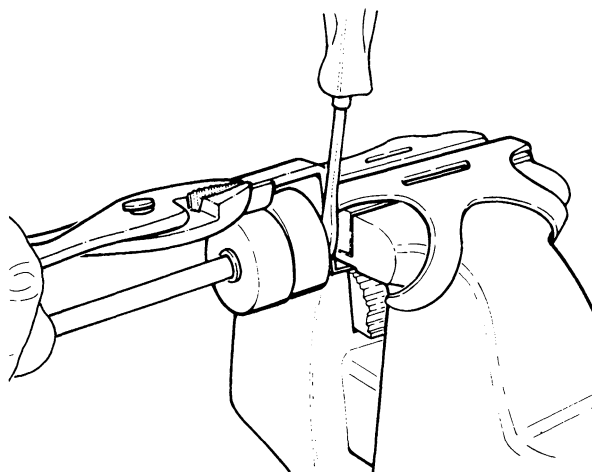
Item	Description
4	Pins
5	Pick-Up Tube and Filter
6	Cover
7	Output Shaft
8	Screws

23. Remove the high-low shift fork by first rotating it until the roller is free from the cam then sliding out of engagement from the shifting hub.

**REMOVE HIGH-LOW SHIFT FORK**

C7448-1A

24. Remove the helical cam assembly from the front case. If it is necessary to disassemble the helical cam assembly, care should be exercised as the cam is slid rearward to disengage it from the spring. The spring is energized and can release violently. The spring must be removed from the helical cam and the shaft finger. Do not get your fingers in the way when disengaging the spring. It will rotate to the point that the spring ends will be roughly 180 degrees apart.

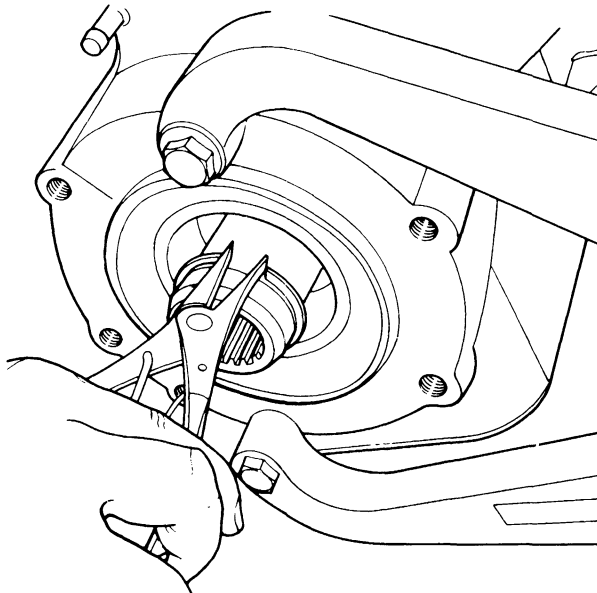
**DISASSEMBLY OF HELICAL CAM ASSEMBLY**

C7449-1A

25. Remove the high-low shift hub.
 26. Remove the front output shaft from the front case.
 27. Turn the front case over and remove the front oil seal out of the case using Seal Remover T74P-77248-A and Slide Hammer T50T-100-A.

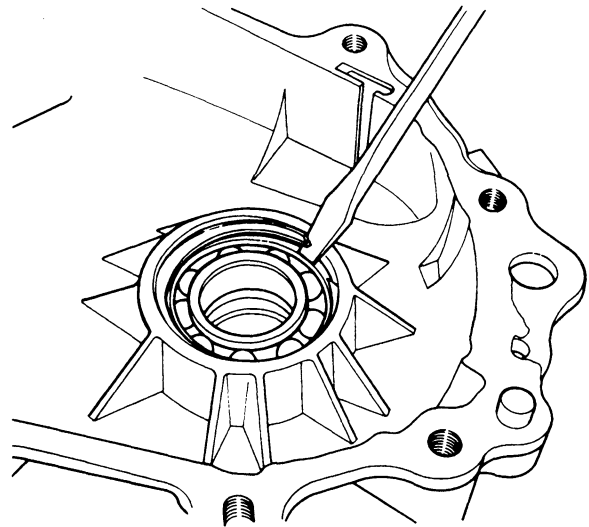
DISASSEMBLY AND ASSEMBLY (Continued)

28. Reaching through the front opening of the case with a pair of snap ring pliers, expand the snap ring on the input shaft and carrier assembly allowing it to drop out of the bearing. The carrier assembly, including the input shaft is serviced as an assembly only. If the needle bearing or bushing is to be replaced in the input shaft, drive out both of them through the input shaft splines using appropriate tools.



REMOVE INPUT SHAFT BEARING SNAP RING C7851-1A

29. Remove the ring gear by prying out the internal snap ring and lifting out the gear.
30. Remove the front input shaft bearing by removing the internal snap ring securing the bearing to the case and drive it out from the outside of the case using Bearing Cup Replacer T73T-1202-B and Driver Handle T80T-4000-W.
31. Remove the front output shaft bearing from case by removing the internal snap ring retaining the output shaft bearing in the case. Drive the bearing out of the case from the front of the case using Bearing Cup Replacer T73T-1202-B and Driver Handle T80T-4000-W.



REMOVE FRONT OUTPUT SHAFT BEARING RETAINING SNAP RING

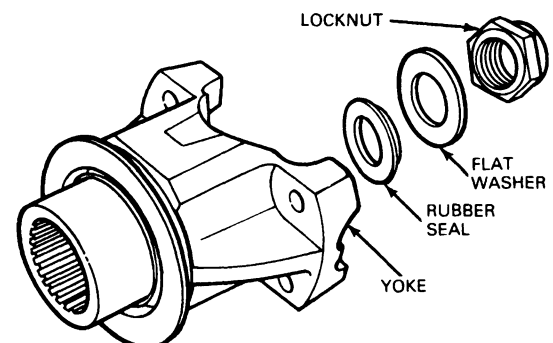
C7852-1A

Assembly

NOTE: Before assembly, lubricate all parts with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent.

Clean all chips out of the case attaching bolt holes.

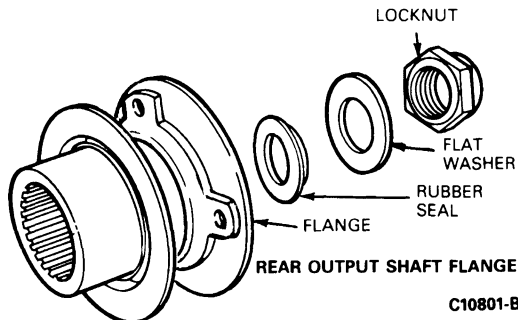
1. Install the input shaft bearing and the front output shaft bearing into the case using Bearing Installer T80T-4000-P and Driver Handle T80T-4000-W. Install the appropriate internal snap rings retaining the bearings in the case.
2. Install the front output shaft seal into the case until it is fully seated against the case using Output Shaft Seal Installer T86T-7034-CH.
3. Install the front output shaft through the lower bearing of the case. The front output shaft is retained in the case by the front yoke assembly. Install the front yoke assembly onto the output shaft, the rubber seal, the flatwasher, and the locknut. Tighten locknut to 163-203 N·m (120-150 ft·lbs).



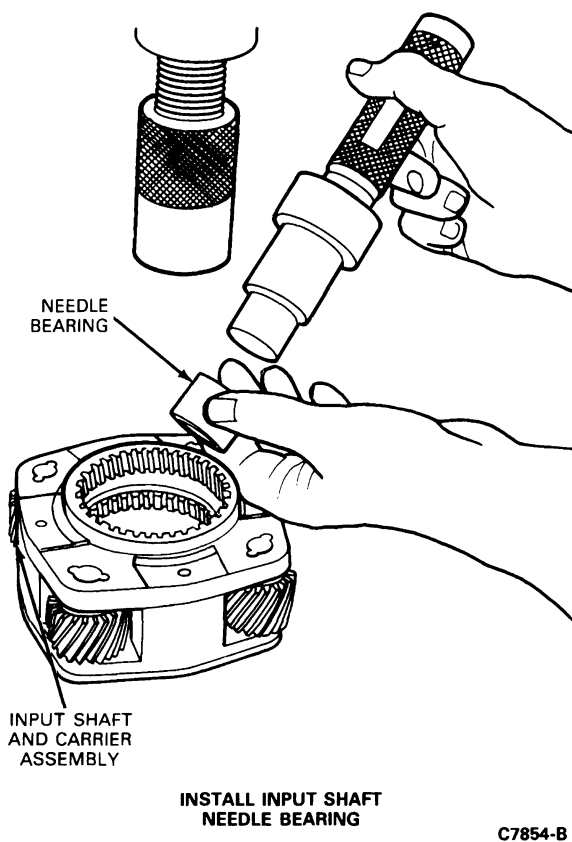
FRONT OUTPUT SHAFT YOKE

C7853-C

DISASSEMBLY AND ASSEMBLY (Continued)



4. Press the needle bearing and bronze bushing into the input shaft with the appropriate tools.



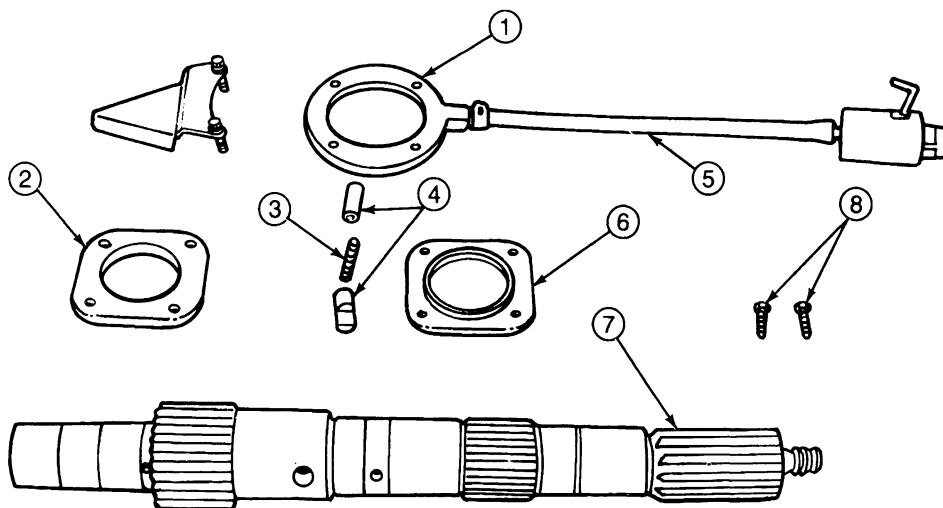
5. Install the ring gear into the slots in the case and retain it with the large internal snap ring making sure that it is fully seated.

6. Insert the input shaft and carrier assembly in the case through the input shaft bearing being careful not to damage the gear teeth when aligning them with the ring gear teeth.
7. While supporting the input shaft and carrier assembly in the case, install a new snap ring on the front side of the bearing making sure that it is fully seated in the snap ring groove of the input shaft.
8. Install the upper input shaft oil seal into the case using an appropriate tool until it is fully seated against the case.
9. Reassemble the helical cam assembly by engaging one end of the spring on the shaft finger and the other end of the spring on the cam finger. With the shaft finger secured carefully in a soft-jawed vice, turn the cam to wind up the spring until the fingers of the cam and the shaft are in alignment and slide the cam forward to lock the spring in the cocked position.
10. Install the cam assembly in the small hole of the case with the shaft vertical.
11. Lubricate all pump components with clean automatic transmission fluid.
12. Reassemble pump and output shaft as follows:
 - a. Place the oil pump cover, with the word "TOP" facing the front of the front case, on the output shaft.
 - b. Install two pins (with the flats facing rear of vehicle) with the spring between the pins in the oil pump bore in the output shaft.
 - c. Place the oil pump body and pick-up tube over the shaft and make sure that the pins are riding against the inside of the pump body.
 - d. Place the oil pump rear cover with the words "TOP REAR" facing the rear of the case on the output shaft.

NOTE: The word "TOP" on the front cover and the rear cover should be pointing in the same direction.

- e. Install the pump retainer with the tabs facing the front of the transfer case.
- f. Install the four retaining screws and rotate the output shaft while tightening the screws to prevent the pump from binding. Tighten the screws to 4-4.5 N·m (36-40 in-lb).

NOTE: The output shaft must turn freely within the oil pump. If binding occurs, loosen the four screws and retighten.

DISASSEMBLY AND ASSEMBLY (Continued)**Rear Output Shaft and Oil Pump Assembly**

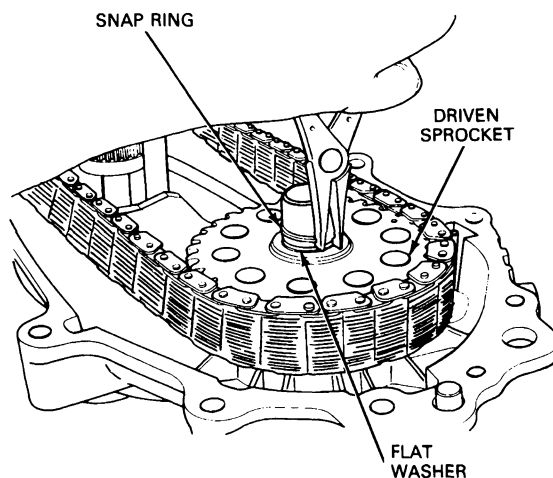
C7855-D

Item	Description
1	Pump Body
2	Cover
3	Spring

(Continued)

Item	Description
4	Pins
5	Pick-Up Tube and Filter
6	Cover
7	Output Shaft
8	Screws

13. Install the high-low shift hub.
14. Install the high-low shift fork by engaging it with the shift hub flange and rotating it until the roller is engaged with the lower groove of the helical cam.
15. Install the shift rail through the high-low fork bore and into the rail bore in the case.
16. Install the output shaft and oil pump assembly in the input shaft.
NOTE: Make sure that the external splines of the output shaft engage the internal splines of the high-low shift hub. Make sure that the oil pump retainer and oil filter leg are in the groove and notch of the front case.
17. Install magnet in the slot provided in the front case.
18. Assemble the following components as outlined:
 - a. Assemble the drive sprocket into the chain.
 - b. Assemble the driven sprocket into the chain so the word REAR is facing upward.
NOTE: The sprocket will face the rear of the vehicle when properly installed.
 - c. Place the sprockets and chain as an assembly over the rear and front output shafts.
 - d. Install the washer and snap ring that retains the lower sprocket to the front output shaft.



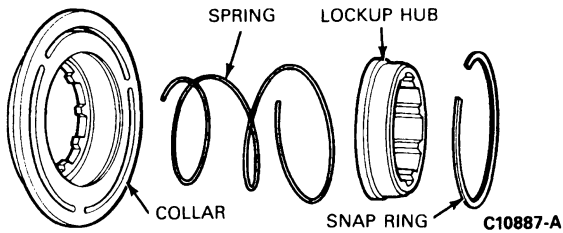
C10886-A

19. Assemble the 2W-4W lockup assembly as follows:
 - a. Position the small end of the tapered compression spring in the lockup collar.

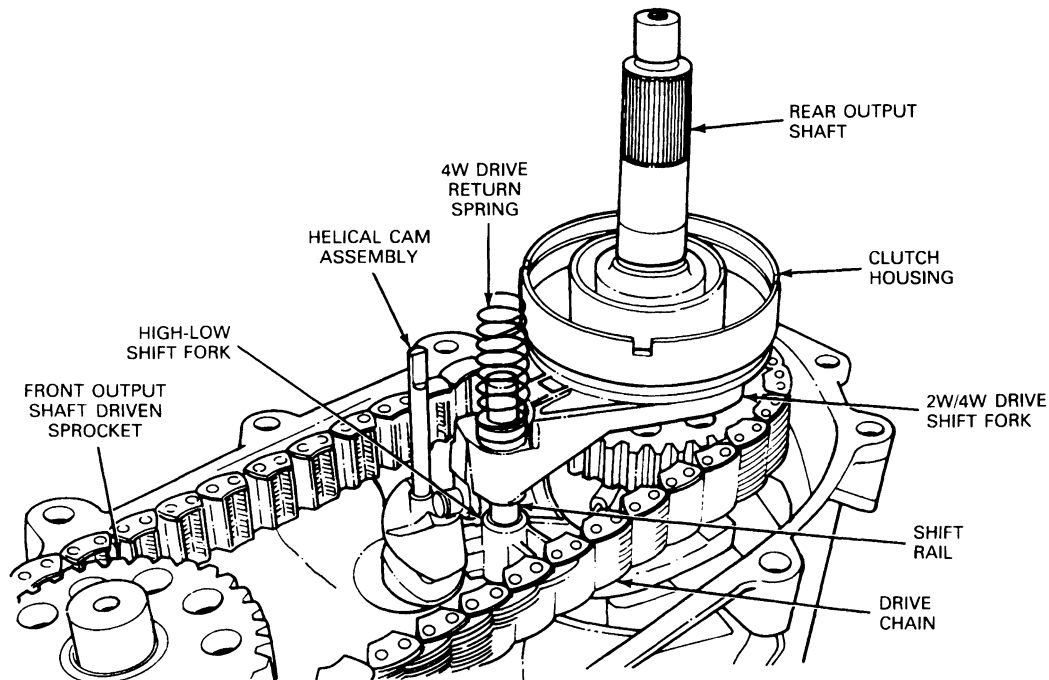
DISASSEMBLY AND ASSEMBLY (Continued)

- b. Place the lockup hub over the large end of the spring and compress the spring while installing the internal snap ring.

NOTE: The snap ring holds the lockup assembly together.



20. Install the lockup assembly and its shift fork over the external splines of the sprocket and the shift rail with the clutch face facing rearward and the long boss of the shift rail facing forward.
21. Assemble the 4WD return spring over the shift rail and against the shift fork.
22. Place the 4WD hub over the external splines of the output shaft.
23. Place the clutch housing over the splines of the output shaft and secure with the appropriate snap ring. Make sure that the snap ring is fully seated in the snap ring groove.

Installation, Shift Mechanism

C7856-C

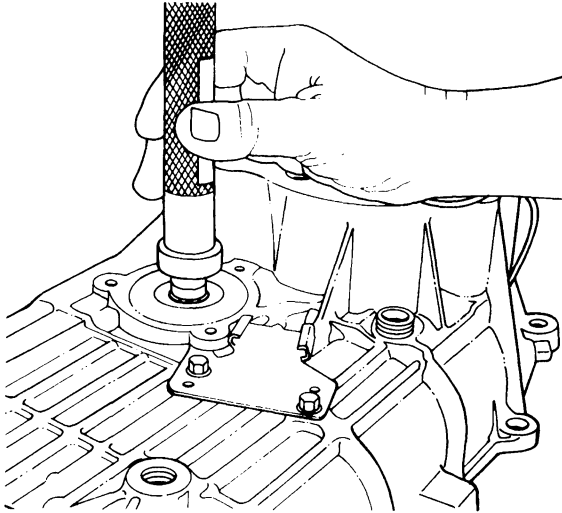
24. Press the front output shaft inner needle bearing in the bore in the cover using appropriate tools.

25. Press the rear output shaft bearing into the bore in the cover using appropriate tools.

DISASSEMBLY AND ASSEMBLY (Continued)

26. Install a new shift shaft bushing and oil seal into the cover using appropriate tools.

SHIFT SHAFT BUSHING AND SEAL INSTALLATION



C7857-B

27. Install new O-rings (if the old rings are cracked or broken) on the clutch coil assembly studs and grommet. Install the clutch coil assembly from inside the rear cover until the wire and studs extend through the cover. Install the three nuts and tighten to 8-11 N·m (6-8 lb-ft).

CAUTION: Do not kink or trap the wire while seating the clutch coil assembly to the cover.

28. Install the rear output shaft oil seal in the bearing retainer using the appropriate tool and making sure that it is fully seated.
29. Coat the mating surface of the front case with a very small bead of non-acid cure Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent.
- CAUTION: If too much Silicone Rubber is used when sealing the case halves, it is possible for the excess sealant to plug the oil filter and cause transfer case failure.**
30. Place the cover on the case making sure that the lower output shaft, shift shaft and shift rail are aligned. Install and tighten the 12 No. 50-Torx® head case-to-cover bolts to 30-49 N·m (22-36 ft-lb).
31. Install the rear bearing snap ring on the output shaft making sure that the snap ring is fully seated in the groove of the shaft.
32. Install the speed sensor in its bore of the cover.
33. Apply a bead of non acid cure Silicone Rubber, E7TZ-19562-A (ESL-M4G273-A), or equivalent, to the face of the rear bearing retainer.
34. Place the rear bearing retainer onto the rear cover and secure with the four Torx® head bolts tightened to 30-49 N·m (22-36 ft-lb).

CAUTION: Do not trap the brown wire beneath the bearing retainer.

35. Install the rear output shaft yoke assembly onto the rear splines of the output shaft. Install the rubber seal, flat washer and 30mm locknut on the output shaft and tighten to 163-203 N·m (120-150 ft-lb).

36. Using pliers equipped with soft jaws, rotate the triangular shift shaft so it is aligned with the triangular slot in the motor.

37. Slightly loosen the two nuts that attach the slotted support bracket to the end of motor house.

NOTE: Do not loosen the two nuts or studs that attach the motor end cap to motor housing.

38. Apply non-acid cure silicone rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent, to motor housing base and install on transfer case.
39. Install three N800670-S screws along with speed sensor 7K470 bracket and tighten to 8-11 N·m (6-8 ft-lb).
40. Holding the slotted support bracket tight against the motor housing end, secure the bracket to the transfer case, turning the N802503-S with N801723-S 12 lock washer to 8-11 N·m (6-8 ft-lb).
41. Retighten the two nuts that attach the slotted support bracket to the end of motor to 2.7-3.4 N·m (2-2.5 ft-lb).

NOTE: If the shaft will not stay in the 4H position, rotate the shaft clockwise to the 2H position. Install the motor and rotate counterclockwise until the motor is aligned with the mounting holes.

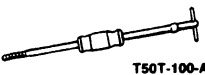
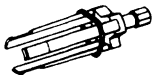
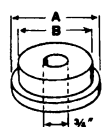
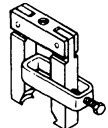
42. Install the brown clutch coil wire to the No. 1 center terminal, and, if removed, the speed sensor green wire to the No. 4 connector position and the blue wire to the No. 5 connector position. Install the locking sleeve.
43. Install the wire connector mounting bracket on the rear cover. Install the bolts and tighten to 8-11 N·m (6-8 ft-lb).
44. Install the wire connector to the mounting bracket.
45. Install the drain plug and tighten to 9-23 N·m (7-17 ft-lb).
46. Install the transfer case as described in the Removal and Installation portion of this section.
47. Place a 3/8 inch drive ratchet in the fill plug and remove the plug. Fill the transfer case with 1.9 Liters (2.0 U.S. Quarts) of Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid, XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent.
48. Install the fill plug and tighten to 9-23 N·m (7-17 ft-lb).

SPECIFICATIONS


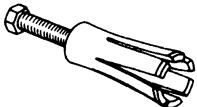
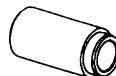
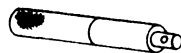

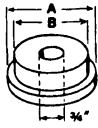
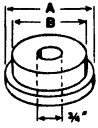

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
Case Half Attaching Bolts	30-49	22-36
Four Wheel Drive Indicator Switch	34-47	25-35
Front and Rear Output Yokes to Transfer Case	163-203	120-150 Rear 150-180 Front
Drain Plug	9-23	7-17
Fill Plug	9-23	7-17
Transfer Case to Transmission Adapter	34-58	25-43
Heat Shield to Transfer Case	54-61	40-45
Skid Plate to Frame	20-27	15-20
Front Driveshaft to Front Output Yoke	11-20	8-15
Rear Driveshaft to Rear Output Circular Flange — Bolt — Bronco	28-33	20-28
Rear Driveshaft to Rear Output Yoke — Nut — F150-F350 4x4	11-20	8-15
Oil Pump Cover Screws	4-4.5	36-40 In-Lb
Clutch Coil Retaining Nuts	8-11	6-8
Rear Bearing Retainer	30-49	22-36
Shift Motor Screws	8-11	6-8
Support Bracket to Shift Motor	2.7-3.4	2-2.5
Wire Bracket to Rear Cover	8-11	6-8

SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer — 2-1/2 lb.	 T50T-100-A
TOOL-1175-AC Seal Remover	 TOOL-1175-AC
T80T-4000-P Bearing Installer	 T80T-4000-P
T74P-77248-A Seal Remover	 T74P-77248-A

(Continued)

Tool Number / Description	Illustration
T61L-7657-B Oil Seal Installer	 T61L-7657-B
T85T-7034-AH Extension Housing Bushing Remover	 T85T-7034-AH
T85T-7034-BH Extension Housing Bushing Installer	 T85T-7034-BH
T80T-4000-W Driver Handle	 T80T-4000-W
T86T-7034-CH Output Shaft Seal Installer	 T86T-7034-CH
T73T-1202-B Bearing Cup Replacer	 T73T-1202-B
T73T-1202-A Bearing Cup Replacer	 T73T-1202-A
T83T-7065-B Output Shaft Seal Installer	 T83T-7065-B

Tool Number	Description
D80L-100-A	Blind Hole Puller Set
D80L-100-T	Collet (Universal 1-1/4 to 1-1/2 Inch)
D80L-100-H	Actuator Pin (Use with Blind Hole Puller)

ROTUNDA EQUIPMENT

Tool Number	Description
077-00019	Transmission Jack
007-00001	Digital Volt-Ohmmeter

SECTION 07-07B Transfer Case, Manual Shift

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION (Cont'd.)	
Fluid Level Check	07-07B-20	Rear Output Shaft Extension Housing Oil Seal, Slip Spline Type	07-07B-5
DESCRIPTION	07-07B-1	Shift Lever	07-07B-4
DIAGNOSIS AND TESTING	07-07B-2	Transfer Case	07-07B-2
DISASSEMBLY AND ASSEMBLY		SPECIAL SERVICE TOOLS/EQUIPMENT	07-07B-20
Transfer Case	07-07B-6	SPECIFICATIONS	07-07B-20
REMOVAL AND INSTALLATION		VEHICLE APPLICATION	07-07B-1
Oil Seal, Front Output Yoke (All) And Rear Output Flange (Bronco)	07-07B-6		

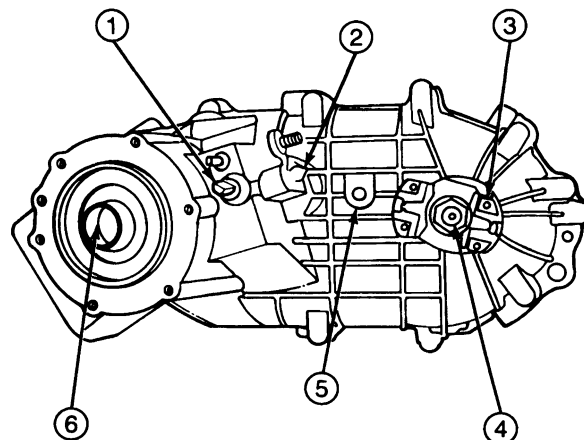
VEHICLE APPLICATION

F-150-250-350 and Bronco Vehicles

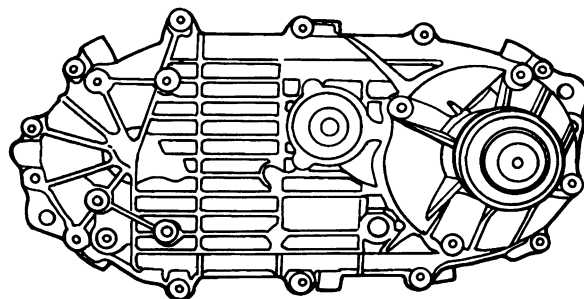
DESCRIPTION

The Borg-Warner 13-56 manual shift transfer case is a part-time three-piece transfer case. The case is magnesium, except for F-350 applications which have an aluminum front case half and an opening for a power take-off (PTO). The unit is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft and allows towing of the vehicle without disconnecting the rear driveshaft.

On the front case half, the input shaft, front output shaft, four-wheel drive indicator switch, and shift lever are located. On the rear case half, the rear output shaft, output shaft bearing retainer (or slip yoke-type bearing retainer), and drain and fill plugs are located. Two types of bearing retainers are used: a rear fixed output circular flange and a slip-yoke type.



FRONT VIEW



BORG-WARNER 13-56 — MANUAL SHIFT
TRANSFER CASE — REAR

C7860-C

Item	Description
1	Four-Wheel Drive Indicator Switch
2	Shift Lever

(Continued)

DESCRIPTION (Continued)

Item	Description
3	Front Output Shaft Yoke
4	Front Output Shaft
5	Fill Plug for PTO Use (F-350 Only)
6	Front Input Shaft

DIAGNOSIS AND TESTING

Refer to Section 07-00B for diagnosis and testing procedures.

REMOVAL AND INSTALLATION

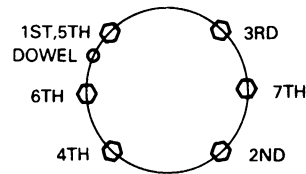
Transfer Case

Removal

1. Raise vehicle on a hoist and position suitable safety stands under vehicle.
2. Remove skid plate, if equipped.
3. Place a drain pan under transfer case, remove drain plug and drain fluid from transfer case.
NOTE: Drain transfer case only if transfer case disassembly is required.
4. Disconnect four-wheel drive indicator switch wire connector at transfer case.
5. Disconnect front driveshaft from front output yoke.
6. Disconnect rear driveshaft from rear output shaft yoke.
7. Disconnect vent hose (7D494) from transfer case.
8. Disconnect the control rod (7A315) between the transfer case shift lever (7B106) and the control lever assembly (7E069).
CAUTION: When removing the control rod (7A315) from the control lever assembly, do so very gently so as not to damage the control lever assembly.
CAUTION: Catalytic converter is located beside heat shield. Be careful when working around catalytic converter because of the extremely high temperatures generated by the converter.
9. Support transfer case with a transmission jack such as Rotunda Number 077-00019 or equivalent.
10. Remove the bolts retaining transfer case to transmission adapter.
11. Slide transfer case rearward off the transmission output shaft and lower transfer case from vehicle. Remove gasket between transfer case and adapter.

Installation

1. Clean transmission and transfer case gasket surfaces and place a new gasket between transfer case and adapter.
2. Raise the transfer case with the transmission jack so that the transmission output shaft aligns with the splined transfer case input shaft. Slide the transfer case forward onto the transmission output shaft and onto the dowel pin. Install the six transfer case retaining bolts to the extension housing. Tighten the bolts to 34-58 N·m (25-43 ft·lb) in the sequence shown.



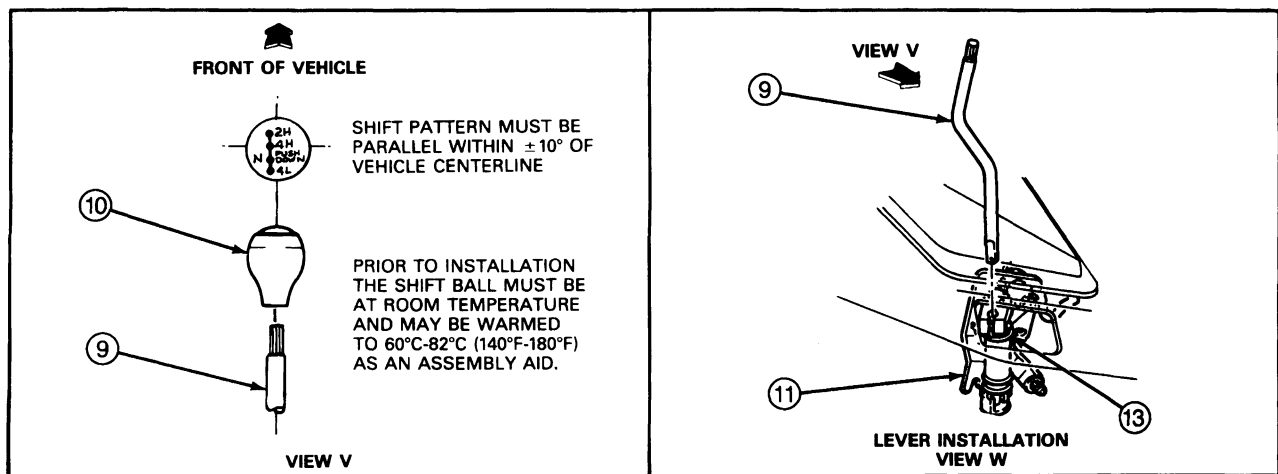
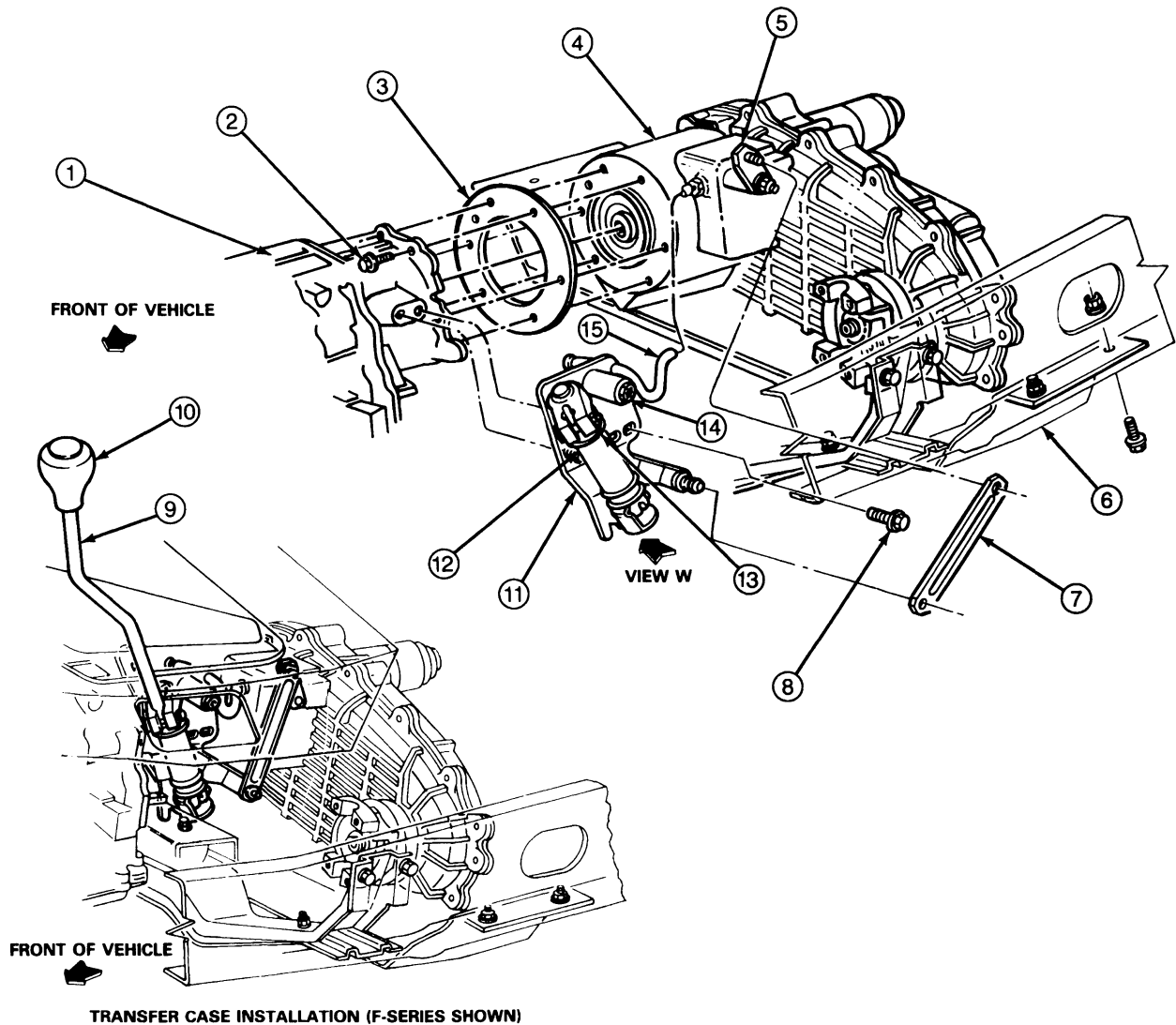
TIGHTEN CASE TO EXTENSION BOLTS IN THIS SEQUENCE

C7434-1A

3. Remove transmission jack from transfer case.
4. Connect rear driveshaft to rear output shaft yoke. For Bronco, tighten bolts to 28-33 N·m (20-25 ft·lb), for F150-250-350 4x4, tighten nut to 11-20 N·m (8-15 ft·lb).
5. Connect vent hose (7D494) to transfer case.
6. Attach the control rod (7A315) between the transfer case shift lever (7B106) and the control lever assembly (7E069).
7. Connect four-wheel drive indicator switch wire connector at transfer case.
8. Connect front driveshaft to front output yoke. Tighten nut to 11-20 N·m (8-15 ft·lb). On F-350 vehicles, tighten driveshaft to transfer case bolts to 28-33 N·m (20-25 ft·lb).
9. Install skid plate to frame. Tighten nuts and bolts to 20-27 N·m (15-20 ft·lb).
10. Install drain plug and tighten to 9-18 N·m (6-14 ft·lb). Remove fill plug at rear of transfer case and install Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent to the bottom of the fill plug hole. Install fill plug and tighten to 9-23 N·m (7-17 ft·lb). If vehicle is equipped with a PTO, refer to Fill Level Check, Transfer Case with PTO, in this section.
11. Remove safety stands and lower vehicle.

REMOVAL AND INSTALLATION (Continued)

Transfer Case Installation



C7861-F

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	7003	Transmission and Extension Housing Assembly
2	N605804-S100	Bolt 41-55 N·m (30-41 Ft·Lb)
3	7086	Gasket
4	7A195	Transfer Case Assembly
5	7B106	Shift Lever
6	7E063	Skid Plate
7	7A135	Connecting Shift Rod
8	58695-S2	Bolt 96-122 N·m (71-90 Ft·Lb)

(Continued)

Item	Part Number	Description
9	7E067	Lever
10	7F067	Ball
11	7E069	Control Lever Assembly
12	391219-S2	Bolt 92-125 N·m (68-92 Ft·Lb)
13	—	Nut (Part of 7E069 Control Lever) 27-38 N·m (20-28 Ft·Lb)
14	—	Bolt (Part of 7E069 Control Lever) 92-125 N·m (68-92 Ft·Lb)
15	7D494	Hose, Vent

Shift Lever

NOTE: Remove the shift ball only if the shift ball, boot or lever (7E067) is being replaced.

Removal

1. Shift transfer case into 2H.
2. Raise vehicle on hoist and position suitable safety stands under vehicle.
3. Loosen (do not remove) the nut retaining the shift handle (7E067) to the control lever assembly (7E069). Remove the shift handle (7E067) from the control lever assembly (7E069).
4. Remove the vent hose (7D494) from the notch in the detent plate.
5. Remove the control rod (7A315) from the control lever assembly (7E069).

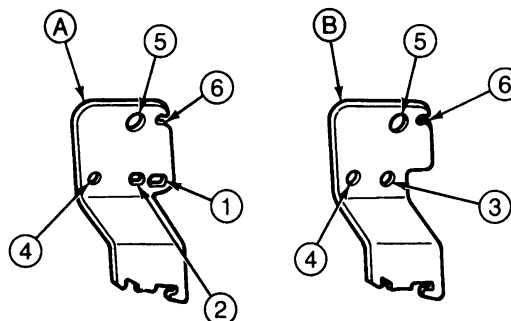
CAUTION: When removing the control rod (7A315) off the control lever assembly (7E069), do so very gently so as not to damage the control lever assembly.

6. Loosen (do not remove) the large pivot bolt holding the control lever assembly (7E069) to the detent plate.
7. Swing the control lever assembly (7E069) out of the way and remove the two bolts (39129-S2) retaining the detent plate to the transmission extension housing. Remove the entire control lever assembly from the vehicle.

Installation

1. Prior to installing the control lever assembly, be sure the transfer case link (7B106) is in the 2H position (pointing upward).
2. Install the two bolts (39129-S2) to retain the control lever assembly (7E069) to the transmission extension housing and tighten to 96-122 N·m (71-90 ft·lb). Refer to the following illustration for bolt hole application.
3. Attach the control rod (7A315) to the control lever assembly (7E069).

4. Tighten the large pivot bolt to 92-125 N·m (68-92 ft·lb).
5. Attach the vent hose (7D494) into the notch in the detent plate so the white mark is flush to the outside surface of the plate.
6. Install the shift lever (7E067) into the control lever assembly (7E069). Tighten the retaining nut to 27-38 N·m (20-28 ft·lb).
7. Check transfer case for proper shifting and operation.



C10894-A

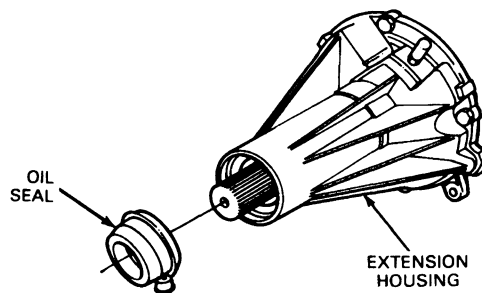
TRANSFER CASE DETENT PLATES (LEGEND)

Item No.	Description
A	Detent Plate (All Transmissions Except E4OD)
B	Detent Plate (E4OD)
1	Bolt Hole (AOD, ZF Lt. Dty, Mazda R2)
2	Bolt Hole (C6, ZF Hvy. Dty, T-18)
3	Bolt Hole (E4OD)
4	Bolt Hole (All Transmissions)
5	Pivot Bolt Hole (All Transmissions)
6	Notch (Vent Hose)

CC10895-A

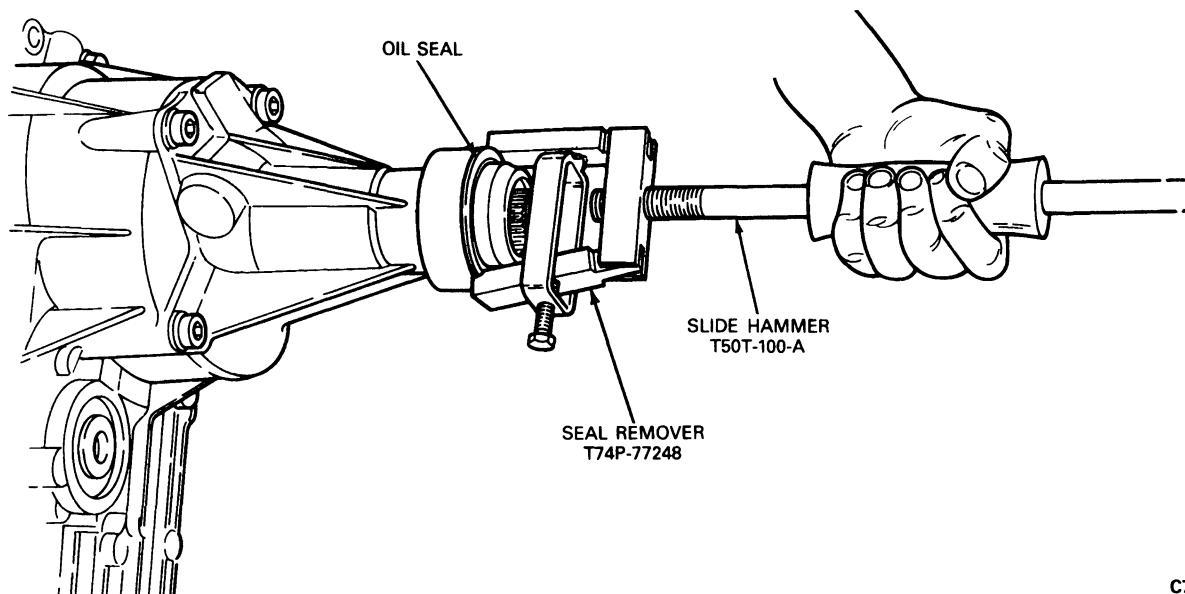
REMOVAL AND INSTALLATION (Continued)**Rear Output Shaft Extension Housing Oil Seal, Slip Spline Type****Removal**

1. Raise the vehicle on a hoist and position suitable safety stands under vehicle.
2. Disconnect driveshaft from rear of transfer case. Refer to Section 05-01.



C7863-C

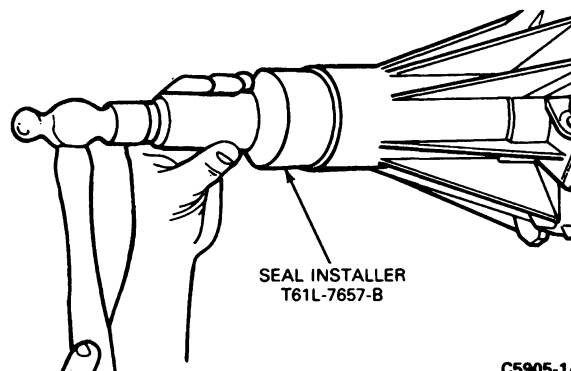
3. With a screwdriver, pry the oil seal from the bearing retainer. The seal may also be removed using Slide Hammer T50T-100-A and Seal Remover T74P-77248-A. Discard the oil seal.

Oil Seal Remover, Slip Spline Type, Rear Bearing Retainer (Fixed Yoke Similar)

C7864-C

Installation

1. Position the seal in the retainer so the notch on the seal faces upward and the drain hole in the rubber dust boot faces downward. Drive the seal in the retainer using Seal Installer T61L-7657-B.



C5905-1A

2. Install driveshaft. Refer to Section 05-01.
3. Remove safety stands and lower vehicle.

REMOVAL AND INSTALLATION (Continued)**Oil Seal, Front Output Yoke (All) And Rear Output Flange (Bronco)****Removal**

1. Raise the vehicle on a hoist and position suitable safety stands under vehicle.
2. Remove the rear or front driveshaft from the transfer case output shaft yoke. Wire the driveshaft(s) out of the way.
3. Remove the output shaft yoke by removing the 30mm nut, steel washer and rubber seal from the rear or front output shaft and remove the yokes.
4. Remove the oil seal from the rear output housing bore with Seal Remover T74P-77248-A, and Impact Slide Hammer T50T-100-A.

Installation

1. Make sure the output housing bore and face are free from nicks and burrs. Position the oil seal into the front or rear output housing bore, making sure that the oil seal is not cocked in the bore. Drive the oil seal into the bore with Output Shaft Seal Installer T86T-7034-CH.

2. Install the yoke, rubber seal, steel washer and locknut on the front or rear output shafts. Tighten the nut to 203-244 N·m (150-180 ft-lb) front; 163-203 N·m (120-150 ft-lb) rear.
3. Connect the front or rear driveshaft to the transfer case output shaft yoke. Tighten the bolts to specifications. Refer to Specifications in this section.
4. Check lubricant level. Adjust as required.
5. Remove safety stands and lower the vehicle from the hoist.

DISASSEMBLY AND ASSEMBLY**Transfer Case****Disassembly**

1. Remove transfer case from vehicle as outlined in this section.

DISASSEMBLY AND ASSEMBLY (Continued)

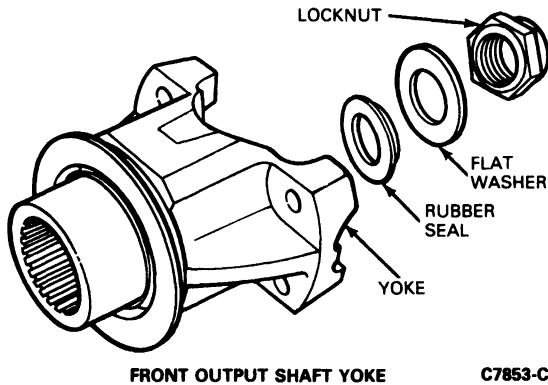
Item	Part Number	Description
1	7045	Nut (rear yoke / flange)
2	7B363	Washer (rear yoke / flange)
3	7052	Seal, Oil (rear spline) Seal, Oil (rear flange)
4	7B214	Flange Assy, Rear (rear flange)
6	—	Flange (rear flange) (Serviced as part of 7B214 Assembly)
7	7A010	Plug, Pipe
8	7A443	Bolt (1987-88) Bolt and Washer Assy (1989 and later)
9	7085	Extension Assy (rear spline) Cap Assy, Bearing (rear yoke / flange)
10	7B215	Seal, Oil (rear spline) Seal, Oil (rear yoke / flange)
14	—	Extension (rear spline) Cap, Bearing (rear yoke / flange) (Serviced as part of 7085 Assembly)
26	7917	Ring, Snap
27	7A443	Bolt (1987-88) Bolt and Washer Assy (1989)
28	7005	Cover Assy, Transfer Case
29	7025	Bearing, Ball
30	7127	Bearing, Needle
35	7005	Cover, Transfer Case
36	7E290	Magnet
37	7219	Spring, Return
38	7917	Ring, Snap
40	7100	Hub, Shift Collar
42	7917	Ring, Retaining
43	7D164	Hub Lockup
44	7D126	Spring, Sleeve Return
45	7106	Collar, Lockup
46	7240	Rail, Shift
47	7289	Fork Assy, Shift, 2W-4W
48	7C430	Facing, Shift Fork
49	7917	Ring, Retaining
50	7119	Washer
51	7177	Sprocket, Drive
52	7177	Sprocket, Driven
53	7A029	Chain, Drive
55	7A291	Bolt
56	7E215	Retainer, Pump
57	7A152	Cover, Pump, Rear
58	382486-S	Clamp, Hose
59	7A210	Coupling, Hose
60	7A098	Strainer, Oil

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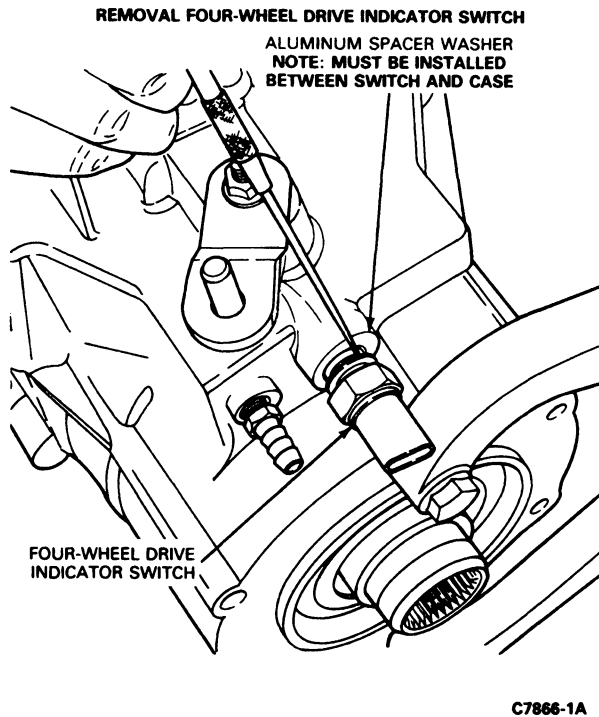
Item	Part Number	Description
61	7A149	Housing, Pump
62	7A250	Pin, Pump
63	7A205	Spring, Pump Pin
64	7A152	Cover, Pump, Front
65	7061	Shaft, Output (rear)
66	7100	Hub, Reduction
67	7289	Ford Assembly Reduction
68	—	Facing, Shift Fork (Serviced as Part of 7289 Assembly)
70	—	Retainer (Serviced as Part of 7289 Assembly)
71	—	Roller, Cam (Service as Part of 7289 Assembly)
72	—	Pin
73	—	Fork, Reduction (Serviced as Part of 7289 Assembly)
74	7E440	Switch, 4WD Indicator
75	—	Setscrew
77	7B106	Lever, Shaft and Pin Assy
78	7C349	Spring, Assist
79	—	Bushing, Assist
80	7F063	Cam, Shift
85	7B215	Seal, Oil
86	—	Ring, Retaining
87	7A398	Carrier Assy, Complete (with PTO) Carrier Assy, Complete (without PTO)
88	7C122	Ring, Retaining
89	7A153	Gear, Ring
90	—	Gear, PTO (with PTO)
91	7045	Nut
92	7B363	Washer
93	7052	Seal, Oil
94	7B214	Yoke Assembly, Front
96	—	Yoke (Serviced as Part of 7B214 Assembly)
97	7061	Shaft, Output Shaft, Output (optional)
98	7034	Barb, Breather
99	381673-S	Bolt (with PTO)
100	7165	Cover, PTO (with PTO)
101	7166	Gasket (with PTO)
102	7005	Case Assy, Transfer
103	7B215	Seal, Oil
104	7917	Ring, Retaining
105	7025	Bearing, Ball
106	7917	Ring, Retaining
107	7025	Bearing, Ball
108	7288	Seal, Oil
109	—	Pin Dowel
110	7005	Case, Transfer (with PTO) Case, Transfer (without PTO)

DISASSEMBLY AND ASSEMBLY (Continued)

2. Remove front output shaft yoke nuts, washers, and rubber seals and remove the front output yoke from the transfer case. On Bronco, repeat procedure for rear output circular flange.

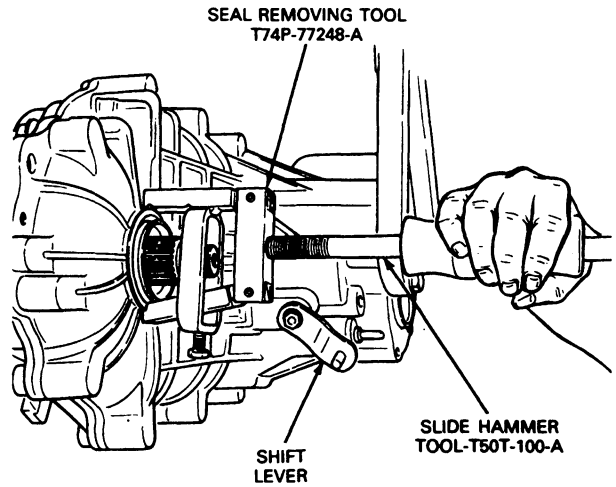


3. Remove the four-wheel drive indicator switch and aluminum washer from the transfer case. Do not lose this washer as it is required for the proper operation of this switch.



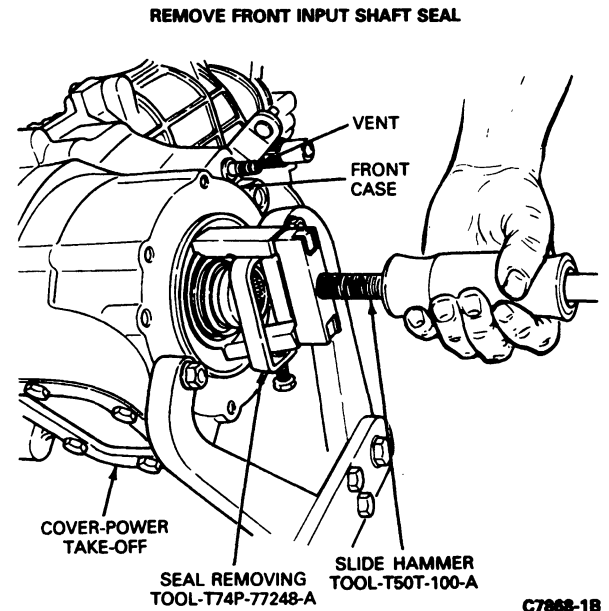
4. Remove the front and rear output shaft yoke seals using Oil Seal Remover T74P-77248-A and Slide Hammer T50T-100-A.

NOTE: A screwdriver may be used to remove the seal. Discard seal once removed.



REMOVE FRONT OUTPUT SHAFT SEAL C7867-1B

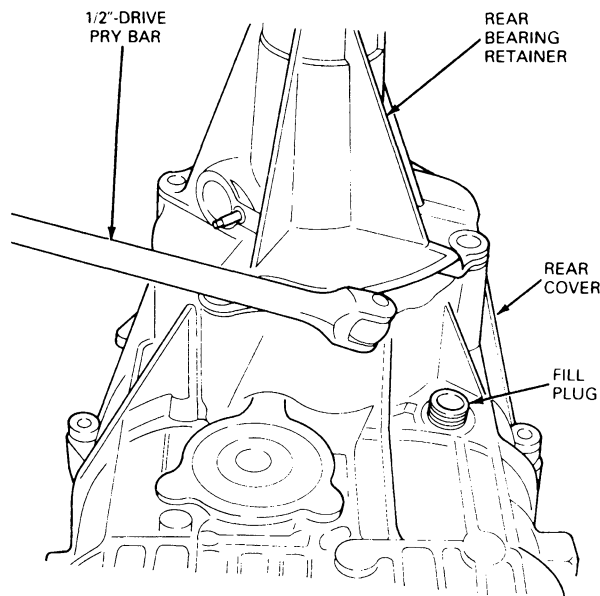
5. Remove the input shaft seal using same tools.



DISASSEMBLY AND ASSEMBLY (Continued)

6. Remove the four No. 50 Torx® head bolts securing the rear bearing retainer to the cover. Pry the rear bearing retainer from the cover using a 1/2-inch drive breaker bar between the pry bosses and separate and remove the bearing retainer from the cover. Remove all traces of silicone rubber from the mating surfaces of the cover and the bearing retainer.

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium cases.

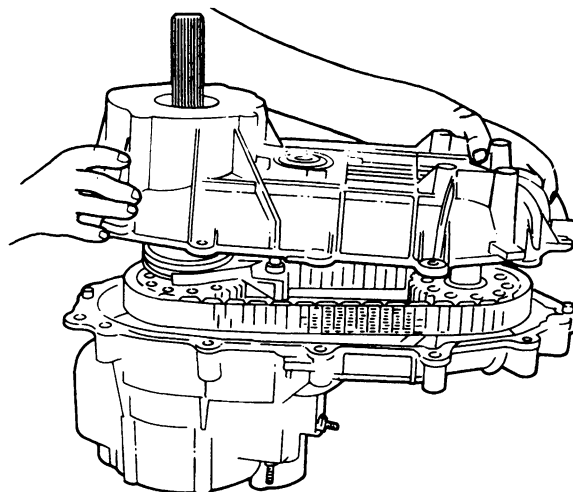


REMOVE REAR BEARING RETAINER

C7869-1A

7. Remove the snap ring on the rear output shaft retaining the upper rear ball bearing using snap ring pliers.
8. Remove the 12 No. 50 Torx® head bolts that retain the front case to the rear cover. Insert a 1/2-inch drive breaker bar between the pry bosses and separate. Lift the front case from the rear cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the front case and the rear cover.

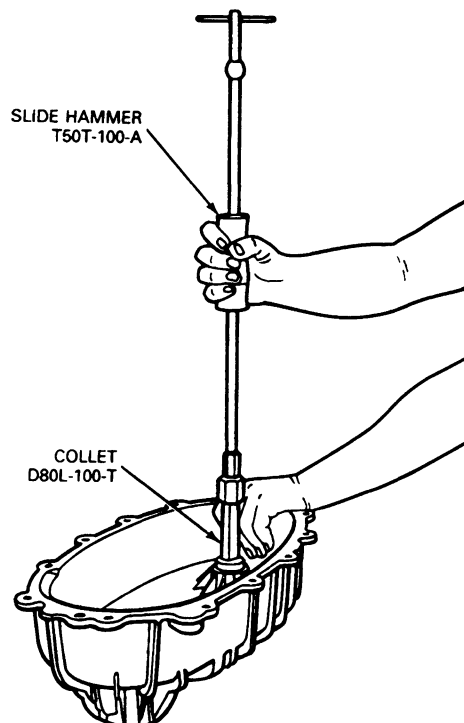
CAUTION: When removing the silicone rubber, use care not to damage the mating surfaces of the magnesium housings.



REMOVE REAR COVER FROM CASE ASSEMBLY

C7441-1A

9. Remove front output shaft inner needle bearing from the rear cover with Slide Hammer T50T-100-A and Collet D80L-100-T from Blind Hole Puller Set D80L-100-A or equivalents.

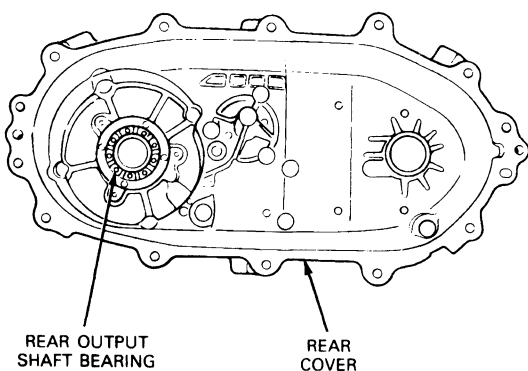


C9082-1A

DISASSEMBLY AND ASSEMBLY (Continued)

10. Drive out the rear output shaft bearing from the inside of the case using a brass drift tapping it lightly with a small hammer so as not to cause any damage to the case.

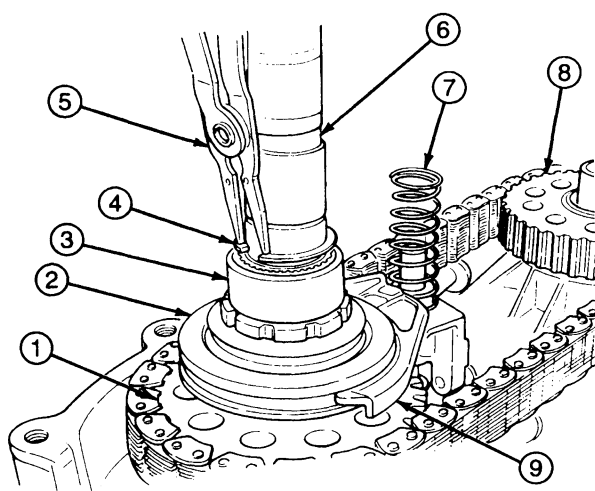
REAR COVER — REAR OUTPUT SHAFT BEARING/
FRONT OUTPUT SHAFT INNER BEARING



C10802-A

11. Remove the snap ring from the output shaft securing the shift collar hub. Slide the 4WD hub off of the output shaft.

**2WD-4WD Sprockets and Lockup Assemblies,
Chain Drive and Driven Sprockets**



C7872-D

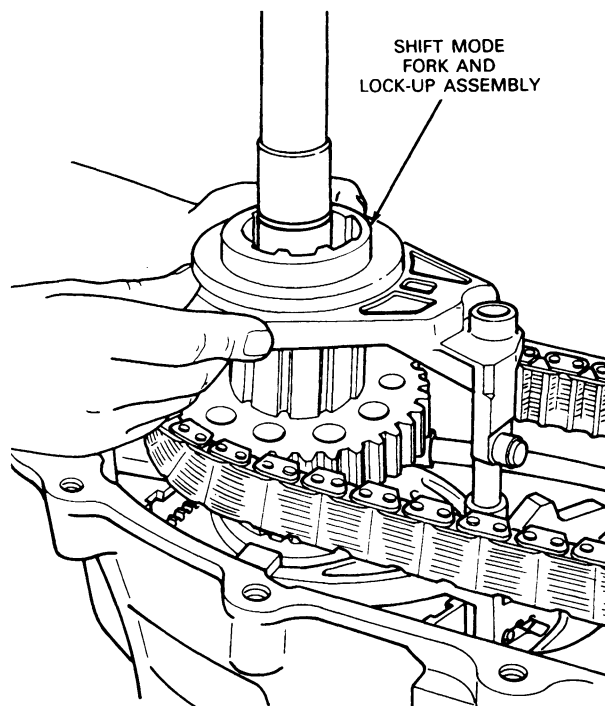
Item	Description
1	Drive Sprocket
2	2W-4W Lockup Assembly
3	4WD Hub
4	Snap Ring

(Continued)

Item	Description
5	Snap Ring Pliers
6	Rear Output Shaft Assembly
7	Spring
8	Driven Sprocket
9	Mode Shift Fork

TC7872A

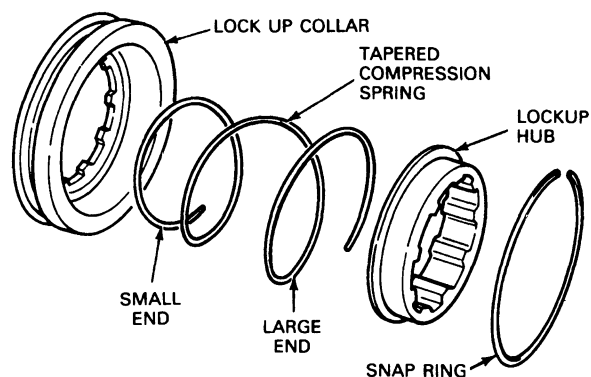
12. Remove the spring from the shift rail and lift the mode (2WD / 4WD) shift fork complete with the shifting collar from the rear output shaft.



C7873-1A

13. Disassemble the 2W-4W lockup assembly by removing the internal snap ring and pull the lockup hub and spring from the collar.

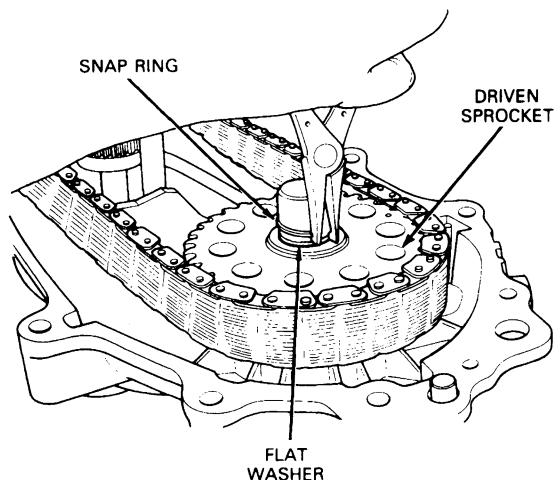
2W/4W LOCK UP COLLAR ASSEMBLY



C7874-B

DISASSEMBLY AND ASSEMBLY (Continued)

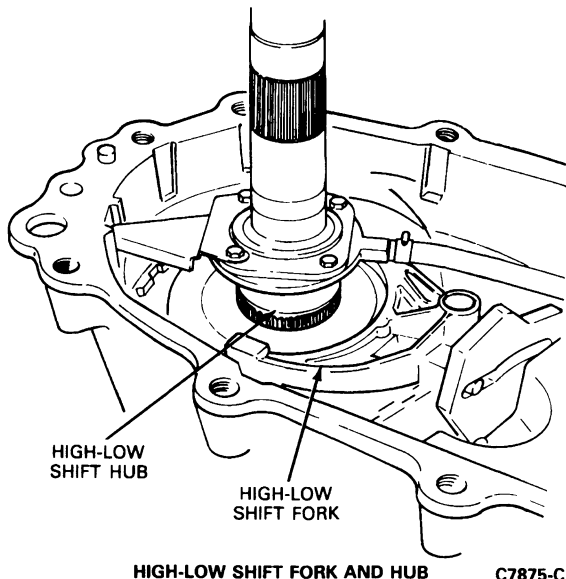
14. Remove the snap ring retaining the driven sprocket to the front output shaft. Grasp the drive and driven sprocket complete with the chain and lift them at the same time from the drive and driven output shafts.



REMOVE SNAP RING — DRIVEN SPROCKET

C7446-C

15. Remove the shift rail by sliding it straight out from the shift fork.
16. Remove the high-low shift fork by first rotating it until the roller is free from the cam, then sliding out of engagement from the high-low shift hub.

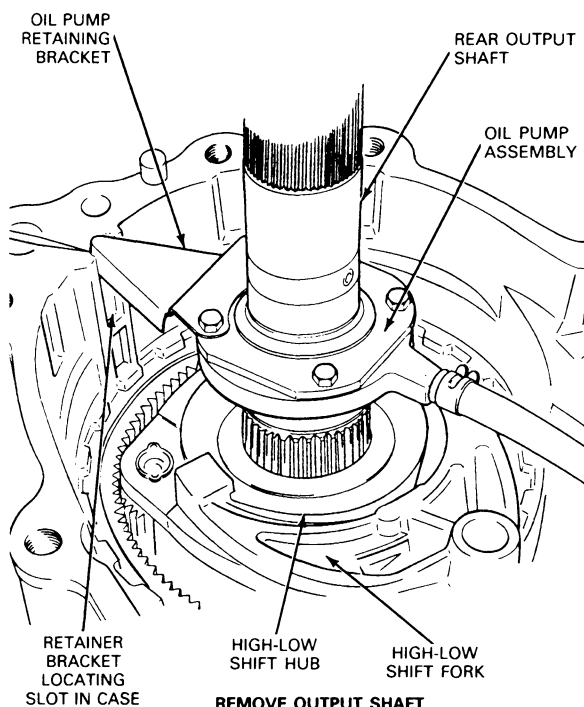


HIGH-LOW SHIFT FORK AND HUB

C7875-C

17. Remove the magnet from its slot in the case.
18. Lift out the pump screen and remove the output shaft assembly with the pump assembled on it. If the pump is to be disassembled, remove the four bolts from the pump body. Note the position of the pump front body, pins, spring, rear cover and pump retainer as removed.

CAUTION: Do not disassemble oil pump unless the oil pump retaining bracket has been bent or broken, or pump damage is indicated. Indications of pump damage are bluing or blackening of the pump, or loosening of the pump bolts.



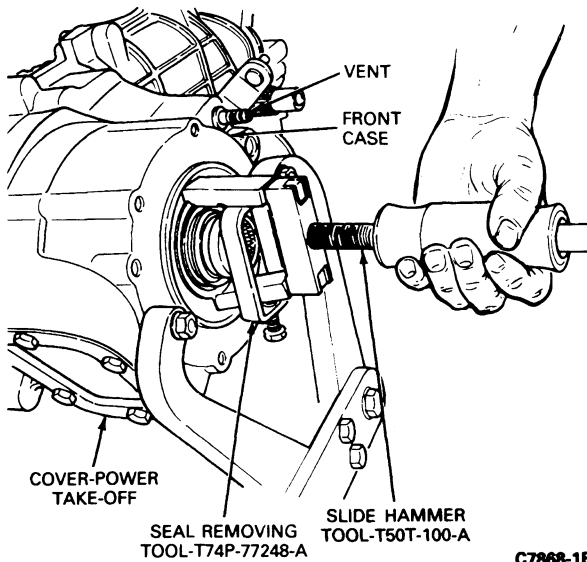
REMOVE OUTPUT SHAFT ASSEMBLY WITH OIL PUMP ASSEMBLY

C7876-1A

19. Remove the high-low shift hub.

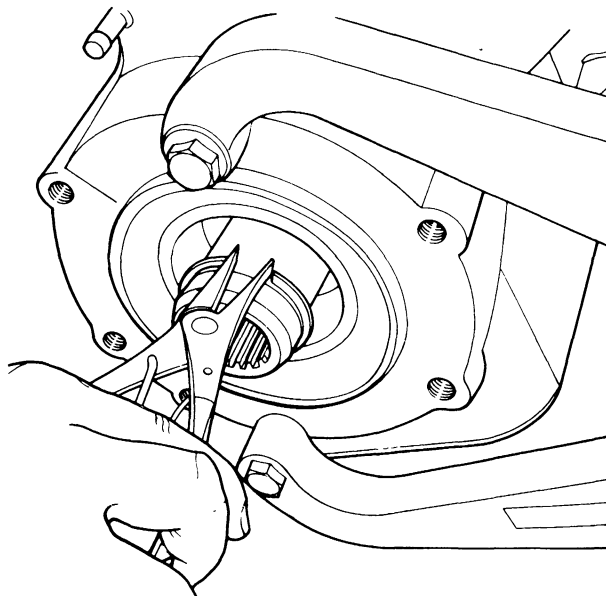
DISASSEMBLY AND ASSEMBLY (Continued)

20. Turn the front case over and remove the front input oil seal from the case using Oil Seal Remover T74P-77248-A and Slide Hammer T50T-100-A.

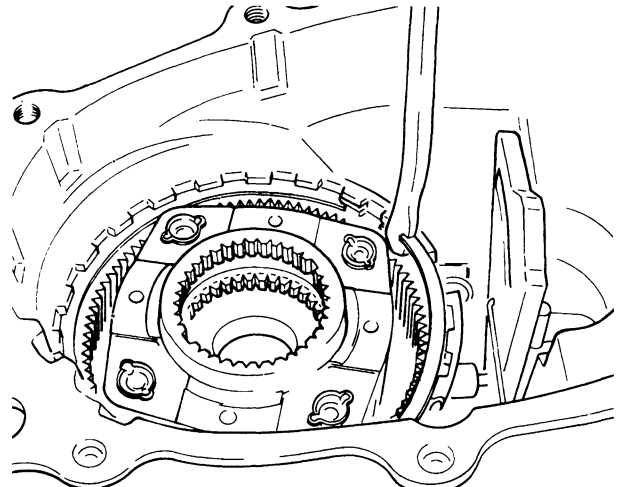
REMOVE FRONT INPUT SHAFT SEAL

C7868-1B

21. Reaching through the front opening with a pair of snap ring pliers, carefully expand the snap ring on the input shaft allowing it to drop out of the bearing. The carrier assembly, including the input shaft, is serviced as an assembly only. If the bearing or bushing is to be replaced, drive out both of them through the input spline using suitable tools such as a brass drift and a small hammer, being careful not to damage the case.

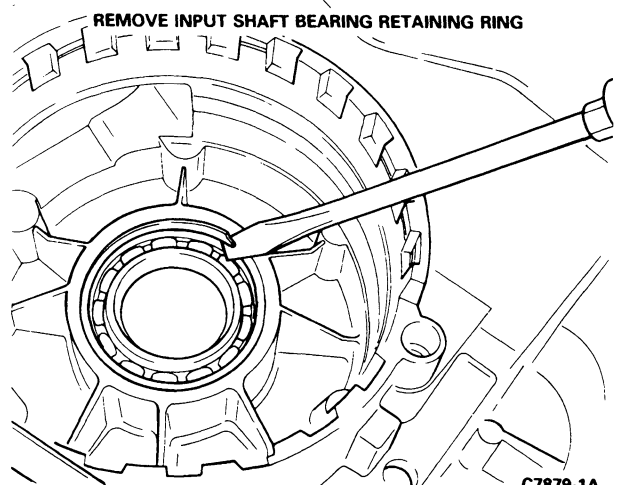
**REMOVE INPUT SHAFT BEARING SNAP RING** C7851-1A

22. Remove the ring gear by prying out the internal snap ring with a screwdriver and lift out the gear.

**REMOVE RING GEAR RETAINING SNAP RING**

C7877-1A

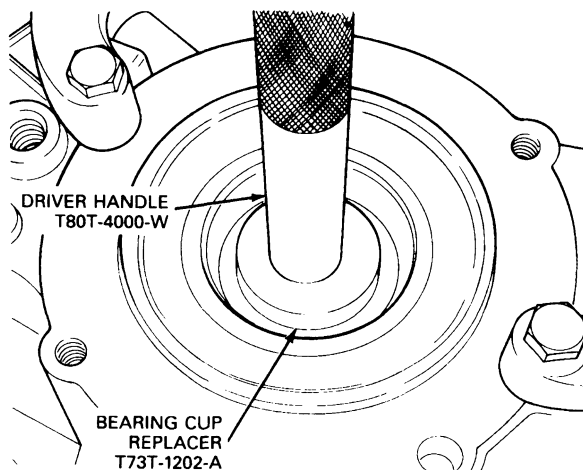
23. Remove the internal snap ring securing the input shaft bearing to the case.

**REMOVE INPUT SHAFT BEARING RETAINING RING**

C7879-1A

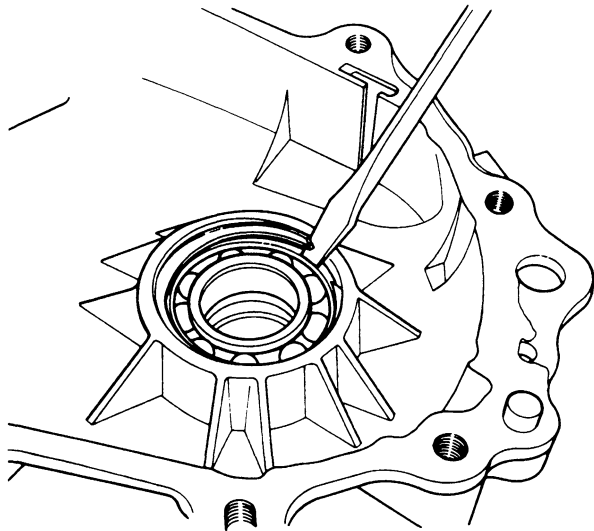
DISASSEMBLY AND ASSEMBLY (Continued)

24. Remove the input shaft bearing using Bearing Cup Replacer T73T-1202-A and Driver Handle T80T-4000-W.

**REMOVE INPUT SHAFT BEARING**

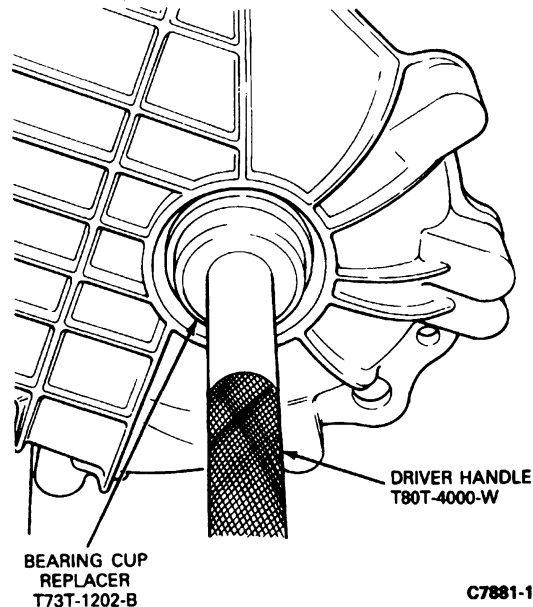
C7880-C

25. Remove the internal snap ring securing the front output shaft bearing in the magnesium housing.

**REMOVE FRONT OUTPUT SHAFT BEARING RETAINING SNAP RING**

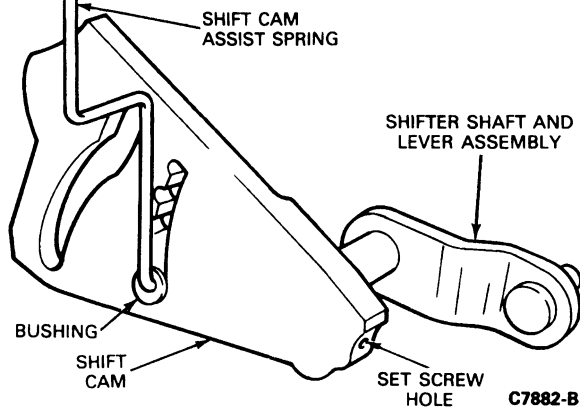
C7852-1A

26. Drive the bearing out from the front of the case using Bearing Cup Replacer T73T-1202-B and Driver Handle T80T-4000-W.

REMOVE FRONT OUTPUT SHAFT BEARING

C7881-1B

27. Remove the 4WD indicator switch (7E440).
28. Place the shift lever in the NEUTRAL position so the shift cam set screw can be seen through the hole for the 4WD indicator switch.
29. Remove the set screw using a hex key tool.
30. Remove the shift lever by sliding it out of the case.
31. Remove the shift cam.
32. Remove the shift shaft seal by carefully prying it out of the case, being careful not to damage the magnesium.
33. Remove the shift cam, assist spring, and assist spring bushing from the case.

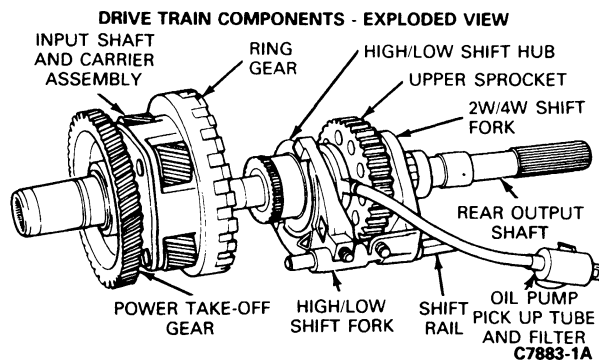
SHIFT CAM, LEVER AND SHAFT INSTALLATION

C7882-B

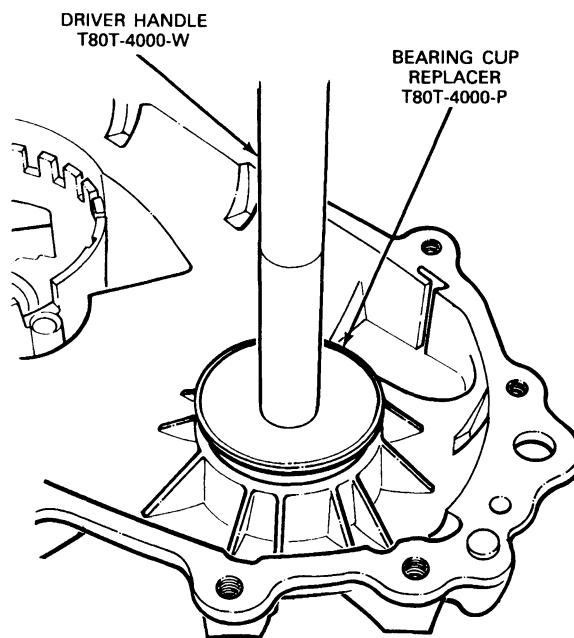
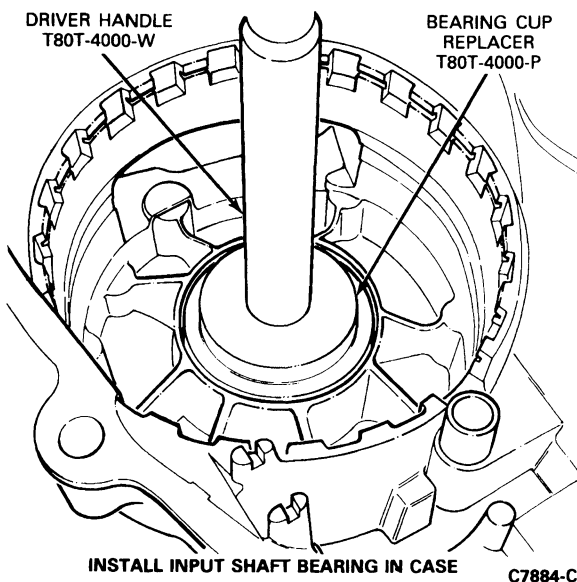
DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

Before assembly, lubricate all parts with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent. Remove all chips from the bolt holes in the case and rear cover.



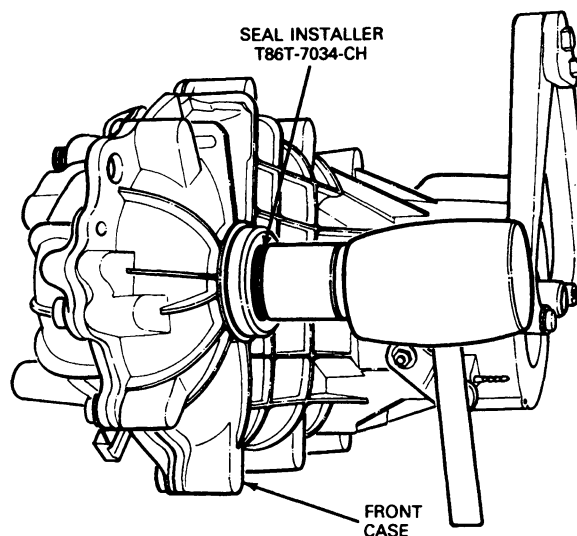
1. Install the input shaft and the front output shaft bearings in the case using Bearing Cup Replacer T80T-4000-P and Driver Handle T80T-4000-W. Install the internal snap rings retaining the bearings in the case.



INSTALL FRONT OUTPUT SHAFT BEARING

C7885-C

2. Drive the front output shaft seal into the case until it is fully seated against the case using Oil Seal Installer T86T-7034-CH.



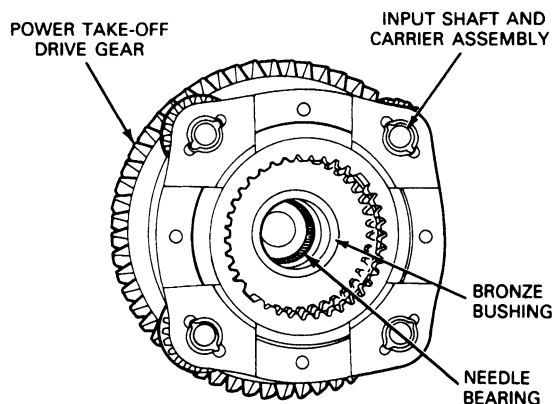
FRONT OUTPUT SHAFT SEAL INSTALLATION

C7886-1B

3. Install the front output shaft through the lower bearing. The front output shaft is held in place in the case by the front output yoke and oil seal slinger assembly. Install the front yoke assembly onto the front output shaft then the rubber seal, flat washer and 30mm locknut. Tighten the yoke locknut to 163-203 N·m (120-150 ft·lb).

DISASSEMBLY AND ASSEMBLY (Continued)

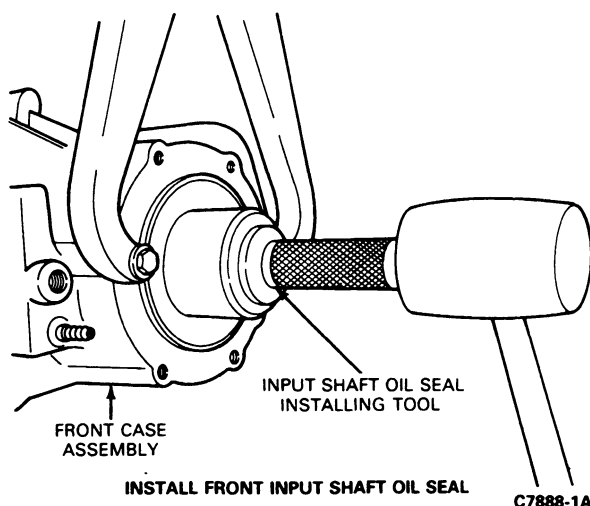
4. Press the needle bearing and bronze bushing into the input shaft and carrier assembly with the appropriate tools, making sure that the bearing and bushing are driven in straight.



FRONT INPUT SHAFT AND CARRIER ASSEMBLY

C7887-1A

5. Install the ring gear into the slots in the case and retain it with the large internal snap rings making sure that it is fully seated.
6. Install the input shaft and carrier assembly in the case through the input shaft bearing, being careful not to damage the gear teeth when aligning them with the ring gear teeth.
7. While supporting the carrier assembly in position, install a **new** snap ring on the front side of the input shaft bearing, making sure that it is fully seated in the snap ring groove of the input shaft.
8. Install the upper input shaft oil seal into the case using an appropriate tool until it is fully seated against the case.



INSTALL FRONT INPUT SHAFT OIL SEAL

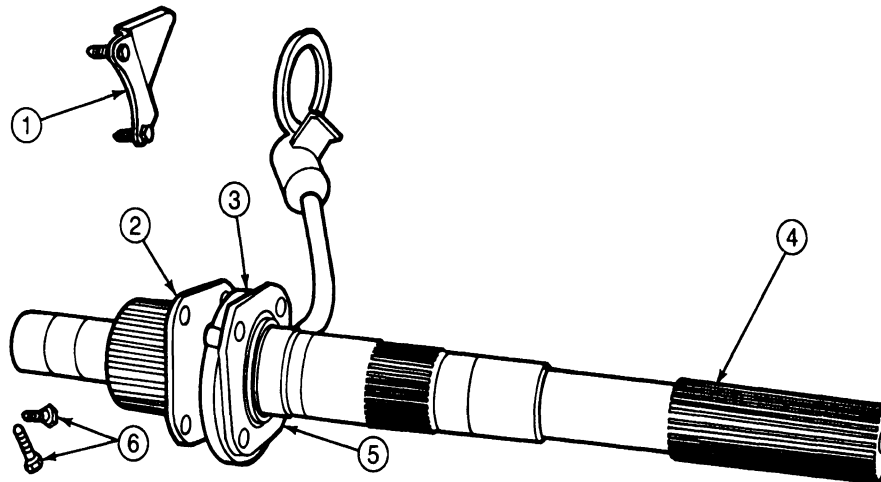
C7888-1A

9. Install a new shifter shaft seal into the case using an appropriate tool.
10. Install the shift cam assist spring in position in the bushing of the shift cam and in the recess in the case.
11. Assemble the shift cam assembly into the case by sliding the shift shaft and lever assembly through the case and seal into engagement with the shift cam. Install the set screw through the holes in the case for the 4WD indicator switch.
12. Lubricate all pump parts with clean automatic transmission fluid prior to assembly.
13. Assemble the pump and output shaft as follows:
- Place the oil pump cover with the word TOP facing the front of the case.
 - Install the two pins (with the flats facing toward the rear of the vehicle) with the spring between the pins and place the assembly in the oil pump bore in the output shaft.
 - Place the oil pump body and pick-up tube over the shaft and make sure that the pins are riding against the inside of the pump body.
 - Place the oil pump rear cover with the words TOP REAR facing the rear of the case.

NOTE: The word TOP on the front cover and the rear cover should be on the same side.

- Install the pump retainer with the tabs facing the front of the transfer case.
- Install the four retaining bolts and rotate the output shaft while tightening the bolts to prevent the pump from binding. Tighten bolts to 4-4.5 N·m (36-40 in·lb).

NOTE: The output shaft must turn freely within the oil pump. If binding occurs, loosen the four bolts and retighten as outlined.

DISASSEMBLY AND ASSEMBLY (Continued)**Rear Output Shaft and Oil Pump Installation**

C7889-B

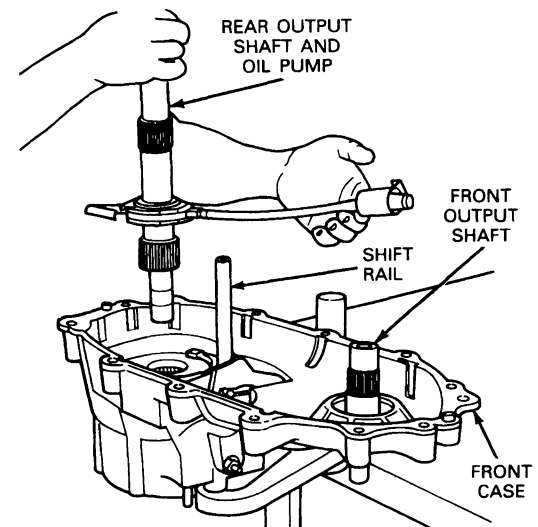
Item	Description
1	Pump Retainer
2	Oil Pump Front Cover

(Continued)

Item	Description
3	Oil Pump Body and Pick-Up Tube
4	Output Shaft
5	Oil Pump Rear Cover
6	Retaining Bolts

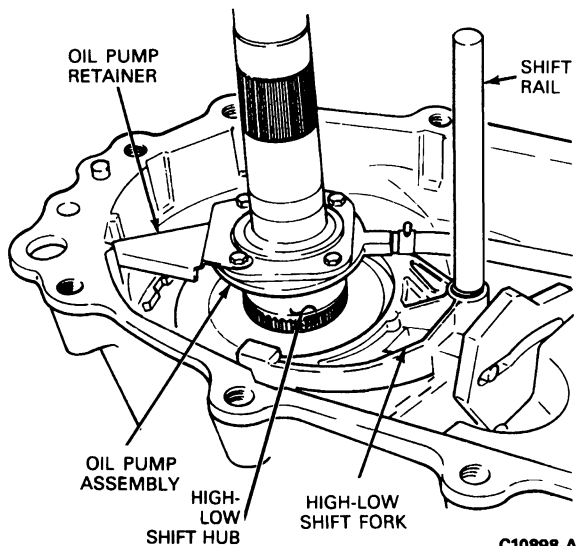
14. Install the high-low shift hub.

Install the high-low shift fork by engaging it with the shift hub flange and rotating it until the roller is engaged with the lower groove of the cam.

15. Install the shift rail through the high-low fork bore and into the rail bore in the case.**16. Install the output shaft and oil pump assembly in the input shaft. Make sure that the external splines of the output shaft engage the internal splines of the high-low shift hub. Make sure that the oil pump retainer and oil filter leg are in the groove and notch of the front case. Install the magnet in the slot in the front case.**

INSTALLATION — REAR OUTPUT SHAFT AND OIL PUMP
C11163-A

DISASSEMBLY AND ASSEMBLY (Continued)



17. Assemble the following components as outlined:

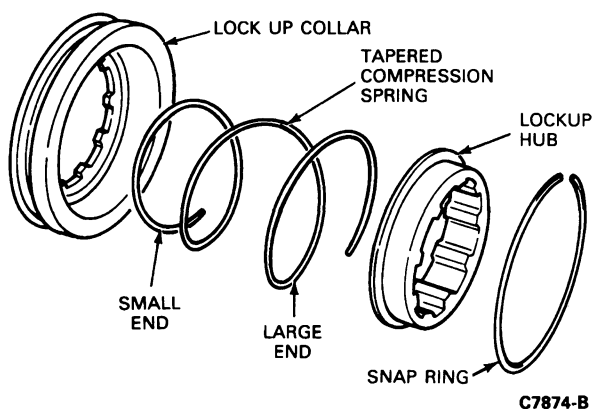
- Assemble the drive sprocket into the chain.
- Assemble the driven sprocket into the chain so the word REAR is facing upward.
NOTE: The sprocket will face the rear of the vehicle when properly installed.
- Place the sprockets and chain as an assembly over the rear and front output shafts.
- Install the washer and snap ring that retains the lower sprocket to the front output shaft.

18. Assemble the 2W-4W lockup assembly as follows:

- Position the small end of the tapered compression spring in the lockup collar.
- Place the lockup hub over the large end of the spring and compress the spring while installing the internal snap ring.

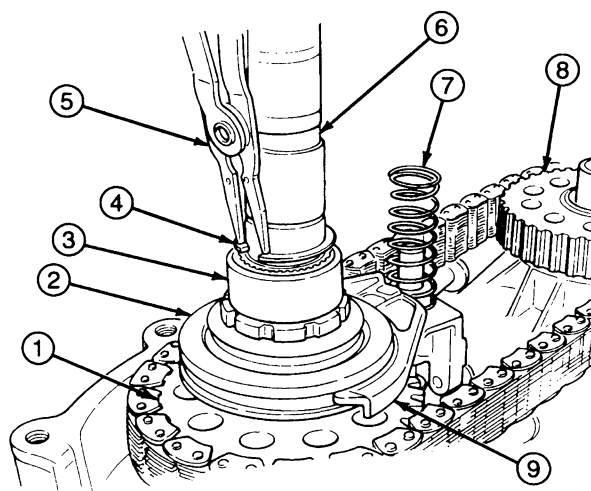
NOTE: The snap ring holds the lockup assembly together.

2W/4W LOCK UP COLLAR ASSEMBLY



- Install the lockup assembly and its shift fork over the external splines of the drive sprocket and the shift rail with the long boss of the shift rail facing forward.
- Assemble the 4WD return spring over the shift rail and against the shift fork.
- Place the 4WD hub over the external splines of the output shaft and secure with the appropriate snap ring. Make sure that the snap ring is fully seated in the snap ring groove.

2WD-4WD Sprockets and Lockup Assemblies, Chain Drive and Driven Sprockets



C7872-D

Item	Description
1	Drive Sprocket
2	2W-4W Lockup Assembly
3	4WD Hub
4	Snap Ring
5	Snap Ring Pliers
6	Rear Output Shaft Assembly
7	Spring
8	Driven Sprocket
9	Mode Shift Fork

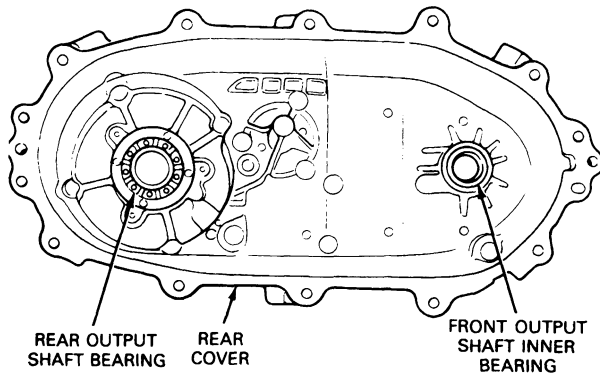
TC7872A

- Press the front output needle bearing in its bore in the rear cover using an appropriate tool.

DISASSEMBLY AND ASSEMBLY (Continued)

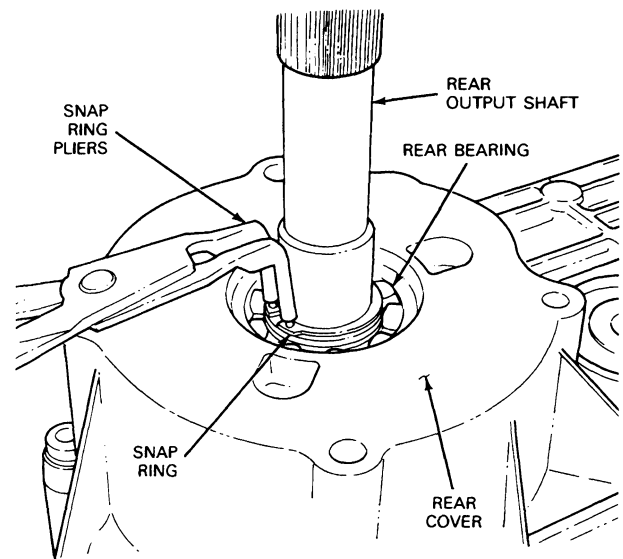
23. Press the rear output shaft bearing into position in the cover using an appropriate tool. Install bearing snap ring retainer in cover.

REAR COVER - REAR OUTPUT SHAFT BEARING/
FRONT OUTPUT SHAFT INNER BEARING



C7871-1A

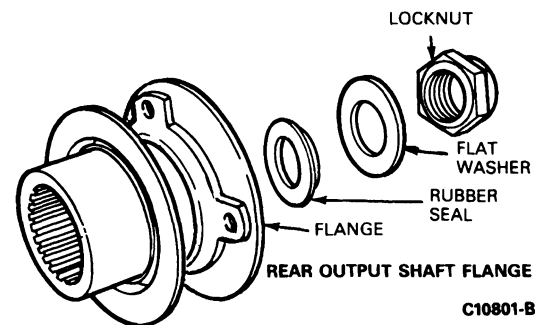
24. Install the rear output shaft oil seal in the bearing retainer using the appropriate tool and making sure that it is fully seated.
25. Coat the mating surface of the front case with a very small bead of non-acid cure Silicone Rubber E7TZ-19562-A (ESL-M4G273-A) or equivalent.
- CAUTION: If too much Silicone Rubber is used when sealing the case halves, it is possible for the excess sealant to plug the oil filter and cause transfer case failure.**
26. Place the cover on the case making sure that the front output shaft, shift shaft and shift rail are aligned. Install and tighten the 12 No. 50-Torx® head case to cover bolts to 30-49 N·m (22-36 ft·lb).
27. Install the rear bearing snap ring on the output shaft making sure that the snap ring is fully seated in the groove of the shaft.



REMOVE REAR BEARING SNAP RING

C7439-1C

28. Apply a very small bead of non-acid cure Silicone Rubber ET7Z-19562-A (ESL-M4G273-A) or equivalent to the face of the rear bearing retainer or rear slip yoke extension housing.
29. Place the rear bearing retainer or rear slip yoke extension housing in its position and secure with the four Torx® bolts tightened to 30-49 N·m (22-36 ft·lb).
30. On transfer case with slip yoke rear bearing retainer housing, remove the extension oil seal using Oil Seal Remover T74P-77248-A and Slide Hammer T50T-100-A. Install a new bushing using Extension Housing Bushing Installer T85T-7034-BH and Driver Handle T80T-4000-W. Install a new seal using Oil Seal Installer T61L-7657-B.
31. For fixed yoke models, install the rear output shaft yoke and slinger assembly onto the rear splines of the output shaft. Install the rubber seal, flat steel washer and 30mm locknut on the output shaft and tighten to 163-203 N·m (120-150 ft·lb).



C10801-B

32. Install the drain plug and tighten to 9-23 N·m (7-17 ft·lb).

DISASSEMBLY AND ASSEMBLY (Continued)

33. Install the 4WD indicator lamp switch with aluminum washer into the case. Tighten switch to 34-47 N·m (25-35 ft-lb).
34. Install the transfer case as outlined.
35. Fill transfer case as outlined.
36. Start engine, check transfer case for correct operation. Stop engine and check fluid level. Fluid should drip out of level hole. If fluid flows out of level hole, the oil pump may not be functioning properly.

ADJUSTMENTS

Fluid Level Check

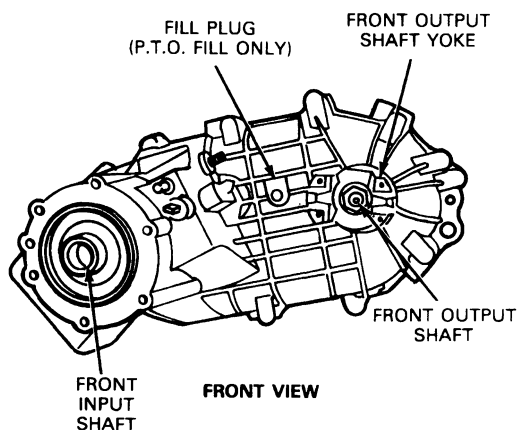
Transfer Case Without PTO

Remove the fill plug from the rear case. Fluid level should be just below the fill plug. If the fluid is below the level, fill with Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZ-19582-B) or equivalent to correct level.

Transfer Case With PTO

NOTE: The 13-56 transfer case, when equipped with a PTO, requires 4.1 quarts more lubricant than transfer cases without a PTO, bringing the total fill capacity to 6.1 quarts. Motorcraft MERCON® Multi-Purpose Automatic Transmission Fluid XT-2-QDX or -DDX (E4AZX-19582-B) or equivalent is the required lubricant to be used in all transfer cases.

CAUTION: If the proper fill procedures are not followed, transfer case or PTO failure could result. Transfer cases with PTO's will have a fill plug labeled "FOR PTO FILL ONLY" on the front of the case.



1. Remove the fill plug labeled "FOR PTO FILL ONLY" from the front of the transfer case.
2. Fill with specified lubricant to the bottom of the fill plug hole.
3. Install fill plug and tighten to 9-23 N·m (7-17 ft-lb).

SPECIFICATIONS

TORQUE SPECIFICATIONS


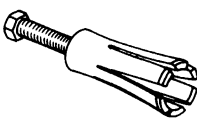
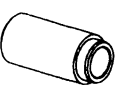


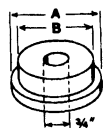
Description	N·m	Lb·Ft
Case Half Attaching Bolts	30-49	22-36
Four Wheel Drive Indicator Switch	34-47	25-35
Front and Rear Output Yokes to Transfer Case	163-203	120-150 Rear; 150-180 Front
Drain Plug	9-23	7-17
Fill Plug	9-23	7-17
Transfer Case to Transmission Adapter	34-58	25-43
Heat Shield to Transfer Case	54-61	40-45
Skid Plate to Frame	20-27	15-20
Front Driveshaft to Front Output Yoke — F-150-250, Bronco	11-20	8-15
Rear Driveshaft to Rear Output Yoke — Bolt — Bronco	28-33	20-28
Rear Driveshaft to Rear Output Yoke — Nut — F150-F350 4x4	11-20	8-15
Front Driveshaft to Front Output Yoke — F-350	28-33	20-25
Control Lever Assembly to Transmission Extension Housing	96-122	71-90
Shift Lever Retaining Nut	27-38	20-28

SPECIAL SERVICE TOOLS/EQUIPMENT

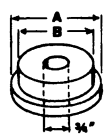

Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer — 2-1/2 lb.	 T50T-100-A
TOOL-1175-AC Seal Remover (Use with Impact Slide Hammer)	 TOOL-1175-AC
T80T-4000-P Bearing Cup Replacer	 T80T-4000-P
T74P-77248-A Oil Seal Remover	 T74P-77248-A

(Continued)

SPECIAL SERVICE TOOLS/EQUIPMENT (Continued)

Tool Number / Description	Illustration
T61L-7657-B Oil Seal Installer	 T61L-7657-B
T85T-7034-AH Extension Housing Bushing Remover	 T85T-7034-AH
T85T-7034-BH Extension Housing Bushing Installer	 T85T-7034-BH
T80T-4000-W Driver Handle	 T80T-4000-W
T86T-7034-CH Oil Seal Installer	 T86T-7034-CH
T73T-1202-B Bearing Cup Replacer	 T73T-1202-B

(Continued)

Tool Number / Description	Illustration
T73T-1202-A Bearing Cup Replacer	 T73T-1202-A
T83T-7065-B Output Shaft Seal Installer	 T83T-7065-B

Tool Number	Description
D80L-100-A	Blind Hole Puller Set
D80L-100-T	Collet (1-1/4 to 1-1/2 Inch)
D80L-100-H	Actuator Pin (Use with Blind Hole Puller)

ROTUNDA EQUIPMENT

Tool Number	Description
077-00019	Transmission Jack

GROUP

CLUTCH

08

(7000)

SECTION TITLE	PAGE	SECTION TITLE	PAGE
CLUTCH.....	08-01-1	CLUTCH CONTROLS	08-02-1
CLUTCH GENERAL SERVICE	08-00-1		

SECTION 08-00 Clutch General Service

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		CLEANING AND INSPECTION (Cont'd.)	
Alignment Correction, Warner		Clutch Release Bearing.....	08-00-13
Transmission.....	08-00-13	Flywheel Face Runout.....	08-00-15
Bleed Procedure for External Slave		Flywheel Runout, Crankshaft End Play	
Cylinder	08-00-10	Check	08-00-15
Bleed Procedure, Concentric Slave		Pilot Bearing Assembly	08-00-15
Cylinder	08-00-9	Pressure Plate and Cover.....	08-00-14
Dowel Replacement Procedure.....	08-00-13	Slave Cylinder Leaking	08-00-15
Flywheel Housing Alignment, Warner		DIAGNOSIS AND TESTING	
Transmission.....	08-00-11	Diagnosis Guides.....	08-00-2
Hydraulic Clutch, Master Cylinder Push rod		Testing Procedures	08-00-7
Adjustment, F-Series and Bronco	08-00-10	SPECIAL SERVICE TOOLS	08-00-15
CLEANING AND INSPECTION		VEHICLE APPLICATION	08-00-1
Clutch Disc	08-00-14		

VEHICLE APPLICATION

F-150-250-350, F-Super Duty Chassis Cab and Commercial Chassis, and Bronco Vehicles Equipped with Manual Transmissions

DIAGNOSIS AND TESTING**Diagnosis Guides**

CONDITION	POSSIBLE SOURCE	ACTION
Clutch thud.	<ul style="list-style-type: none"> Excessive engine crankshaft end play. 	<ul style="list-style-type: none"> Repair engine per specifications. Refer to the Powertrain Control Emissions Diagnosis Manual.
Clutch vibration (torsional). Vehicle moving — 8 cyl. engine at road speed 49-96 km/h (30-60 mph), 6 cyl. engine at 49-96 km/h (30-60 mph).	<ul style="list-style-type: none"> Incorrect clutch disc installed. After-market (off-brand) clutch disc installed. Malfunctioning engine. Incorrect installation of coupling shaft or drive shaft assembly. 	<ul style="list-style-type: none"> Install specified clutch disc. Install specified clutch disc. Refer to Section 08-01. Check engine performance, tune up engine. Refer to the Powertrain Control/Emissions Diagnosis Manual. Install correct parts. Align driveline. Refer to appropriate section in Group 05.
Clutch linkage clicking (popping noise).	<ul style="list-style-type: none"> Clutch release lever requires lubrication. 	<ul style="list-style-type: none"> Lubricate conical seat of release lever with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Reposition override release lever.
Gear clash.	<ul style="list-style-type: none"> Clutch disc warped or bent preventing full release. Warped pressure plate. Transmission housing misalignment. Pressure plate attaching bolts loose. Air in hydraulic system. 	<ul style="list-style-type: none"> Replace clutch disc. Refer to Section 08-01. Replace pressure plate. Refer to Section 08-01. Realign housing. Tighten bolts. Bleed clutch hydraulic system.
Gear jump-out	<ul style="list-style-type: none"> Transmission housing misalignment. 	<ul style="list-style-type: none"> Realign housing.
Noise — clutch fully engaged.	<ul style="list-style-type: none"> Transmission problem. 	<ul style="list-style-type: none"> Refer to transmission problems diagnosis for corrective action. Refer to Section 07-00.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
Start-up chatter during light clutch engagement in low or reverse.	<ul style="list-style-type: none"> ● Engine roughness. ● Insufficient disc cushion, or improperly formed disc segments. ● Throttle linkage improperly adjusted. ● Engine misaligned. Not properly seated on mounts. ● Body mounts improperly tightened (incorrect torque). ● Oil or grease on clutch disc. ● Glazed flywheel surface. ● Clutch disc warped or bent (little or no reserve). ● Pressure plate attaching bolts loose or missing. ● Loose engine mount attaching bolts. ● Loose transmission and/or clutch housing attaching bolts. ● Clutch housing loose or misaligned. ● Pressure plate fingers bent, out-of-plane or sticking (will not return, hung-up). ● Release lever (fork) bent, broken or cracked. 	<ul style="list-style-type: none"> ● Tune engine. Check idle speed. Refer to the Powertrain Control/Emissions Diagnosis Manual. NOTE: Can be purchased as a separate item. ● Replace clutch disc. ● Readjust. Refer to Section 07-00. ● Loosen engine mount bolts, align and center engine so engine mounts center in teardrop holes. Refer to appropriate section in Group 03. ● Check for correct front and rear body mounts, proper installation and bolt torque. Refer to Section 02-03. ● Correct leak, replace disc, clean pressure plate and flywheel friction surfaces with clean solvent (alcohol base). Deglaze flywheel. ● Deglaze flywheel surface with coarse emery cloth, stroke parallel to machining lines. ● Replace clutch disc. Refer to Section 08-01. ● Replace broken or missing bolts, tighten to specification. Refer to Section 08-01. ● Tighten bolts. Refer to appropriate section in Group 03. ● Tighten bolts. ● Realign. ● Replace pressure plate. Refer to Section 08-01. ● Replace release lever. Refer to Section 08-02.
Clutch inoperative.	<ul style="list-style-type: none"> ● Release lever broken. ● Pressure plate worn or warped. ● Clutch hydraulic system leaking externally or internally. ● Disc worn or warped. ● Flywheel worn or warped. 	<ul style="list-style-type: none"> ● Replace release lever. Refer to Section 08-02. ● Replace pressure plate. Refer to Section 08-01. ● Replace hydraulic component that leaks externally, or replace clutch master cylinder if suspected of internal leakage. ● Replace clutch disc. Refer to Section 08-01. ● Re-face or replace flywheel.
Clutch noise squeal (engine idling — clutch released when cold).	<ul style="list-style-type: none"> ● Pilot bearing in crankshaft not square with crankshaft (misaligned). ● Release bearing. ● Clutch housing misalignment (pilot bore and face runout). 	<ul style="list-style-type: none"> ● Replace pilot bearing. Seat properly in crankshaft. Do not grease. Clean input shaft pilot and apply coat of light oil for initial lube only. Refer to Section 08-01. ● Replace release bearing. Refer to Section 08-02. ● Align housing.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
Squeak (engine off).	<ul style="list-style-type: none"> No lube on release rod bushings or clutch pedal shaft bushings. No lube on release lever at fulcrum and/or release bearing hub retaining clips. Loose steering column cover or brake and clutch pedal support bracket at instrument panel. Clutch master cylinder push rod rubbing in rubber boot. 	<ul style="list-style-type: none"> Replace all worn bushings. Apply Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent to inside and outside of bushing prior to assembly. Remove release lever and bearing. Daub Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent under leading edge of retaining clips of release bearing and in fulcrum seat of release lever. Tighten all attaching parts to specifications. Refer to Section 11-04 in the Body / Chassis Manual. Lubricate boot with silicon lubricant spray.
Scrubby pedal action and feel.	<ul style="list-style-type: none"> No lube at release lever fingers or rear face of release bearing. No lube in release bearing hub. Scored transmission input shaft retainer. Clutch pedal binding in pedal support. 	<ul style="list-style-type: none"> Daub Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent at leading edge of release lever fingers. Replace release bearing and transmission input shaft retainer. Fill annular groove of release bearing hub with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Lubricate clutch pedal shaft, bushings and pedal support.
Rattle — engine idling, clutch engaged or on light engagement.	<ul style="list-style-type: none"> Pedal hang-up (pedal does not return to stop). 	<ul style="list-style-type: none"> Dry pedal shaft — lube pedal shaft and bushings. Check for broken or missing clutch pedal assist spring. Replace if necessary. Refer to Section 08-02.
Slipping clutch.	<ul style="list-style-type: none"> Oil on disc assembly (also caused clutch clatter). Broken pressure plate. Worn clutch facings. 	<ul style="list-style-type: none"> Replace disc after washing flywheel and pressure plate friction surfaces with clean solvent. Refer to Section 08-01. Deglaze flywheel and pressure plate. Replace pressure plate. Refer to Section 08-01. Replace facings or complete driven disc assembly.
Clutch "squeaks" or "scrapes" when pedal is depressed.	<ul style="list-style-type: none"> Clutch linkage under dash panel shows lack of lubrication, binding, interference(s), excessive wear or misalignment. Linkage inside clutch housing shows lack of lubrication, binding, excessive wear or misalignment. Pressure plate binds or has interference, broken or bent Belleville spring. Other (previous problem sources OK). 	<ul style="list-style-type: none"> Lubricate, repair or replace as required, then road test. Lubricate, repair or replace as required, then road test. Replace pressure plate, then road test. Refer to Section 08-01. Perform "Inspection and Alignment Procedure". Refer to Section 08-00. Repair as required, then road test.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
<p>Clutch chatters during starts.</p> <p>NOTE: A light chatter or shudder in the vehicle when engaging the clutch at light throttle is a normal occurrence. This condition results from the new lower numerical axle ratio. It may be more pronounced in heavily loaded vehicles. Drivetrain function and durability are not affected by this chatter condition. Therefore, drivetrain components, particularly clutches, should not be replaced or rebuilt in an attempt to eliminate this condition.</p>	<ul style="list-style-type: none"> ● Engine rough idle hesitation during acceleration. ● Engine misaligned, not properly seated on mounts. ● Engine, transmission, or cab mounts misaligned and/or loose. ● Release bearing or transmission retainer inadequately lubricated, misaligned, worn or galled. ● Flywheel housing bore and face out of alignment (Warner Transmissions only). ● Loose or missing pressure plate attaching bolts. ● Bent or out-of-plane pressure plate fingers. ● Clutch disc contaminated with oil. ● Clutch disc warped, cracked, or friction material loose. ● Pressure plate warped or shows hot spots. ● Flywheel warped, or discolored (excessive heat). ● Inadequate disc cushion, or improperly formed disc segments. 	<ul style="list-style-type: none"> ● Adjust or correct engine idle as required. Refer to Powertrain Control/ Emissions and Diagnosis Manual. ● Align and center engine mounts in teardrop holes. Refer to appropriate section in Group 03. ● Align, replace, and tighten mounts as required. ● Replace release bearing or transmission retainer as required. Refer to Section 08-02. ● Correct per shop manual procedure in this section (Warner Transmissions only). ● Replace and/or tighten to specification. Refer to Section 08-01. ● Replace pressure plate if release fingers are more than 0.060 inch out-of-plane. Refer to Section 08-01. ● Correct leak, replace disc and clean pressure plate as required. Refer to Section 08-01. ● Replace disc. Refer to Section 08-01. ● Replace pressure plate. Refer to Section 08-01. ● Reface or replace flywheel. ● Replace clutch disc. Refer to Section 08-01.
Clutch noisy.	<ul style="list-style-type: none"> ● Release bearing worn or damaged. ● Pressure plate release fingers worn or damaged. ● Flywheel housing and engine crankshaft out of alignment (Warner Transmissions only). ● Transmission front extension not properly engaged. 	<ul style="list-style-type: none"> ● Replace bearing. Refer to Section 08-02. ● Replace pressure plate assembly. Refer to Section 08-01. ● Align or replace housing as required (Warner Transmissions only). ● Repair as required. Refer to appropriate section in Group 07.
Clutch slips after the pedal is fully released.	<ul style="list-style-type: none"> ● Clutch pedal linkage binding (outside of flywheel housing). ● Transmission input shaft bearing retainer and pressure plate worn, damaged or lack lubrication. Clutch disc worn. ● Master cylinder lever (7A554) not set correctly. 	<ul style="list-style-type: none"> ● Lubricate, repair and replace linkage parts as required. Refer to Section 08-02. ● Lubricate or replace parts as required. Refer to Section 08-01. ● Perform master cylinder push rod adjustment.
Clutch does not disengage completely.	<ul style="list-style-type: none"> ● Clutch linkage and bushings (outside of flywheel housing) worn, cracked or bent. ● Damaged or worn clutch disc, pressure plate or release lever. ● Damaged or worn crankshaft pilot bearing. ● Clutch disc hub spline does not move freely on transmission input shaft spline. ● Clutch hydraulic system inoperative. ● Incorrect clutch disc installed. ● Loose or missing pressure plate attaching bolts. ● Master cylinder lever (7A554) not set correctly. 	<ul style="list-style-type: none"> ● Repair or replace the damaged or worn bushings, levers and rods. ● Replace damaged or worn parts as required. Refer to Section 08-01. ● Replace bearing as required. Refer to Section 08-02. ● Repair or replace parts as required. ● Replace clutch hydraulic system components as required. ● Replace clutch disc. Refer to Section 08-01. ● Replace and/or tighten to specification. Refer to Section 08-01. ● Perform master cylinder push rod adjustment.

DIAGNOSIS AND TESTING (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
Clutch pedal hangs up at top of stroke.	<ul style="list-style-type: none"> Pedal or cross-shaft lever interfering with dashboard wiring. Broken or missing clutch pedal assist spring. Loose clutch pedal attaching nut. Improperly positioned cross-shaft lever. Release bearing and hub grinding on transmission input shaft bearing retainer. Hydraulic system (piston) binds internally. 	<ul style="list-style-type: none"> Reroute or tie interfering wires. Refer to Section 08-02. Replace spring. Refer to Section 08-02. Tighten nut. Refer to Section 08-02. Replace cross-shaft lever. Lubricate bearing hub with Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent. Replace transmission input shaft retainer if worn. Replace master cylinder or slave cylinder as required. Refer to Section 08-02.
Heavy pedal efforts on a fast pedal stroke, but normal pedal efforts on a slow pedal stroke.	<ul style="list-style-type: none"> Restriction in hydraulic tubing. 	<ul style="list-style-type: none"> Replace hydraulic tubing.

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SYMPTOM: CLUTCH NOISE — TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	PEDAL ACTION (ENGINE OFF)		
	<ul style="list-style-type: none"> With engine off, check for noise and binding condition when pedal is depressed and then released. Are noise and binding present? 	Yes No	GO to A2. GO to "Squeaks" or "Scrapes" Diagnosis Charts.
A2	PEDAL ACTION (ENGINE RUNNING)		
	<ul style="list-style-type: none"> With engine running, depress pedal. Is noise present? <p>NOTE: A light intermittent clucking noise may result during pedal application. Some noise under these situations will not adversely affect clutch function and does not necessarily indicate a failed release bearing or out-of-plane pressure plate release fingers. Inspection of these components is not required unless the noise is excessive.</p>	Yes No	GO to A3. GO to A4.
A3	CLUTCH ENGAGEMENT		
	<ul style="list-style-type: none"> With engine running, check for squealing noise when engaging clutch. Is squealing noise present? 	Yes No	ROAD TEST. GO to A5.
A4	RELEASE BEARING / PRESSURE PLATE FINGERS		
	<ul style="list-style-type: none"> Inspect the release bearing and pressure plate fingers for wear. Is bearing rough / noisy? Are pressure plate fingers worn? 	Yes No	ROAD TEST. REPLACE bearing. Refer to Section 08-02. REPLACE pressure plate (refer to Section 08-01) if release fingers are more than 1.52mm (0.060 inch) out-of-plane as installed on flywheel. CHECK flywheel housing bore and face alignment, then ROAD TEST.
A5	PILOT BEARING		
	<ul style="list-style-type: none"> Inspect pilot for proper installation, wear and loss of lubrication. Is bearing worn? 	Yes No	ROAD TEST. REPLACE as required. Refer to Section 08-01.

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DIAGNOSIS AND TESTING (Continued)**Testing Procedures****Squeak or Scrubby Noise Test**

1. Work the clutch pedal up and down.
2. Note any binding condition or lack of lubrication in the linkage. To help pinpoint noise it may be necessary to disconnect and isolate some components.

Transmission Neutral Gear Rollover or Transmission Bearing Noise Test

1. Let engine idle, placing transmission shift selector in neutral position.
2. Depress clutch pedal.
NOTE: With the clutch pedal fully depressed, transmission input shaft will stop rotating.
3. If the input shaft bearing or transmission gears were causing a noise, the noise should stop.
4. If noise is still present, perform Clutch Release Bearing (Rotational Underload) Noise Test.

Clutch Release Bearing (Rotational Underload) Noise Test

NOTE: A light intermittent clicking or rattling noise may result during pedal application due to the clutch solenoid lockout switch and speed control clicking. Some noise under these conditions will not adversely affect clutch function and does not necessarily indicate a failed release bearing or out of plane pressure plate release fingers. Inspection of these components is not required unless the noise is excessive.

1. Let the engine idle with the transmission shift selector in neutral position.
2. Depress clutch pedal approximately one inch.
3. Listen for any change in noise level.

If the release bearing is the cause of the noise, the noise should stop with pedal depressed. Replace release bearing. Refer to Section 08-02.

Bearing Travel Measurement**F-Series with 7.3L Diesel and 7.5L Gasoline Engines, External Slave Cylinder Applications (ZF Transmission)**

1. With the clutch pedal depressed fully to the floor, measure the external slave cylinder push rod travel.
2. The push rod should extend 11mm (0.43 inch) minimum. Do not replace the clutch hydraulic system if the measurement exceeds this distance.
3. If release bearing travel does not meet the travel requirements check the reservoir fluid level.

NOTE: The slave cylinder must be in place when checking the fluid level. The proper level is indicated by a step on the reservoir.

4. Fill to the specified level with Ford Heavy Duty Brake Fluid C6AZ-19542-AA or -BA (ESA-M6C25-A) or equivalent DOT 3 fluid. Do not overfill. The upper portion of the reservoir must accept fluid displaced from the slave cylinder as the clutch wears.

CAUTION: Carefully clean the top and sides of the reservoir before opening to prevent contamination of the system with dirt, water and other foreign material. Remove the reservoir diaphragm when checking or adding fluid. Carefully replace the diaphragm, cover gasket and cover after filling.

5. If the reservoir requires any fluid, check the hydraulic system components for leakage.
6. Remove the rubber boots from the cylinder and check for leakage past the pistons. A slight wetting of the surfaces is acceptable. If excessive leakage is evident, replace the leaking component.

F-Series and Bronco with 4.9L and 5.0L Engines (T-18 Transmission)

1. With the clutch pedal fully depressed to the floor, measure the external slave cylinder push rod travel.
2. The push rod should extend 17mm (0.67 inch) minimum. Do not replace the clutch system if the measurement exceeds this distance.
3. If release bearing travel does not meet the travel requirements check the reservoir fluid level.

NOTE: The slave cylinder must be in place when checking the fluid level. The proper level is indicated by a step on the reservoir.

4. Fill to the specified level with Ford Heavy Duty Brake Fluid C6AZ-19542-AA or -BA (ESA-M6C25-A) or equivalent DOT 3 fluid. Do not overfill. The upper portion of the reservoir must accept fluid that is displaced from the slave cylinder as the clutch wears.

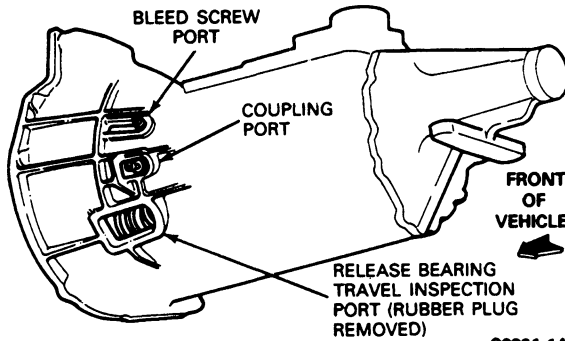
CAUTION: Carefully clean the top and sides of reservoir before opening to prevent contamination of the system with dirt, water and other foreign material. Remove reservoir diaphragm when checking or adding fluid. Carefully replace diaphragm, cover gasket and cover after filling.

5. If the reservoir requires fluid, check hydraulic system components for leakage.
6. Remove rubber boots from cylinder and check for leakage past the pistons. A slight wetting of surfaces is acceptable. If excessive leakage is evident, replace leaking component.

DIAGNOSIS AND TESTING (Continued)

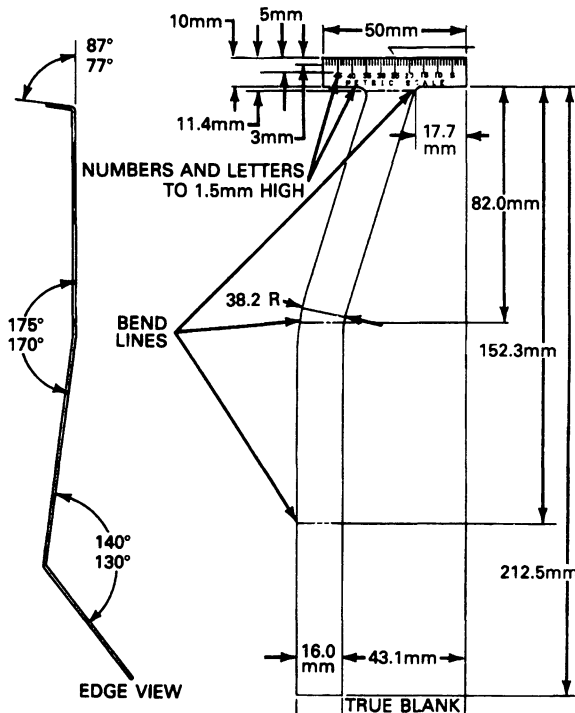
F-Series and Bronco with 4.9L, 5.0L, and 5.8L Gasoline Engines, Concentric Slave Applications (Mazda and T-18 Transmissions)

1. Remove the rubber plug from inspection port in side (Mazda) or bottom (T-18) of transmission clutch housing.



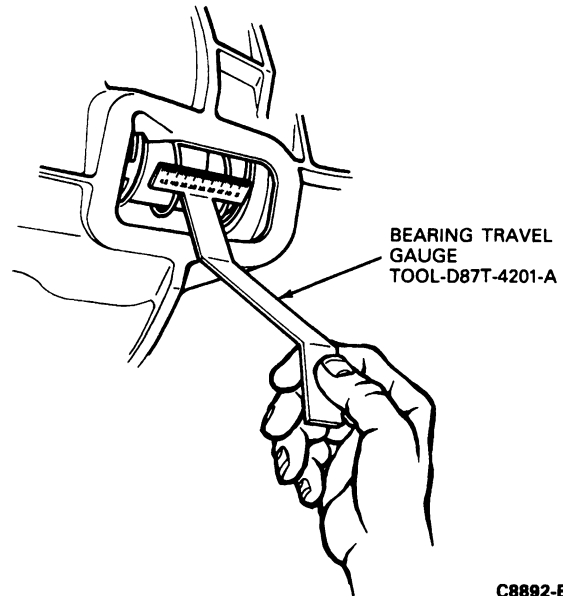
2. Position Bearing Travel Gauge Tool D87T-4201-A or equivalent through inspection port and against the slave cylinder.

NOTE: The following illustration shows details of how service tool can be fabricated locally.

**SERVICE TOOL LAYOUT
(USED FOR CHECKING CONCENTRIC SLAVE TRAVEL)**

3. Using black plastic bearing retainer rear edge as an indicator, take a reading with the clutch pedal fully up.
4. Have an assistant fully depress pedal and take another measurement.
5. The difference between the two readings is the total bearing travel.
6. If bearing travel is less than 10.8mm (0.425 inch), check the hydraulic reservoir fluid level, then inspect the hydraulic system for leaks. Fill the reservoir if required.
7. If a leak is located in system, replace the worn or damaged component and bleed system.
8. If no leak is found, bleed the system.
9. Recheck the bearing travel after repairs have been completed.

CAUTION: Carefully clean the top and sides of the reservoir before opening to prevent contamination of the system with dirt, water and other foreign material. Remove the reservoir diaphragm when checking or adding fluid. Carefully replace the diaphragm, cover gasket and cover after filling.

**Clutch Squeal Test**

A clutch noise sometimes referred to as a "squeal" may be evident as the clutch pedal is held down.

1. Let engine idle, placing transmission shift selector in neutral position.
2. Depress to floor and SLOWLY release clutch pedal.

DIAGNOSIS AND TESTING (Continued)

3. If the noise is reduced or eliminated as the clutch pedal is released and the input shaft begins to turn, the pilot bearing could be the possible cause.

Replace pilot bearing. Refer to Section 08-01. Refer to flywheel housing alignment, and inspection and alignment procedure in this section if alignment is suspect (Warner Transmissions only).

Clutch Chatter and Slippage Test

A clutch or vehicle vibration called "chatter" is evident just as the clutch is released and the vehicle starts to move.

Contamination of the clutch disc friction surfaces, causing uneven friction, may make the power transfer uneven and result in a "chatter."

Oil leakage or grease on the clutch disc is the major cause of chatter.

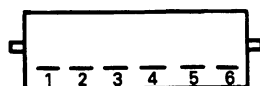
Loose, misaligned or broken engine mounting(s) can cause clutch chatter.

Overheated clutch from excessive slippage or abuse can cause chatter.

Clutch slippage may have several causes (oil leakage on clutch disc, operator abuse, excessively worn disc).

Clutch Interlock Three-Function Switch

1. To check the clutch interlock switch for proper starting function, disconnect the wiring harness from the switch.
2. Using an ohmmeter, probe pins 1 and 2 for continuity, the indicator should read "OPEN" while moving the pedal from a full up position to within approximately 25mm (1 inch) of full travel. Measurement beyond this point should be a "CLOSED" reading (0 ohms).



← FRONT OF VEHICLE

C10899-A

ADJUSTMENTS**Bleed Procedure, Concentric Slave Cylinder
4.9L, 5.0L and 5.8L Gasoline Engines**

NOTE: Under normal conditions, disconnecting the clutch coupling will not introduce air into the system. If air enters system (spongy pedal, or insufficient bearing travel) bleed system.

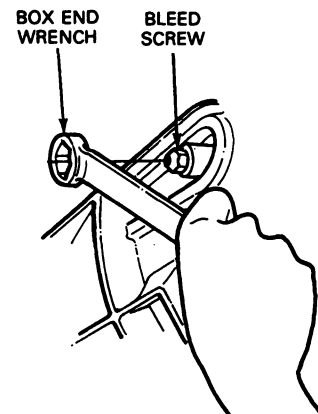
1. Clean dirt and grease from the cap.

2. Remove cap and diaphragm and fill reservoir to the top with approved brake fluid only.

NOTE: Brake fluid must be certified to DOT 3 specification.

NOTE: To keep brake fluid from entering clutch housing, route a suitable rubber tube of appropriate inside diameter from bleed screw to a container.

3. Loosen bleed screw located in the slave cylinder body next to inlet connection.
4. Fluid will flow from master cylinder down tube to slave cylinder.



C8888-1B

NOTE: The reservoir must be kept full at all times so no additional air enters the system.

5. Bubbles appear at the bleed screw outlet, meaning air is being expelled.
6. When the slave is full, a steady flow of fluid will come from the slave outlet. Tighten bleed screw.
NOTE: Maintain brake fluid level at the step in the reservoir at all times.
7. Depress clutch pedal to floor and hold for 1-2 seconds. Release pedal as rapidly as possible. Pedal must be released completely. Pause for 1-2 seconds. Repeat ten times.
8. Check fluid level in reservoir. The fluid should be level with the step when the diaphragm is removed.
9. Repeat Steps 7 and 8 five times. Replace reservoir diaphragm and cap.
10. Hold pedal to floor. Loosen bleed screw to expel additional air.
NOTE: If bleed screw is opened too far, fluid will spray out.
11. Close screw and release pedal.
12. Check fluid level. The hydraulic system should now be fully bled and should release the clutch.

ADJUSTMENTS (Continued)

Bleed Procedure for External Slave Cylinder 7.3L Diesel and 7.5L Gas or 4.9L and 5.0L with T-18 (Four Speed) Transmission

1. Clean reservoir cap and slave cylinder in area of the tube connection.
2. Remove slave cylinder from the transmission bell housing.
3. Use a 3 / 32-inch diameter punch to drive out tube holding pin.
4. Remove the tube from the slave cylinder and place tube end into a container for waste fluid.
NOTE: The tube is connected to the master cylinder, so keep the reservoir cap tight to minimize fluid loss.
5. Hold slave cylinder so connector port is at highest point, by tipping cylinder to approximately 30 degrees. Fill with approved DOT 3 brake fluid through connector port.
NOTE: It may be necessary to "rock" slave cylinder around or push gently on push rod to expel all the air. Pushing on push rod too hard will cause fluid to spray out of the connector hole.
NOTE: Do not allow any moisture or foreign matter to enter slave with brake fluid.
6. When all the air is expelled from the slave cylinder and no more bubbles come out of the port hole, install slave cylinder.



C9028-1A

NOTE: Fluid is expelled from the connector port, as the push rod is compressed attaching it to the transmission and lever.

7. Gravity fill the master cylinder and tube as follows.
 - Remove the reservoir cap and diaphragm.
 - Fluid should flow out the open end of the tube into waste container. Be sure to keep the reservoir full.
 - When fluid is flowing out in a steady, uninterrupted flow and fluid is level with step in reservoir, install cap and diaphragm.
 - Install end of tube into slave cylinder.
 - Replace pin holding tube to slave cylinder body.
8. System should be bled and functioning properly.
 - To verify proper system function, set parking brake and put vehicle in neutral.
 - Start vehicle and shift into reverse gear.
 - If gears grind, other components may be causing the concern.
 - Check slave cylinder push rod travel as described in this section.

Alternate Method

1. Gravity bleed system in place.
2. From under vehicle, with slave cylinder bleed port closed, push external part of release lever slowly toward front of vehicle and release. Repeat this cycle 10-15 times until you no longer hear bubbles in the master cylinder.

NOTE: If release lever cannot be moved toward front of vehicle, the master cylinder lever is incorrectly set. Replace lever. Refer to hydraulic master cylinder push rod adjustment procedure.

Hydraulic Clutch, Master Cylinder Push rod Adjustment, F-Series and Bronco

To determine if the clutch master cylinder push rod and cross-shaft lever pin are in the correct relationship, disconnect the push rod and note if it will reassemble to the pin. When the pushrod is disconnected from the pin, the clutch master cylinder piston is fully retracted rearward and the clutch pedal blade is contacting the rubber bumper up stop.

If the two components are not in alignment, perform the following only in this sequence:

1. Tighten left side clutch pedal attaching nut left side.
2. Install clutch master cylinder push rod to the cross-shaft lever pin.
3. Stroke clutch pedal several times to reset position of shaft to pedal slot.

NOTE: This step is mandatory.

ADJUSTMENTS (Continued)

4. Again, remove the clutch master cylinder push rod from lever pin and evaluate alignment. If the two components are still not in alignment, replace the cross-shaft lever. If the push rod is aligned with the pin, no further action is required.

Flywheel Housing Alignment, Warner Transmission

NOTE: The Mazda R2 and the S5-42 ZF transmission cases are built with integral flywheel housings. Due to this design, there are no alignment procedures required.

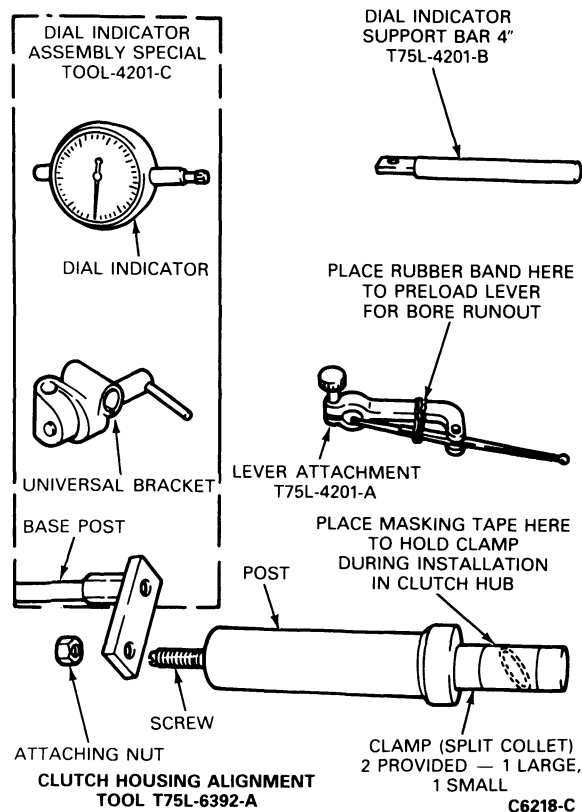
Inspection and / or alignment of the flywheel housing is indicated when symptoms exist of excessive transmission gear wear, transmission jumping out of gear, driveline vibration, clutch pedal vibration or scrubby feel, pilot bearing noise, release bearing noise, or excessive clutch spin time. Common complaint area or obvious misadjustment should always be checked and corrected prior to checking alignment, to be sure the basic system is in working order.

Inspection and Alignment Procedure, Warner Transmission

1. Remove the transmission and flywheel housing from the vehicle. Refer to appropriate section in Group 07.
2. Inspect, clean and / or remove all nicks, burrs, paint and all other foreign material from the following:
 - a. Front and rear face of flywheel housing.
 - b. Flywheel housing bore surface.
 - c. Rear face of engine block.
 - d. Rear engine plate.
 - e. Flywheel housing and engine block dowels. Replace missing or damaged dowels.
3. Install the flywheel housing and rear engine plate to the engine and tighten the mounting bolts to specification. Refer to the appropriate section in Group 07.

NOTE: During the following measurement, the disc hub should be wedged to prevent play (some diesel installations may have some play).

FLYWHEEL HOUSING SPECIAL SERVICE TOOLS

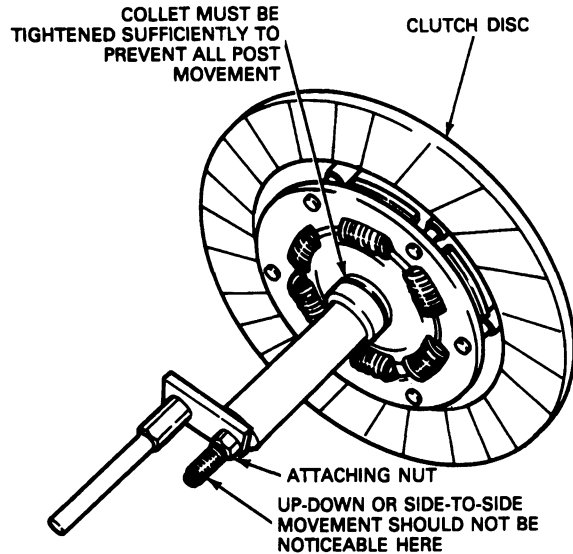


4. Install Clutch Housing Alignment Tool T75L-6392-A, with dial indicator base post attached through the flywheel housing bore into the clutch disc.
5. Tighten the nut on the end of the post assembly until the clamp (split collet) on the opposite end of the assembly grips the clutch disc splined hub tightly.

NOTE: Up, down, or side movement of the post assembly must not be evident during the bore and runout test procedure. If any movement is detectable, the nut should be further tightened until movement is stopped, otherwise erratic readings will result.

ADJUSTMENTS (Continued)

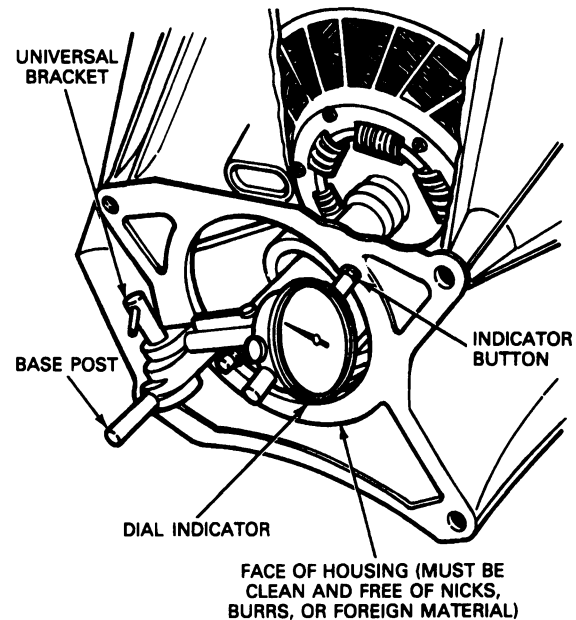
6. To facilitate installation of the collet to the clutch disc hub, place a short piece of masking tape halfway around the collet to hold it at its smallest diameter until it can be inserted and tightened.



C6219-B

7. To check face runout, install Dial Indicator TOOL-4201-C, on the base post using the universal bracket and short support bar Tool T75L-4201-B provided with the alignment kit.
8. Position the dial indicator so the indicator button contacts a circumference just outside the transmission pilot hole. Tighten the universal clamp securely.
9. Push the crankshaft rearward to remove any end play. Set the dial indicator to zero.
10. Holding crankshaft in the rearward position, rotate the crankshaft through one complete revolution by using a wrench on the crankshaft pulley attaching nut. Removal of spark plugs will relieve compression and ease crankshaft rotation. The dial indicator should return to zero after one revolution unless end play or a loose alignment post has affected the reading.
11. During Step 10, the greatest variation between indicator readings for one revolution should be recorded.
- NOTE:** A small mirror will be necessary during this procedure for viewing the dial indicator through its complete rotation.
12. To verify the reading in Step 11, the procedure should be repeated a second time.

HOUSING FACE RUNOUT CHECK — TYPICAL

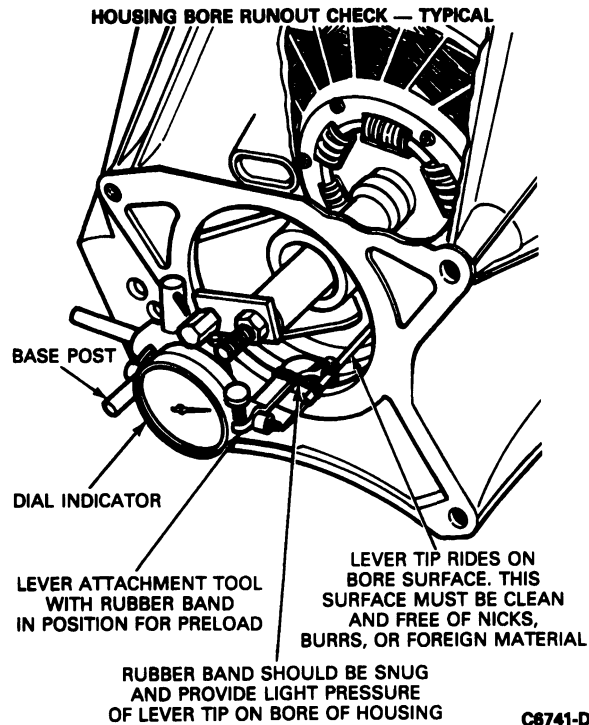


C6740-C

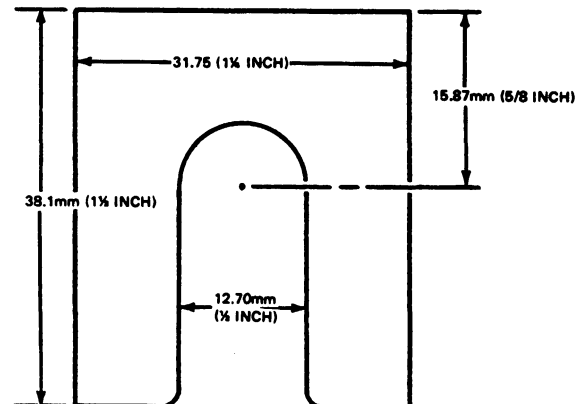
13. After completion of the face runout check, install the dial indicator lever attachment to the dial indicator and position the assembly to check bore runout. Install rubber band to lever prior to installation of lever, to preload the dial indicator for bore readings.
- NOTE:** The rubber band should be installed just snug enough to provide a light pressure of the lever tip on the bore of the housing. If the rubber band is too tight, it may bind the dial indicator or distort the reading.
14. Zero dial indicator and rotate crankshaft through one revolution as in Step 10. Record greatest variation between the indicator readings for the complete crankshaft revolution.
- NOTE:** Verify reading by repeating procedure a second time.
15. If maximum variation measurements obtained in Steps 11 and 14 show face runout exceeds 0.254mm (0.010 inch) and / or bore runout exceeds 0.381mm (0.015 inch), refer to Alignment Correction below.
16. Before re-assembly of transmission to flywheel housing, clean and inspect the front mounting face of the transmission.
17. Remove any nicks, burrs, paint or foreign material for alignment between the components.
18. Check transmission Welch plugs for proper installation.

ADJUSTMENTS (Continued)

19. If the dowels on flywheel housing or rear face of engine are missing or damaged, refer to dowel removal and installation procedures in this section.



Fabricated Flywheel Housing Shim



C1784-1B

Dowel Replacement Procedure

1. Use a drift pin on through holes and vice grip pliers or a similar tool on blind holes to remove dowels.

NOTE: Dowels should be pulled or driven from their seat. Do not damage surface area around the dowel.

2. Install all solid type dowels by driving into place using a brass or plastic mallet.

NOTE: Drive dowel squarely into place until fully seated. Do not damage the surrounding surface area.

Alignment Correction, Warner Transmission

Since any change in face alignment will change bore alignment, it may be possible to correct bore alignment by changing the face alignment. Face alignment can be changed by shimming between the flywheel housing and engine. The following illustration shows the type of shim which can be fabricated.

The shim required is one-half the maximum (minus) indicator reading and should be located at the point of maximum (minus) indicator reading.

If both the bore and face alignment are out of limits, shim between the flywheel housing and engine to bring the face alignment within limits. Check bore alignment.

If the bore alignment is out of limits and face alignment is within limits, shim the flywheel housing to the limit of face misalignment and check the bore alignment. If it is still not within limits, replace housing.

CLEANING AND INSPECTION

Clutch Release Bearing

Wipe all oil and dirt off the release bearing. The bearing is prelubricated and should not be cleaned with solvent. On all vehicles, the clutch release bearing and hub are serviced as a single unit. Do not disassemble for inspection or replacement.

Inspect the release bearing as follows:

1. Hold the bearing, hub and back plate and rotate outer race while applying a compressive pressure. If bearing rotation is rough, replace bearing.
2. Inspect / remove any surface scoring or burrs that may impede the sliding motion of the release bearing on the transmission input shaft retainer. Any scoring or burrs should be polished off with a fine grade emery paper.

Prior to installation, lubricate for release bearing operation with lithium base grease such as Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent, at the following points:

1. Fill annular groove of release bearing.

CLEANING AND INSPECTION (Continued)

2. Thin coat on inside diameter of release bearing.
3. Fingers of clutch release lever (7.3L diesel and 7.5L gas engines only).
4. Fulcrum point of clutch release lever (7.3L diesel and 7.5L gas engines only).

Failure situations for release bearing operation:

1. Misalignment of clutch release lever (7.3L diesel and 7.5L gas engines only).
2. Misalignment between engine and transmission. This condition will exhibit symptoms as transmission jumping out of gear, driveshaft vibration, excessive spin time resulting in gear clash, and clutch chatter on start-up. Refer to inspection and alignment procedures in this section (Warner Transmissions only).

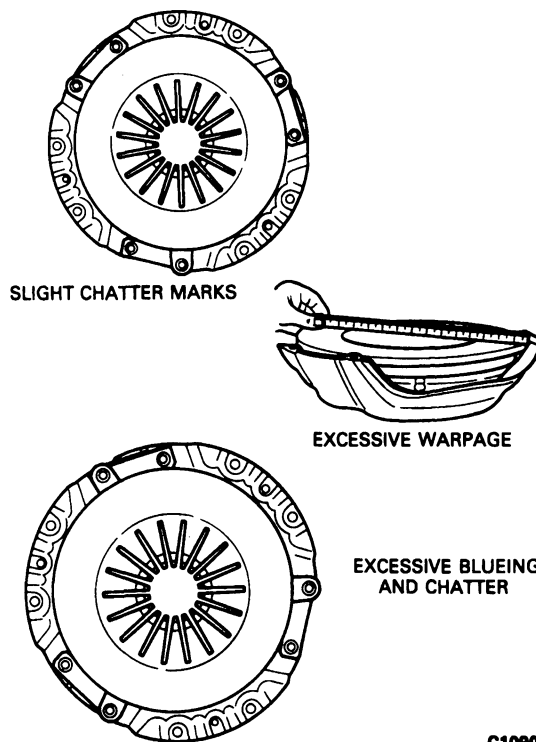
Pressure Plate and Cover

The Belleville design pressure plate assemblies do not need to be lubricated.

1. Inspect pressure plate surface for burn marks, scores, flatness or ridges.
2. If the pressure plate is badly heat-checked or deeply scored, replace pressure plate and cover assembly.
3. Clean pressure plate and flywheel surfaces with a suitable commercial alcohol base solvent so surfaces are free from any oil film.

NOTE: Do not use cleaners with a petroleum base, and do not immerse the pressure plate in the solvent.

4. If a substantial difference in finger wear exists, the heavily worn finger is binding. Replace the pressure plate.



C10900-A

Clutch Disc

1. Inspect the clutch disc facings for oil or grease. Eliminate the source of any oil or grease before replacing the disc.

NOTE: An excessive amount of grease on the bearing hub will find its way to the disc facings. Too much lubricant in the transmission or a plugged transmission vent will force the transmission lubricant out the input shaft and onto the disc facings.

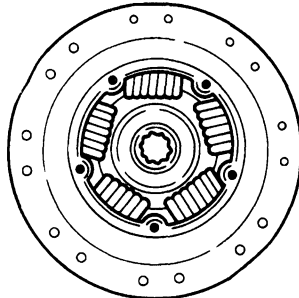
2. Leaking rear engine seals or loose or unsealed flywheel housing attaching bolts allows engine oil to flow onto the disc facings.
3. Inspect the clutch disc for worn or loose facings.
4. Check the disc for warpage and for loose rivets at the hub.
5. Check for broken springs.

NOTE: Springs loose enough to rattle will not cause noise when the vehicle is operating.

CLEANING AND INSPECTION (Continued)

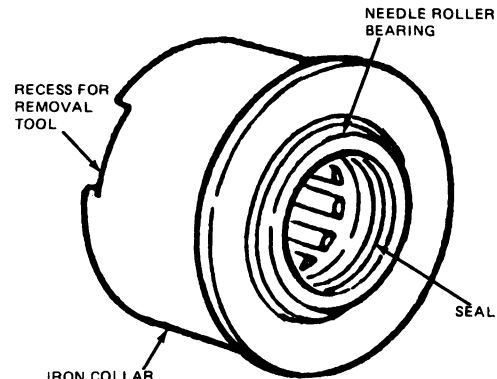
Replace disc if any of these conditions are present. When installing a new disc, do not drop or contaminate with oil or grease.

WEAR PATTERN FROM
WARPED PRESSURE PLATE



C10901-A

CLUTCH PILOT BEARING
ASSEMBLY - 7120



C2961-1B

Flywheel Runout, Crankshaft End Play Check

1. Mount dial indicator base on rear of engine with indicator tip resting on flywheel toward the outer edge.
2. Using a suitable pry bar, shift engine crankshaft forward and rearward while taking an indicator reading. Compare reading with specifications in the Powertrain Control / Emissions Diagnosis Manual.¹

Slave Cylinder Leaking

NOTE: A leak may develop in the clutch slave cylinder inside clutch housing.

1. Check for traces of fluid inside the clutch housing.
2. If fluid is visible at bottom of clutch housing, replace clutch slave cylinder. Refer to Section 08-02.


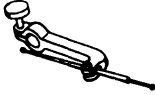

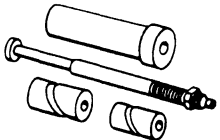
Flywheel Face Runout

Refer to Section 07-00B for flywheel face runout checks.

Pilot Bearing Assembly

1. Check clutch pilot bearing fit in crankshaft bore.
NOTE: Bearing is pressed into crankshaft and should not be loose.
2. Check the pilot bearing (needle type) assembly for misalignment and press fit condition in crankshaft.
3. Visibly inspect the bearing surfaces (needle rollers and transmission input shaft) for scoring, worn or broken rollers, inadequate grease and discoloration due to heating.
4. Check bearing's seal condition. There should be no visible grease leakage on the bearing retainer or the crankshaft. Refer to Section 08-01.

SPECIAL SERVICE TOOLS

Tool Number/ Description	Illustration
TOOL-4201-C Dial Indicator with Bracketry	 TOOL-4201-C
T75L-4201-A Clutch Housing Alignment Adapter	 T75L-4201-A
T75L-4201-B Clutch Housing Alignment Adapter	 T75L-4201-B
T75L-6392-A Clutch Housing Alignment Tool	 T75L-6392-A

¹ Can be purchased as a separate item.

SPECIAL SERVICE TOOLS (Continued)

Tool Number	Description
D78P-4201-B	Dial Indicator / Magnetic Base
D87T-4201-A	Bearing Travel Gauge

SECTION 08-01 Clutch

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION AND OPERATION	08-01-1	REMOVAL AND INSTALLATION (Cont'd.)	
DIAGNOSIS AND TESTING	08-01-1	Clutch Pilot Bearing	08-01-4
REMOVAL AND INSTALLATION		SPECIAL SERVICE TOOLS	08-01-6
Clutch Disc and Pressure Plate Assembly,		SPECIFICATIONS	08-01-5
10.0-Inch, 11.0-Inch, 12.0-Inch	08-01-1	VEHICLE APPLICATION	08-01-1

VEHICLE APPLICATION

F-150-250-350, F-Super Duty Chassis Cab,
Commercial Chassis and Bronco Vehicles Equipped
with Manual Transmission

DESCRIPTION AND OPERATION

The clutch is a single plate, dry friction disc with a diaphragm-style spring pressure plate. The clutch disc has a splined hub which attaches the disc to the transmission input shaft. A diaphragm spring is located between two fulcrum rings riveted to the clutch cover. The clutch operating mechanism consists of a release bearing, and either a fork and external slave cylinder, or an internal concentric slave cylinder.

Other internal clutch parts are a pilot bearing mounted in the crankshaft which supports the end of the input shaft. Bearings are designed for long life and require no lubrication.

DIAGNOSIS AND TESTING

Refer to Section 08-00.

REMOVAL AND INSTALLATION

Clutch Disc and Pressure Plate Assembly, 10.0-Inch, 11.0-Inch, 12.0-Inch

Removal

1. Disconnect the battery negative cable.
2. Remove external slave cylinder, or hydraulic line quick disconnect on concentric slave cylinder applications using Clutch Coupling Tool T88T-70552-A.
3. Remove release lever, if equipped.
4. Remove dust cover, if equipped.
5. Remove the transmission from the vehicle. Refer to appropriate section in Group 07.
6. Mark the assembly position of pressure plate and cover to flywheel if the original clutch components are to be installed.
7. Remove pressure plate, cover assembly and clutch disc from flywheel.

NOTE: Remove the pilot bearing only if replacement is needed.

Installation

CAUTION: The 7.3L cover assembly bolt is 5/16-inch x 18 x .75-inch while the 7.5L MFI cover bolt is 5/16-inch x 18 x .92-inch. The .92 inch-long bolt CANNOT be used with the dual mass flywheel because it will extend beyond the inner surface of the secondary flywheel and interfere with the primary flywheel. Only the .75-inch cover bolt can be used with the dual mass flywheel.

1. Position clutch disc on flywheel so Truck Clutch Alignment Shaft D79T-7550-A or equivalent can enter clutch pilot bearing to align disc.
2. Position clutch plate and cover assembly on flywheel.
3. Align clutch plate and disc, and install the retaining bolts that fasten assembly to flywheel.
4. If installing original clutch components, use the location marks made during removal. Tighten the retaining bolts to specifications. Refer to Specifications at the end of this section.

REMOVAL AND INSTALLATION (Continued)

5. On 7.3L diesel and 7.5L gas engines, clean and lubricate the transmission bearing retainer. Clean and lubricate the bearing hub bore and install on the retainer. Clean and lubricate the release lever pivot stud and clutch release lever fingers.
6. Install the transmission. Refer to appropriate section in Group 07.
7. Position release lever, if equipped, into release bearing hub and align with pivot stud. Push upward on lever until snapped into position.
8. Install dust boot, if equipped.

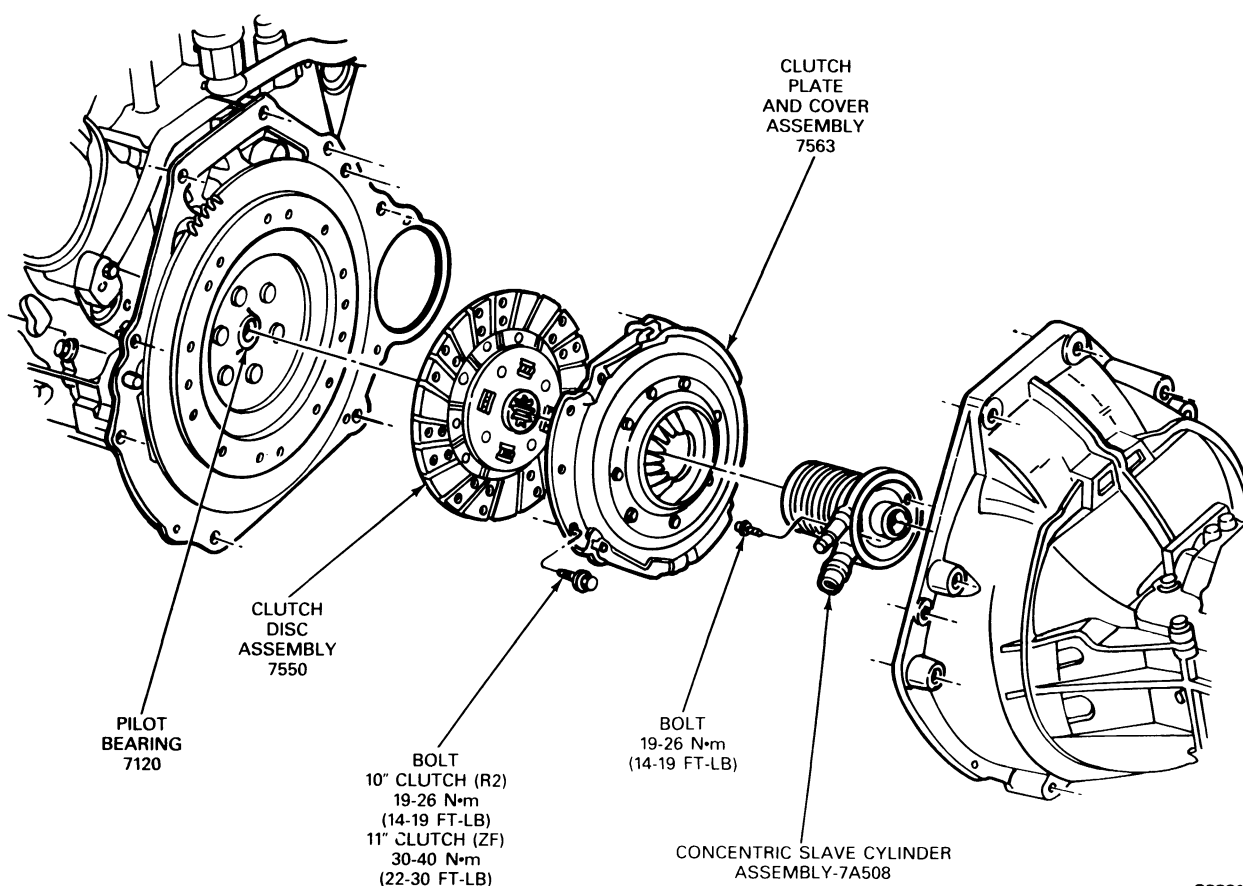
9. Install the external slave cylinder, or attach hydraulic tube quick connect fitting.

10. Connect battery negative cable.

NOTE: When the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

11. Operate vehicle to check clutch operation.

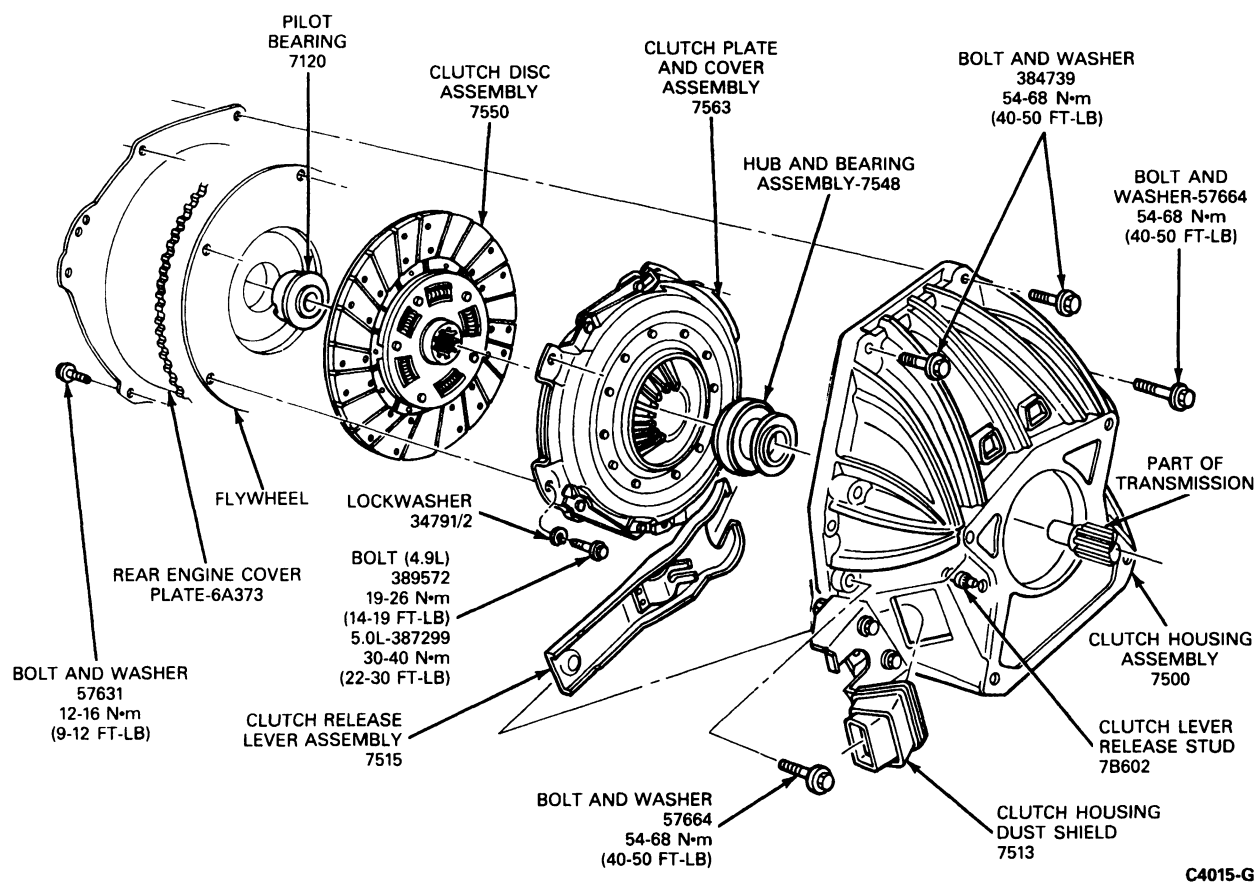
Clutch Installation, F-150-250-350, Bronco with 4.9L, 5.0L and 5.8L Engines (ZF Light Duty or Mazda R2 Transmission)



C8881-D

REMOVAL AND INSTALLATION (Continued)

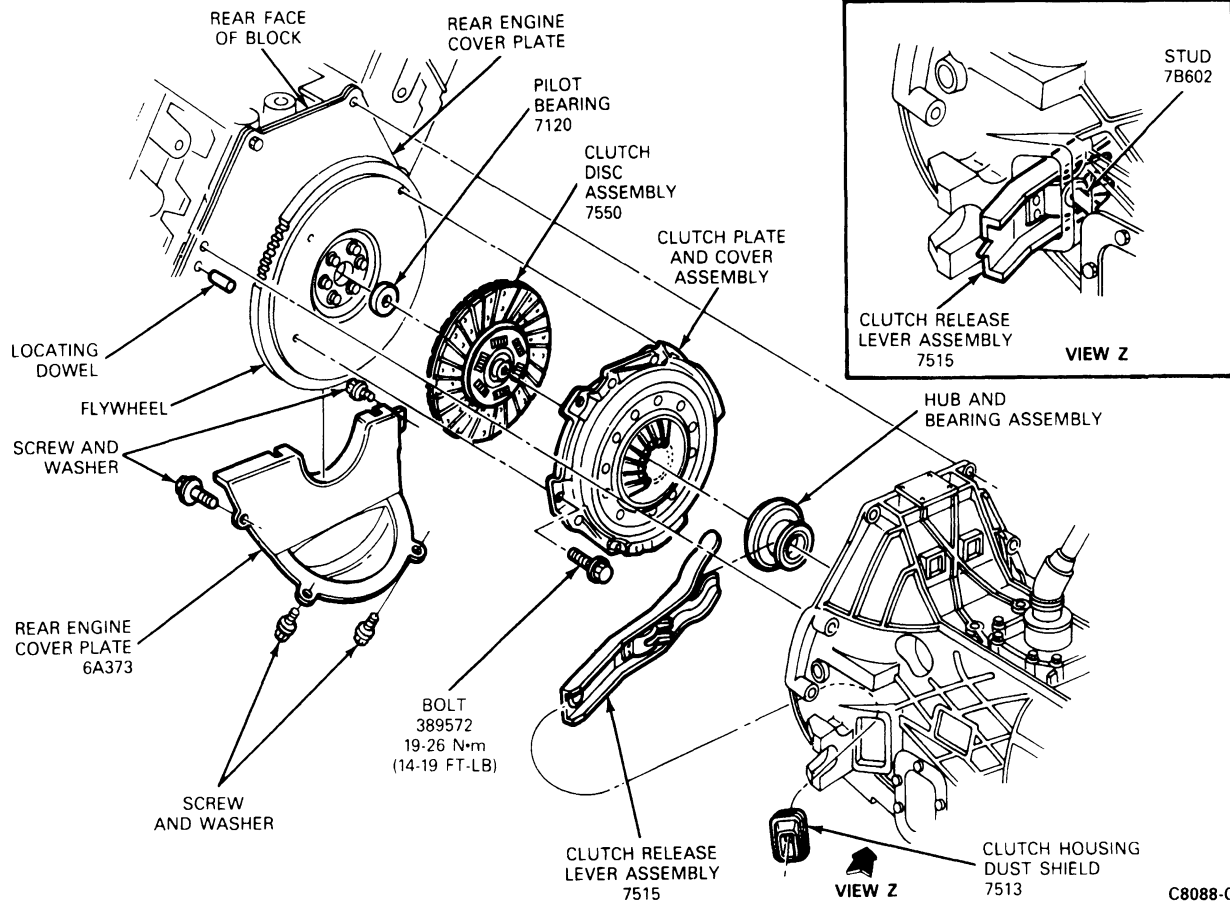
Clutch Installation, F-150-250 and Bronco with 4.9L (300 CID) and 5.0L W (302 Engine), Warner T-18 4-Speed Transmission



C4015-G

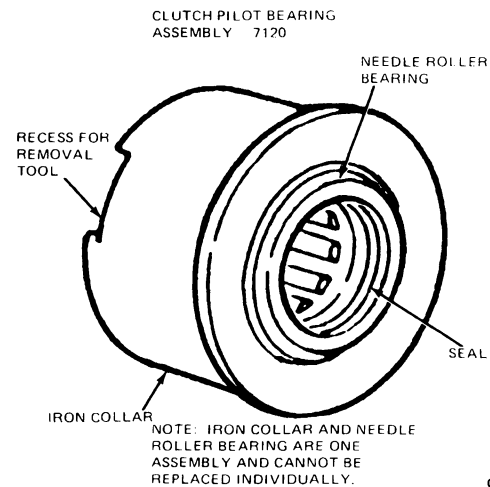
REMOVAL AND INSTALLATION (Continued)

Clutch Installation, F-250 HD, F-350, F-Super Duty Chassis Cab and Commercial Chassis with 7.3L Diesel Engine and 7.5L (460 CID) V-8 Engine (ZF Heavy Duty)



Clutch Pilot Bearing

NOTE: The needle bearing clutch pilot can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pregreased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.

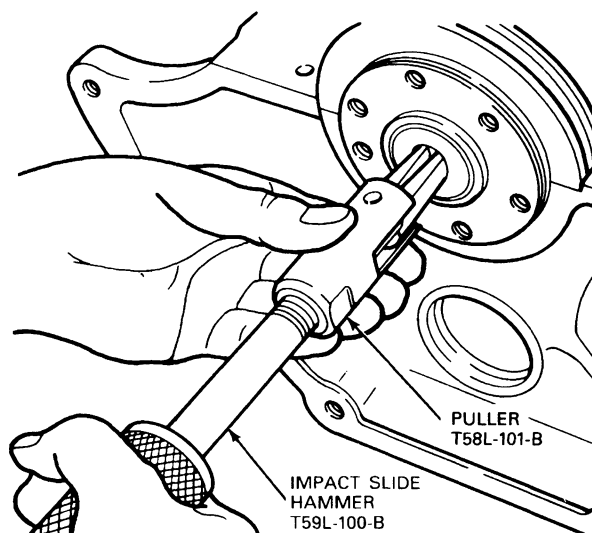


Removal

1. Remove the transmission, clutch pressure plate, and disc. Refer to the appropriate section in Group 07.

REMOVAL AND INSTALLATION (Continued)

2. Using Impact Slide Hammer T59L-100-B, and Puller T58L-101-B remove pilot bearing.

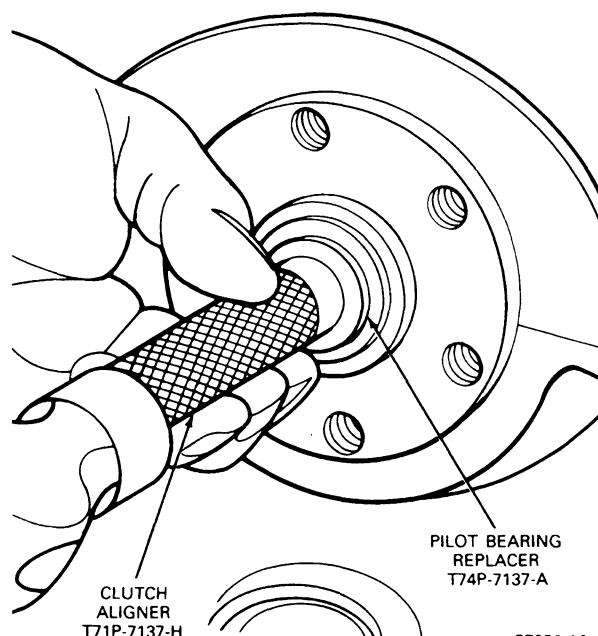


C7029-C

Installation

1. Using suitable pilot bearing replacer and Clutch Aligner T71P-7137-H, install the pilot bearing with seal facing transmission so adapter is not cocked.
2. Install clutch pressure plate, disc, and transmission following the procedure in this section and the appropriate transmission section in Group 07.

NOTE: Do not damage the bearing while inserting input shaft into bearing during transmission installation.



C7030-1A

SPECIFICATIONS**TORQUE SPECIFICATIONS**

F-150, 250, 350 and Bronco with 4.9L, 5.0L and 5.8L Engines, ZF Light Duty or Mazda R2 Transmission

Description	N-m	Lb-Ft
Clutch Bolt		
10 Inch Clutch	19-26	14-19
11 Inch Clutch	30-40	22-30
Concentric Slave Cylinder Bolt	19-26	14-19

TORQUE SPECIFICATIONS

F-150, 250 and Bronco with 4.9L (300 CID) and 5.0L W (302 Engine), Warner T-18 4-Speed Transmission

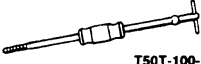

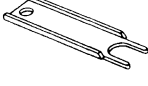
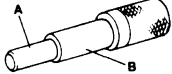
Description	N-m	Lb-Ft
Rear Engine Assembly Bolt and Washer	12-16	9-12
Clutch Plate and Cover 4.9L	19-26	14-19
Assembly Bolt 5.0L	30-40	22-30
Clutch Housing Bolt(s) and Washer(s)	54-68	40-50

TORQUE SPECIFICATIONS

F-250 HD, F-350, F-Super Duty Chassis Cab and Commercial Chassis with 7.3L Diesel Engine and 7.5L (460 CID) V-8 Engine (ZF Heavy Duty)

Description	N-m	Lb-Ft
Clutch Plate and Cover Assembly	19-26	14-19

SPECIAL SERVICE TOOLS

Tool Number/ Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T58L-101-B Puller	 T58L-101-B
T88T-70522-A Clutch Coupling Tool	 T88T-70522-A
T71P-7137-H Clutch Aligner A .582 Inch Dia. B .903 Inch Dia.	 T71P-7137-H

SECTION 08-02 Clutch Controls

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS.....	08-02-9	REMOVAL AND INSTALLATION (Cont'd.)	
DESCRIPTION AND OPERATION		Clutch Release Lever, 7.3L Diesel and 7.5L Gas Engines Only (External Slave Cylinder)	08-02-6
Hydraulic Actuation System	08-02-1	Clutch Slave Cylinder.....	08-02-6
DIAGNOSIS AND TESTING		Cross-Shaft Lever.....	08-02-9
Clutch Hydraulic System	08-02-1	External Slave Cylinder.....	08-02-6
Clutch/Starter Interlock Switch.....	08-02-1	Hydraulic Clutch Line	08-02-5
REMOVAL AND INSTALLATION		Master Cylinder	08-02-4
Clutch Interlock Three-Function Switch	08-02-7	SPECIAL SERVICE TOOLS	08-02-10
Clutch Pedal	08-02-7	SPECIFICATIONS	08-02-9
Clutch Release Bearing.....	08-02-5	VEHICLE APPLICATION	08-02-1

VEHICLE APPLICATION

F-150-250-350, F-Super Duty Chassis Cab,
Commercial Chassis and Bronco Vehicles Equipped
with Manual Transmission

DESCRIPTION AND OPERATION

Hydraulic Actuation System

The hydraulic clutch control system consists of a clutch fluid reservoir and master cylinder assembly, a slave cylinder, connecting tubing and a clutch interlock three-function switch.

The clutch reservoir and master cylinder assembly is located inboard of the brake vacuum booster. Fluid level is checked at the reservoir. A clutch interlock three-function switch is concentrically located on the master cylinder, on all F-Series and Bronco.

The clutch external slave cylinder is mounted on the transmission flywheel housing for vehicles equipped with 7.3L diesel or 7.5L gas engines with an S5-42 ZF Heavy Duty Transmission, or 4.9L or 5.0L gas engines with the Borg-Warner T-18 Transmission. Vehicles equipped with either a 4.9L, 5.0L or a 5.8L gas engine with either an S5-42 ZF Light Duty or a Mazda R2 Transmission are equipped with a concentric slave cylinder, located inside the transmission flywheel housing mounted on the transmission input shaft.

DIAGNOSIS AND TESTING

Clutch Hydraulic System

For diagnostic and testing procedures refer to Section 08-00.

Clutch/Starter Interlock Switch

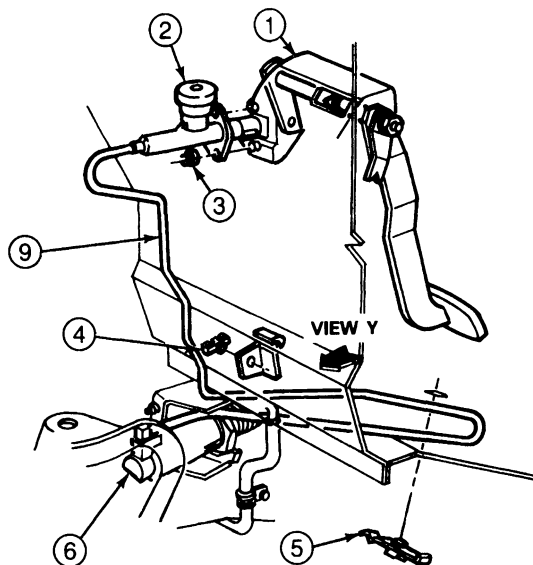
For switch diagnosis and testing, refer to Section 08-00.

REMOVAL AND INSTALLATION

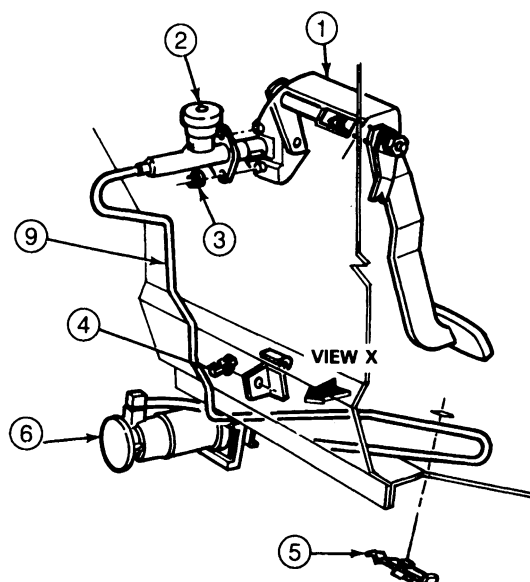
Refer to the following illustration for F-Series and Bronco Hydraulic Clutch System, 7.3L Diesel Engine, 7.5L (460 CID) Gas Engine, 4.9L (300 CID) and 5.0L (302 CID) with S5-42 ZF Heavy Duty and Borg-Warner T-18 Transmissions

REMOVAL AND INSTALLATION (Continued)

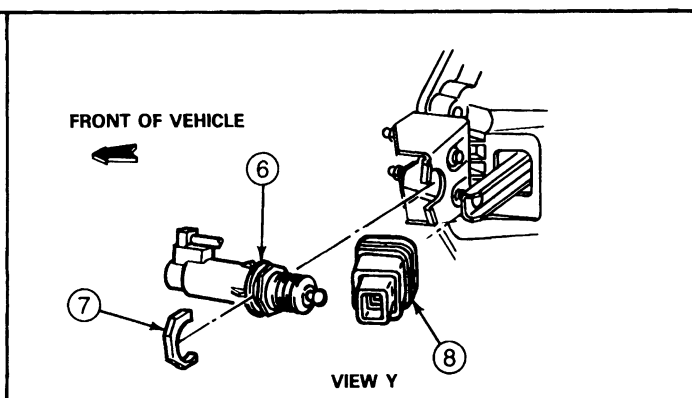
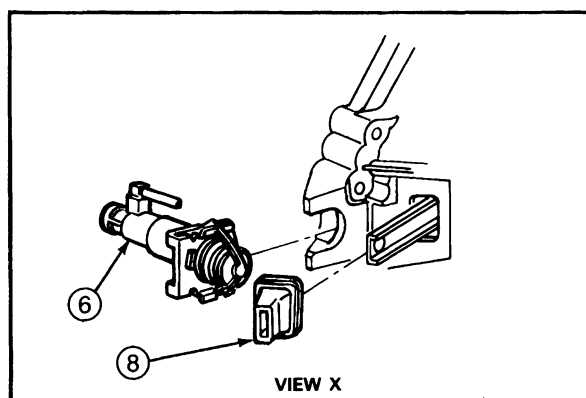
Hydraulic Clutch System, F-Series and Bronco, 7.3L Diesel Engine, 7.5L (460 CID) Gas Engine, 4.9L (300 CID) and 5.0L (302 CID) with S5-42 Heavy Duty and Borg Warner T-18 Transmissions



BORG WARNER T-18



ZF-H/DY TRANSMISSION



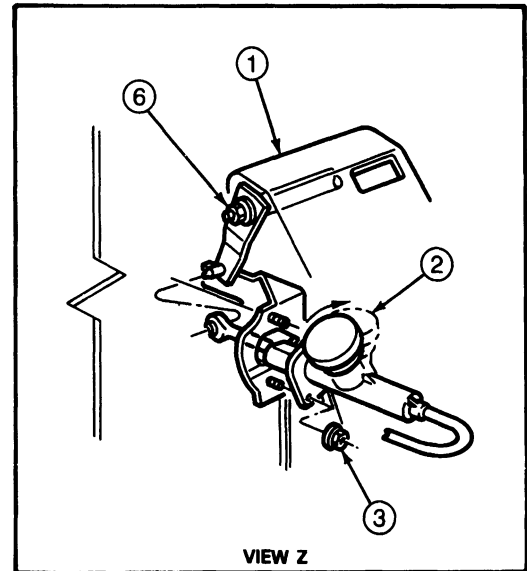
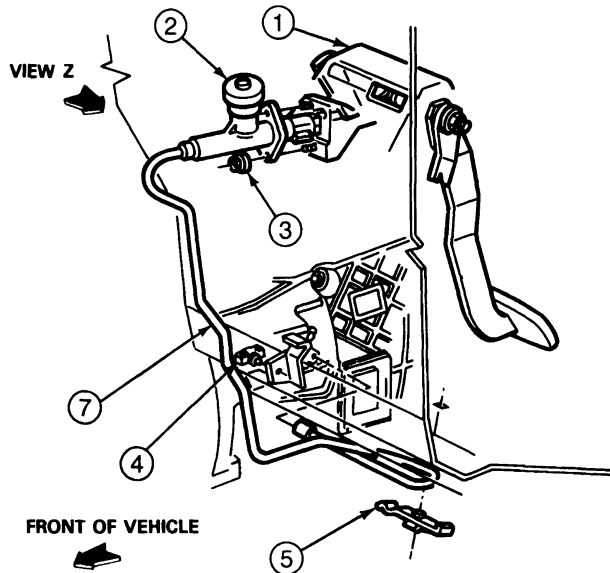
C10906-B

Item	Part Number	Description
1	2450	Bracket, Brake and Clutch Pedal Support
2	7A543	Master Cylinder Assembly, Clutch Hydraulic
3	N620481-S2	Nut M8-1.25 Hex Flange Head 9.5-15 N·m (85-135 In-Lbs)
4	N806880	Clip, Double

(Continued)

Item	Part Number	Description
5	N804443-S100	Clip, 5 / 16 Open Pinched
6	7A554	Cylinder Assembly, Clutch Slave
7	7A603	Retainer
8	5713	Shield
9	7A512	Tube Assembly, Hydraulic Clutch Control

TC10906A

REMOVAL AND INSTALLATION (Continued)**Hydraulic Clutch System, 4.9L, 5.0L and 5.8L Gas Engines with Mazda R2 and S5-42 ZF Heavy Duty Transmissions**

C10908-B

Item	Part Number	Description
1	2450	Pedal and Bracket Assembly — Brake
2	7A543	Master Cylinder, Clutch
3	N620481-S2	Nut M8-1.25 Hex Flange
4	N806880-S100	Clip, Double (Attaches 7A543 to Dash)

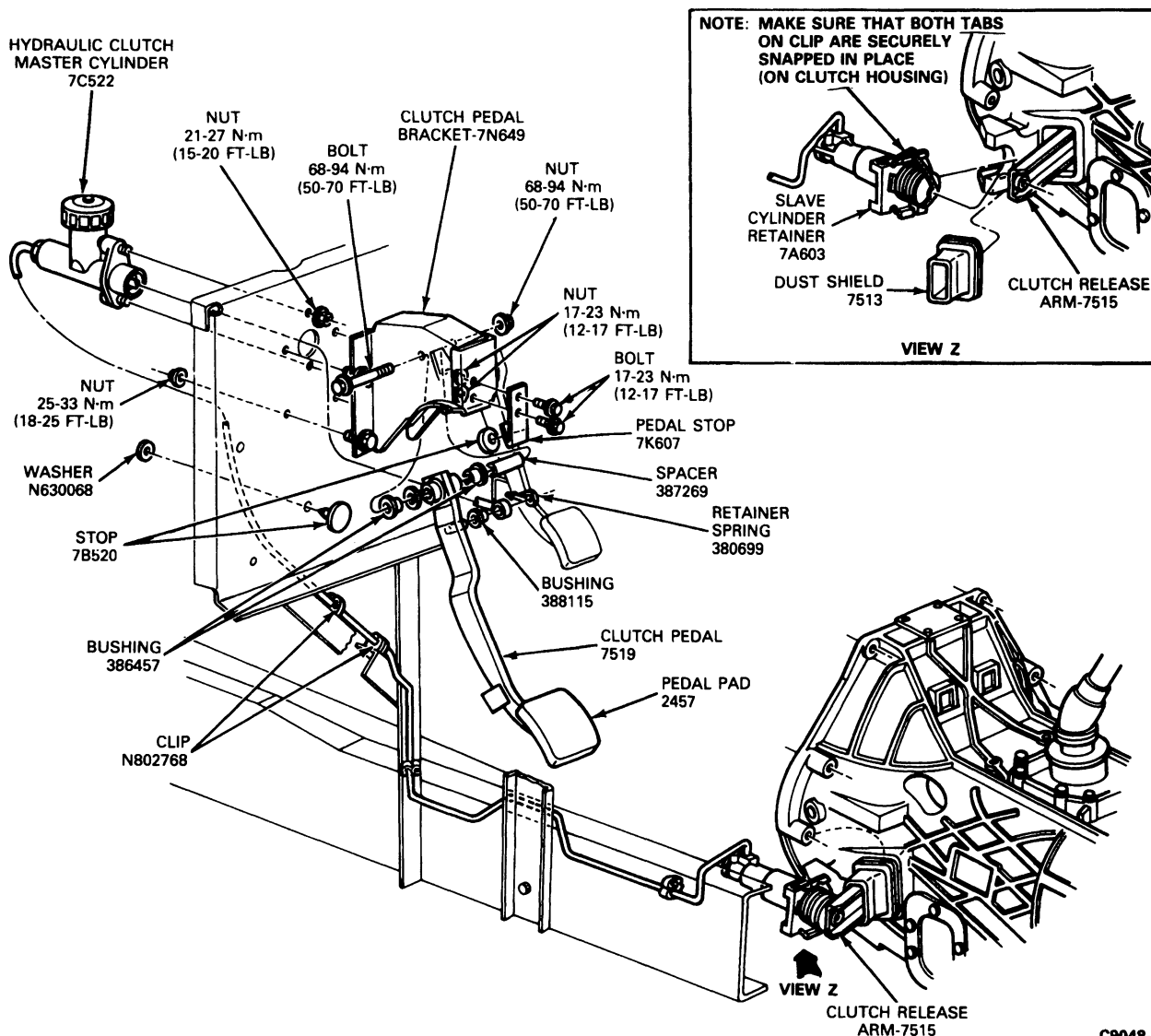
(Continued)

Item	Part Number	Description
5	N804443-S100	Clip, 5 / 16 Open Pinched
6	620483-S2	Nut (Part of Item # 1)
7	7A512	Tube Assembly, Hydraulic Clutch Control

TC10908A

REMOVAL AND INSTALLATION (Continued)

Hydraulic Clutch System, F-Super Duty Commercial Chassis with 7.3L Diesel Engine



C9048-C

Master Cylinder**Removal and Installation**

CAUTION: For vehicles equipped with external slave cylinders, prior to any vehicle service that requires removal of the slave cylinder (i.e., transmission removal), the master cylinder push rod must be disconnected from the clutch pedal. If not disconnected, permanent damage to the slave cylinder will occur if the clutch pedal is depressed while the slave cylinder is disconnected.

1. From cab interior, carefully pry push rod and retainer bushing from cross-shaft lever pin.
2. Disconnect interlock switch connector plug.

3. Remove the two nuts and support bracket retaining the clutch reservoir and master cylinder assembly to the firewall.
4. Disconnect hydraulic tube from master cylinder.
5. Remove clutch reservoir and master cylinder assembly from firewall.
6. When the master cylinder studs are free of dash panel, rotate cylinder 105 degrees counterclockwise to permit interlock switch to exit dash panel. Remove unit from vehicle.

For installation, follow removal procedures in reverse order. Bleed system as outlined in this section.

NOTE: As the clutch disc wears, the fluid level in the reservoir will rise. The fill line step in the reservoir is the normal level for a new system.

REMOVAL AND INSTALLATION (Continued)

NOTE: The proper fluid level is indicated by a step on the reservoir. Do not overfill. The upper portion of the reservoir must accept fluid that is displaced from the slave cylinder as the clutch wears.

Hydraulic Clutch Line

Removal and Installation

1. Note the routing of the hydraulic clutch line from master cylinder to the slave cylinder.
2. Remove retainer pin from master cylinder holding hydraulic clutch line in place.
3. Raise the vehicle and install suitable safety stands.
4. Disconnect hydraulic clutch line from external slave cylinder. On vehicles equipped with concentric slave cylinders, remove tube using Clutch Coupling Tool T88T-70522-A.

For installation, follow the removal procedures in reverse order. Bleed system as outlined in this section.

Clutch Release Bearing

4.9L, 5.0L and 5.8L Engines

Removal

1. Remove transmission. Refer to appropriate section in Group 07.
2. Twist the release bearing and carrier assembly until resistance is felt.
3. Turning assembly farther allows preload spring to push bearing assembly off the slave cylinder.

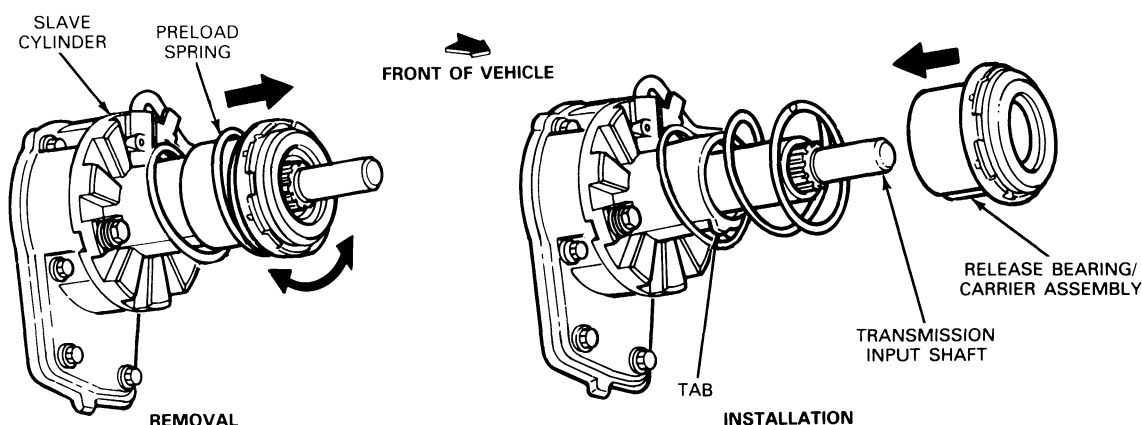
NOTE: On 7.3L and 7.5L engine applications, remove release bearing by sliding it off the transmission input shaft once the transmission is removed from the vehicle. Refer to the appropriate section in Group 07.

Installation

NOTE: Prior to installation, lubricate bearing bore and bearing carrier with Ford Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent.

1. Install release bearing assembly to clutch slave cylinder by pushing into place.

Clutch Release Bearing



C8887-B

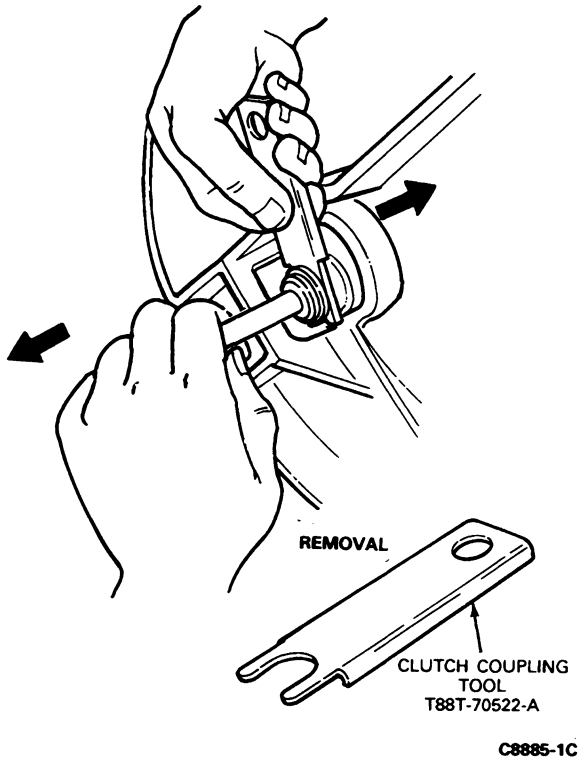
REMOVAL AND INSTALLATION (Continued)

Clutch Slave Cylinder

Concentric Slave Cylinder

Removal

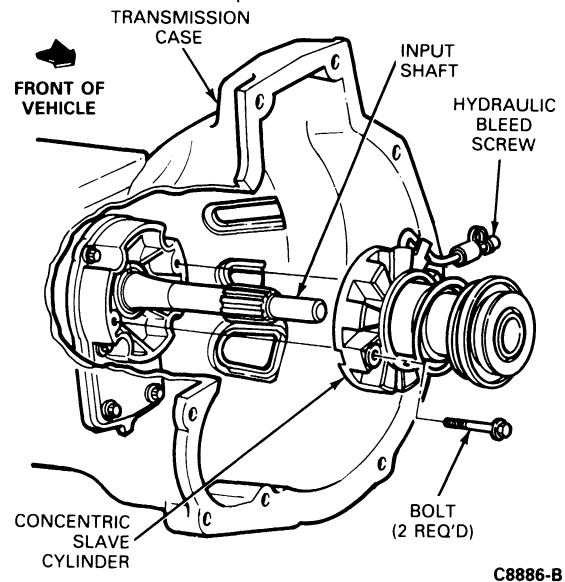
1. Disconnect coupling at transmission with Clutch Coupling Tool T88T-70522-A by sliding the white plastic sleeve toward the slave cylinder while applying a slight tug on tube.
2. Remove the transmission. Refer to appropriate section in Group 07.



3. Remove slave cylinder bolts to the transmission.
4. Remove slave cylinder from transmission input shaft.

Installation

1. Position slave cylinder over transmission input shaft with bleed screw and coupling facing left side of transmission.
2. Install the slave cylinder attaching bolts and tighten to 20-27 N·m (15-20 ft·lb).
3. Install the transmission. Refer to appropriate section in Group 07.
4. Insert male coupling into female coupling on the clutch slave cylinder, check the connection is secure.
5. Bleed the clutch hydraulic system as required. Refer to Section 08-00.



Item	Description
1	Transmission Assembly
2	Input Shaft
3	Hydraulic Bleed Screw
4	Hydraulic Clutch Line Coupling
5	Bolt (2 Required)
6	Concentric Slave Cylinder

External Slave Cylinder

Removal and Installation

1. Remove hydraulic tube retainer pin to slave cylinder.
2. Remove retaining clip from slave cylinder.
3. Remove cylinder from transmission flywheel housing.

For installation, follow removal procedures in reverse order. Refer to Section 08-00.

Clutch Release Lever, 7.3L Diesel and 7.5L Gas Engines Only (External Slave Cylinder)

Removal

1. Raise the vehicle and install safety stands.
2. Remove dust boot from opening in clutch bell housing.
3. Push release lever forward to compress slave cylinder.

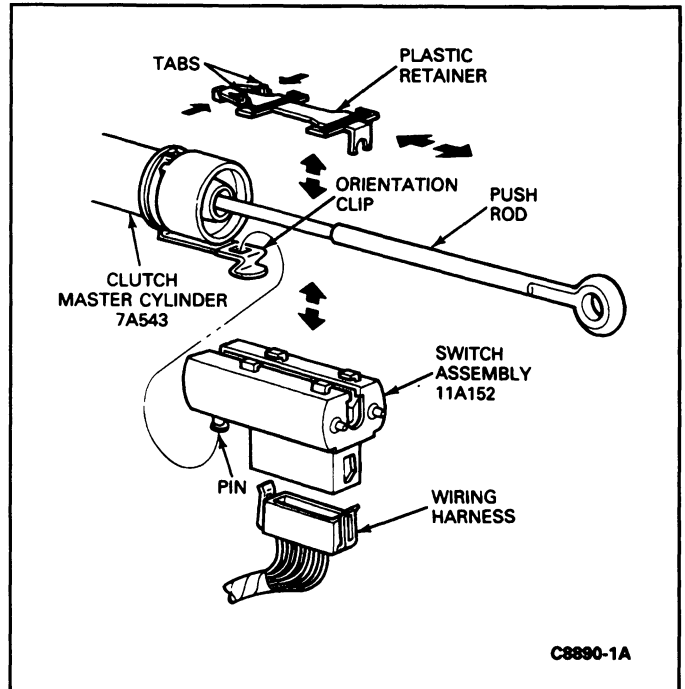
NOTE: On 7.3L diesel and 7.5L gas engines, the steel retainer clip is permanently attached to the slave cylinder.

REMOVAL AND INSTALLATION (Continued)

4. Remove slave cylinder by prying on clip to disengage tangs while pulling slave cylinder free of bracket.
5. Remove release lever by pulling lever outward.

Installation

1. Clean and relube release lever pivot stud, push rod pockets and fingers of release lever.
2. Install release lever on release bearing hub and pivot studs, making sure it is properly positioned.
3. Push the lever inward until it snaps onto stud.
4. Install dust shield in opening in bell housing.
5. Install slave cylinder and attaching clip.
6. Remove safety stands and lower the vehicle.
7. Depress the clutch pedal ten times to fill slave cylinder and to seat components.
8. Fill and bleed system to remove any air in slave cylinder, lines or master cylinder. Refer to Section 08-00.

**Clutch Interlock Three-Function Switch****Removal and Installation**

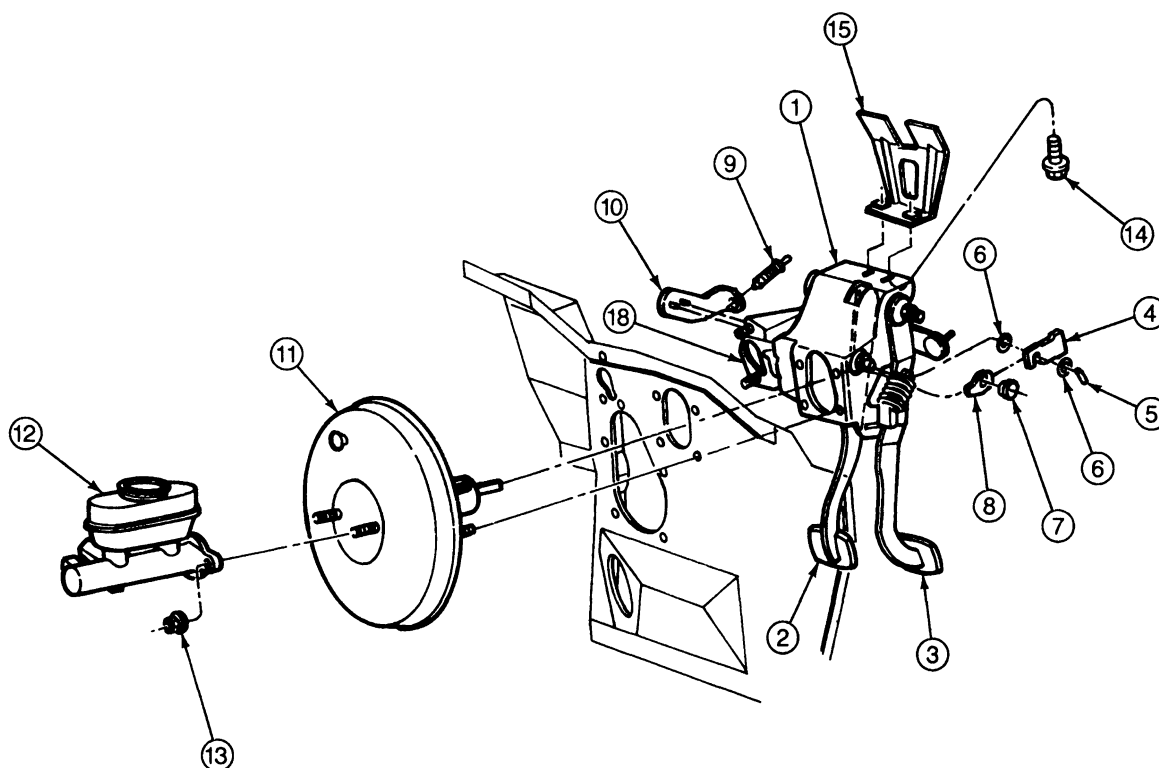
1. Disconnect the wiring harness from switch.
 2. Pull down on orientation clip to separate from switch tab.
 3. Rotate switch one-half turn to expose plastic retainer.
 4. Push tabs together allowing retainer to slide rearward and separate from switch.
 5. Remove switch from master cylinder push rod.
- For installation, follow removal procedures in reverse order.

Clutch Pedal**F-150-250-350, F-Super Duty and Bronco****Removal**

1. Disconnect clutch pedal retracting spring from clutch pedal and bracket.
2. Remove the nut that retains the clutch pedal to the shaft.
3. Remove the clutch pedal.
4. If the brake pedal is to be removed, refer to Section 06-06.

REMOVAL AND INSTALLATION (Continued)

Clutch Pedal Installation, F-150-250-350, F-Super Duty Chassis Cab and Bronco



C11125-A

Item	Part Number	Description
1	2450	Pedal and Bracket Assembly, Brake
2	2455	Pedal, Brake
3	7519	Pedal, Clutch
4	13480	Switch, Stoplight
5	380699-S100	Pin, Self-Locking
6	2B129	Spacer
7	2A309	Bushing
8	2005	Booster, Vacuum

(Continued)

Item	Part Number	Description
9	9C727	Valve, Speed Control Vacuum Dump
10	9C961	Bracket, Speed Control Dump Valve
11	2005	Booster, Vacuum
12	2C156	Master Cylinder
13	382802-S2	Nut 3/8-16 Hex Flange 18-34 N-m (13-18 Ft-Lb)
14	N606687-S2	Screw and Washer M8-1.25 x 16 20-27 N-m (15-20 Ft-Lb)
15	—	"Y" Brace

TC11125A

Installation

1. Position clutch pedal on shaft.
2. Install and tighten nut.

3. Install retracting spring. Make sure spring engages in pedal and bracket slots.
NOTE: Spring installation is easier if spring is first compressed in a vise and retained in a compressed state with mechanics wire until in place. Once in place, cut mechanics wire and remove.

REMOVAL AND INSTALLATION (Continued)

F-Super Duty Commercial Chassis

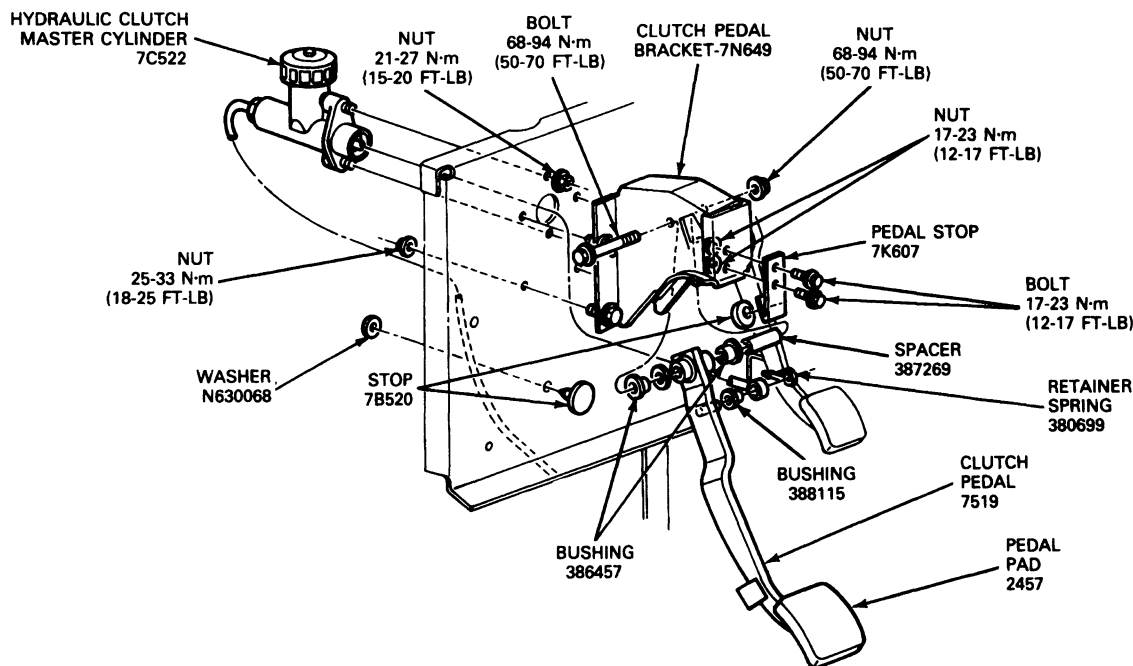
Removal and Installation

1. Disconnect clutch master cylinder push rod from clutch pedal.
2. Remove clutch pedal bracket through bolt and nut.

3. Remove clutch pedal with bushings, washer and the spacer.

For installation, follow removal procedures in reverse order. Tighten clutch and pedal through bolt and nut to 68-94 N·m (50-70 ft·lb).

Clutch System, F-Super Duty Commercial Chassis



Cross-Shaft Lever

Removal

1. Disconnect master cylinder push rod from cross-shaft lever pin. Use a small screwdriver or putty knife to wedge between lever and snap-in bushing.
2. Remove attaching nut.
3. Pry lever from cross-shaft.

Installation

1. Snap the new lever (pin) to the clutch master cylinder push rod bushing.
2. Install lever onto cross-shaft.
3. Install attaching nut finger-tight.
4. Inspect pedal position. Make sure it is against the "up" stop.
5. Tighten attaching nut allowing knurled teeth on shaft to cut matching teeth in lever for correct positioning.

ADJUSTMENTS

The hydraulic clutch system provides automatic clutch adjustment to compensate for disc wear. No adjustment of clutch linkage or pedal position is required. The under-dash mechanism is adjustable and only requires initial adjusting or adjusting if malfunction occurs.

SPECIFICATIONS

TORQUE SPECIFICATIONS HYDRAULIC CLUTCH SYSTEM, F-SUPER DUTY COMMERCIAL CHASSIS WITH 7.3L DIESEL ENGINE

Description	N-m	Lb-Ft
Hydraulic Clutch Master Cylinder Nut	21-27	15-20
Clutch Pedal Bracket Nut	68-94	50-70
Pedal Stop Bolt	17-23	12-17

SPECIFICATIONS (Continued)

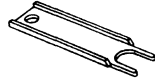
**TORQUE SPECIFICATIONS
CLUTCH PEDAL, F-150-250-350, F-SUPER DUTY AND
BRONCO**

Description	N-m	Lb-Ft
Master Cylinder to Vacuum Booster 3/8-16 Hex Flange Nut	18-34	13-18
Brake Pedal and Brake Assembly to "Y" Brace Screw and Washer M8-1.25 x 16	20-27	15-20

**TORQUE SPECIFICATIONS
F-SUPER DUTY COMMERCIAL CHASSIS**

Description	N-m	Lb-Ft
Hydraulic Clutch Master Cylinder Nut	21-27	15-20
Clutch Pedal Bracket Nut	68-94	50-70
Pedal Stop Nut and Bolt	17-23	12-17
Clutch Pedal Bracket Nut	25-33	18-25

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T88T-70522-A Clutch Coupling Tool	 <p align="center">T88T-70522-A</p>

GROUP

09

(5000)

EXHAUST SYSTEMS

SECTION 09-00 Exhaust Pipes, Mufflers and Converters

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION	
Exhaust System Alignment	09-00-28	Hanger Brackets.....	09-00-5
DESCRIPTION	09-00-1	Muffler and Outlet Pipe Assembly.....	09-00-4
DIAGNOSIS AND TESTING		Muffler Heat Shields.....	09-00-5
Diagnosis Guides.....	09-00-2	SPECIAL SERVICE TOOLS/EQUIPMENT	09-00-29
Restricted Exhaust System Test, Gasoline		SPECIFICATIONS	09-00-28
Engines.....	09-00-2	VEHICLE APPLICATION	09-00-1

VEHICLE APPLICATION

E-150-250-350, F-150-250-350, F-Super Duty, Bronco, Commercial Chassis and Motorhome Chassis Vehicles

DESCRIPTION

Exhaust systems vary between engine, transmission and vehicle models. Catalytic converters use clamshell catalysts of monolithic construction. The catalytic agent is an alloy of platinum, palladium and rhodium. All gasoline-powered vehicles employ the catalytic converter in their emission control systems and require the use of unleaded fuel.

The diesel engine does not use a catalytic converter, and uses only diesel fuel.

The location and type of exhaust system gaskets, retaining clamps and support brackets are shown in the exhaust system illustrations.

This section covers general exhaust system alignment procedures and specifications.

DIAGNOSIS AND TESTING

Exhaust system performance complaints such as excessive back-pressure are usually noticeable by their effect on engine performance.

However, other malfunctioning components may have similar effects on engine performance and be characterized by the same symptoms or complaints. It is, therefore, necessary to refer to the engine diagnosis and service procedures in Powertrain Control / Emissions Diagnosis Manual, ¹when attempting to diagnose this type of problem.

For general exhaust system complaints, refer to the diagnosis guide listed in this section.

DIAGNOSIS AND TESTING (Continued)

Restricted Exhaust System Test, Gasoline Engines

With the engine at normal operating temperature, connect a Rotunda Vacuum Gauge 059-00008 or equivalent to the intake manifold. A gradual drop in the vacuum gauge reading at idle will indicate a restricted exhaust system.

Refer to the Powertrain Control / Emissions Diagnosis Manual ² for test procedures for the 7.3L diesel engine.

Diagnosis Guides

NOISY OR LEAKING EXHAUST DIAGNOSIS GUIDE — TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	CLAMPS AND BRACKETS		
	<ul style="list-style-type: none"> Check for broken or loose clamps and / or brackets. Are clamps and brackets OK? 	Yes No	GO to A2 . REPAIR or REPLACE as necessary. Restart engine. If noise still exists GO to A2 .
A2	SYSTEM COMPONENTS		
	<ul style="list-style-type: none"> Check inlet pipe and muffler for punctures, split seams or improper welds. Are system components OK? 	Yes No	GO to A3 . REPLACE inlet pipe and / or muffler as necessary. If noise still exists GO to A3 .
A3	EXHAUST MANIFOLD		
	<ul style="list-style-type: none"> Inspect exhaust manifold for loose fasteners or cracks. Is exhaust manifold OK? 	Yes No	GO to B1 . TIGHTEN fasteners to specification or REPLACE exhaust manifold. REFER to specific engine section in this manual.

TCU1824D

RESTRICTED EXHAUST SYSTEM DIAGNOSIS GUIDE — TEST B

TEST STEP		RESULT	ACTION TO TAKE
B1	VISUAL INSPECTION		
	<ul style="list-style-type: none"> Is the exhaust system visually OK? 	Yes No	GO to B2 . REPLACE any collapsed exhaust components. GO to B2 .
B2	VACUUM TEST (Gasoline engine only)		
	<ul style="list-style-type: none"> Attach a Rotunda Vacuum Gauge 059-00008 or equivalent to the intake manifold vacuum source. Hook-up Rotunda Tachometer 059-00007 or equivalent. Start engine and gradually increase speed to 2000 rpm with transmission in neutral. Is neutral vacuum above 53.8 kPa (16 inches /Hg)? 	Yes No	REFER to Powertrain Control / Emissions Diagnosis Manual — lack of power. NOTE: Emissions Diagnosis Manual can be purchased as a separate item. GO to B3 .

² Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

RESTRICTED EXHAUST SYSTEM DIAGNOSIS GUIDE — TEST B (Continued)

TEST STEP		RESULT	ACTION TO TAKE
B3	VACUUM TEST — EXHAUST DISCONNECTED (Gasoline engine only)		
	<ul style="list-style-type: none"> ● Turn engine off. ● Disconnect exhaust system at manifold(s). ● Repeat vacuum test. Is the manifold vacuum above 53.8 kPa (16 inches / Hg)? 	Yes No	► GO to B4. ► GO to B5.
B4	VACUUM TEST — CATALYTIC CONVERTER(S) ON, MUFFLER(S) OFF (Gasoline engine only)		
	<ul style="list-style-type: none"> ● Turn engine off. ● Reconnect exhaust system at exhaust manifold(s). ● Disconnect muffler(s). ● Repeat vacuum test. Is the manifold vacuum above 53.8 kPa (16 inches / Hg)? 	Yes No	► REPLACE muffler and RETEST. ► REPLACE catalytic converter and inspect muffler to be sure converter debris has not entered muffler.
B5	EXHAUST MANIFOLD RESTRICTED		
	<ul style="list-style-type: none"> ● Remove the exhaust manifold(s). Inspect the ports for casting flash by dropping a length of chain into each port. Do not use a wire or light to check ports. The restriction may be large enough for them to pass through but small enough to cause excessive back pressure at high engine rpm. ● Is restriction OK? 	Yes No	► REFER to Powertrain Control / Emissions Diagnosis Manual— lack of power. NOTE: Emissions Diagnosis Manual can be purchased as a separate item. ► REMOVE casting flash. If flash cannot be remove, REPLACE exhaust manifold(s) and RETEST.

TCU1825H

Service Repair for Noise, Loose Catalyst or Muffler Heat Shields

NOTE: At idle or during normal driving conditions, a buzz or rattle may be detected, which can be traced to the exhaust system. The heat shield attachment to the muffler or catalyst may come free. The loose shield will vibrate off the muffler or catalyst and cause the buzz or rattle.

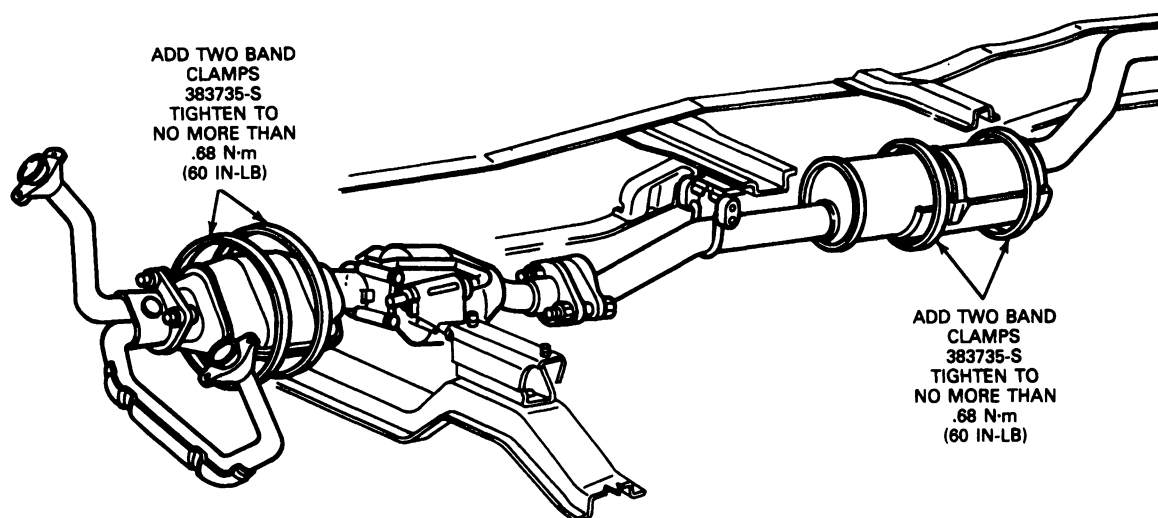
1. Attach two worm clamps (Part #391218) to the catalyst or muffler as shown in the illustration.

NOTE: The catalyst may have two cans. If shields on both cans are loose, four clamps (2 of each) will be required.

2. Align the clamp to secure the heat shield to the muffler or catalyst.
NOTE: Tighten the clamp to no more than 7 N·m (60 in-lb).
3. Trim excess "ear" to approximately 25mm (1 inch).

DIAGNOSIS AND TESTING (Continued)

Securing Heat Shields, Typical



U2411-B

REMOVAL AND INSTALLATION

The exhaust system components are removed, disassembled, assembled and installed using standard tools and procedures. Only remove components to the extent necessary to replace worn or damaged components.

Always refer to the Master Parts Catalog for parts usage and interchangeability before replacing a component part of the exhaust system.

Muffler and Outlet Pipe Assembly

Removal

1. Remove muffler and outlet pipe assembly clamp and U-bolt assemblies as required to remove worn or damaged components.
2. Disconnect muffler and outlet pipe assembly bracket and insulator assemblies.
3. Remove muffler and outlet pipe assembly. It may be necessary to heat the muffler / converter joint in order to separate the muffler assembly from the converter.
4. On SuperCab and Crew Cab vehicles, remove extension pipe.
5. If so equipped, disconnect catalytic converter bracket and insulator assembly.

NOTE: For rod and insulator type hangers, apply a soap solution to the insulator surface and rod ends to permit easier removal of the insulator from the rod end. Avoid use of oils or silicone since they do not dry and may allow the insulator to slip back off once it is installed.

6. Remove catalytic converter.
7. On vehicles with Secondary Air Injection (AIR), disconnect AIR tube assembly.
8. Disconnect inlet pipe from exhaust manifold.
9. Remove inlet pipe assembly.

Installation

CAUTION: Make sure positioning tabs and slots provided at the converter / muffler assembly connections are properly aligned to avoid ground-out conditions with chassis components during assembly.

1. On models using gaskets, clean mating surfaces thoroughly and install a new gasket.
2. On models with catalytic converter, position and install heat shields.
3. Loosely assemble the inlet pipe or inlet pipe and catalyst assembly to the manifold.
4. Place muffler and outlet pipe assembly in vehicle by sliding in over axle housing.
5. Position muffler and outlet pipe assembly by inserting it over the end of the converter and aligning slot to converter tab.
6. Apply a soap solution to metal support rods on muffler and outlet pipe assembly.

NOTE: Avoid use of oils or silicone since they do not dry and may allow the insulator to slip back off once it is installed.

7. Force metal support rods through rubber insulators.

REMOVAL AND INSTALLATION (Continued)

8. Attach hanger bracket clamps and U-bolts and tighten to specifications shown on illustration.
9. Tighten any gasket joints, then install and tighten the sealing clamp at the muffler-to-converter joint.
10. Connect Secondary Air Injection (AIR) tube assembly.
11. Tighten flange-to-manifold nuts to 34-39 N·m (25-36 ft·lb).

CAUTION: To make sure joint seals correctly, the correct clamp must be used.

Hanger Brackets**Removal**

1. Remove muffler and outlet pipe assembly from brackets.
2. Remove nuts from bracket and remove from frame.
3. For F-Series rear hanger bracket, remove rivet which holds bracket to frame.

Installation

1. Position bracket to frame, install and tighten nuts.

2. For F-Series rear hanger bracket, position bracket on frame and attach with M10-1.5 nut and bolt. Tighten to specifications as listed at the end of this section.

Muffler Heat Shields**Removal**

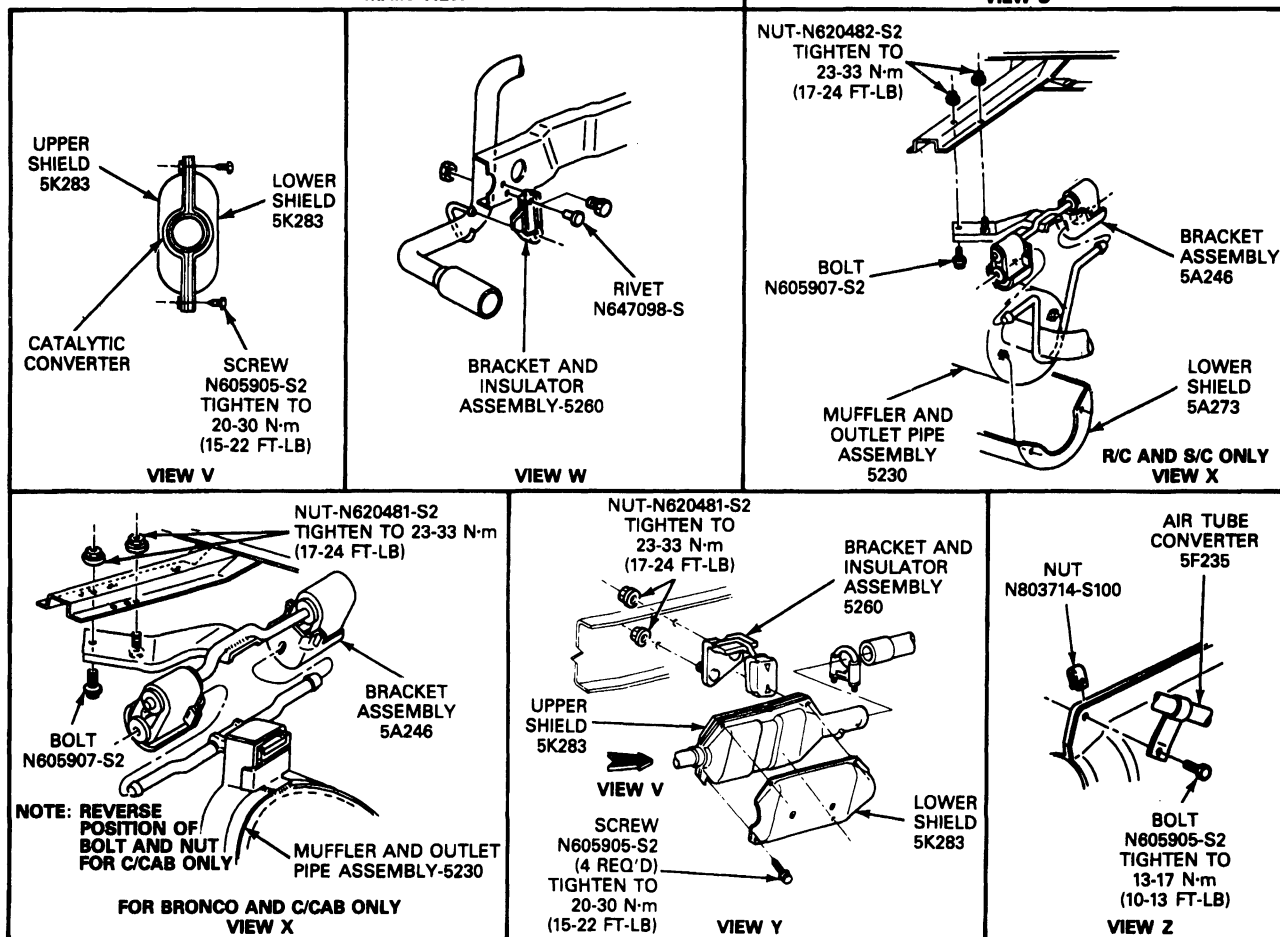
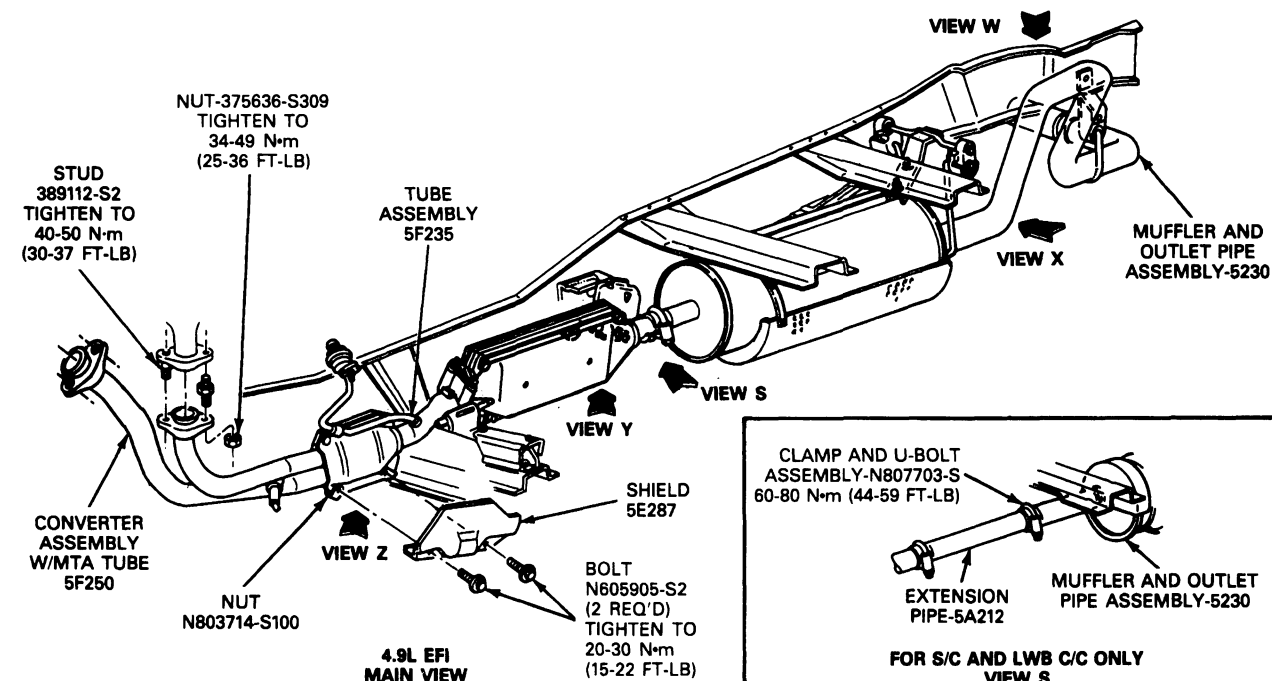
1. Remove band strap(s) from clamp worm gear(s).
2. Remove two screw and washer assemblies which hold shield to rear of muffler.

Installation

1. Position shield(s) on muffler body.
2. Install two screws to rear of muffler. Tighten screws and washer assemblies to 16-23 N·m (12-17 ft·lb).
3. Start band strap(s) in worm gear(s). Tighten to 2 N·m (18 in·lb).

REMOVAL AND INSTALLATION (Continued)

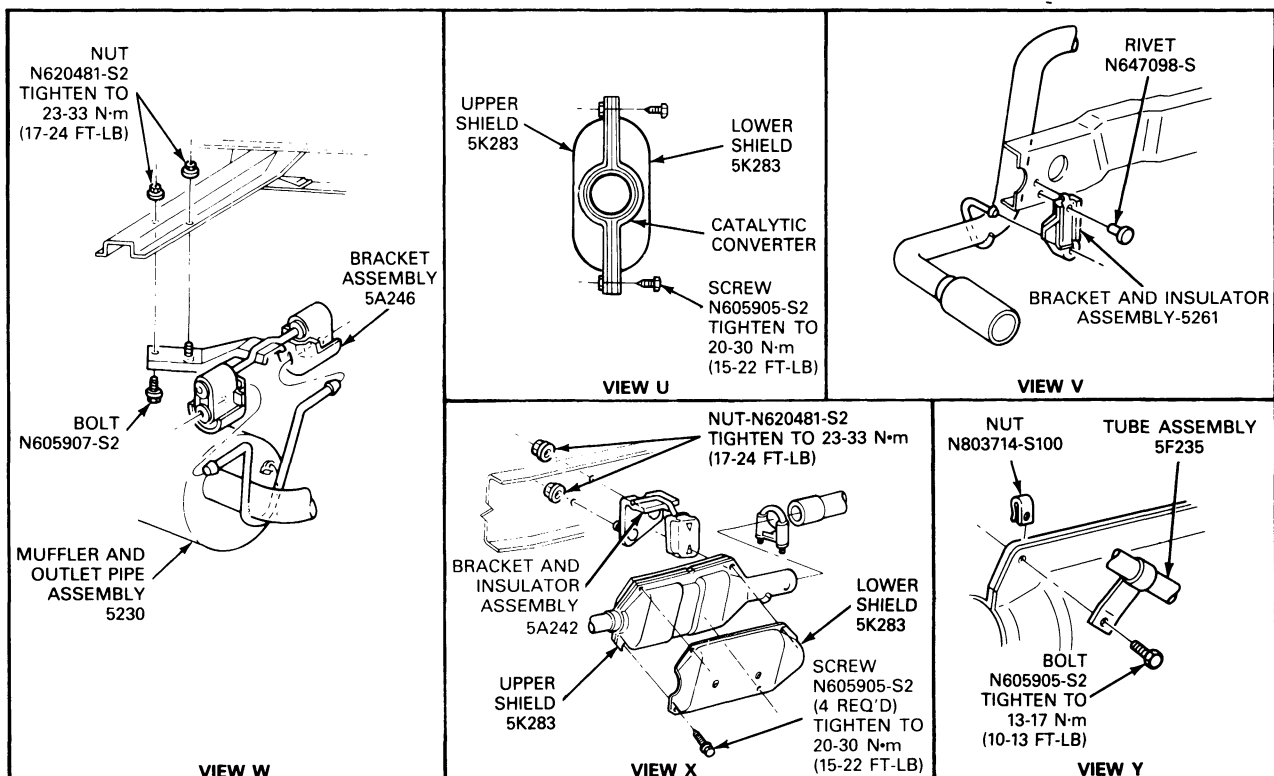
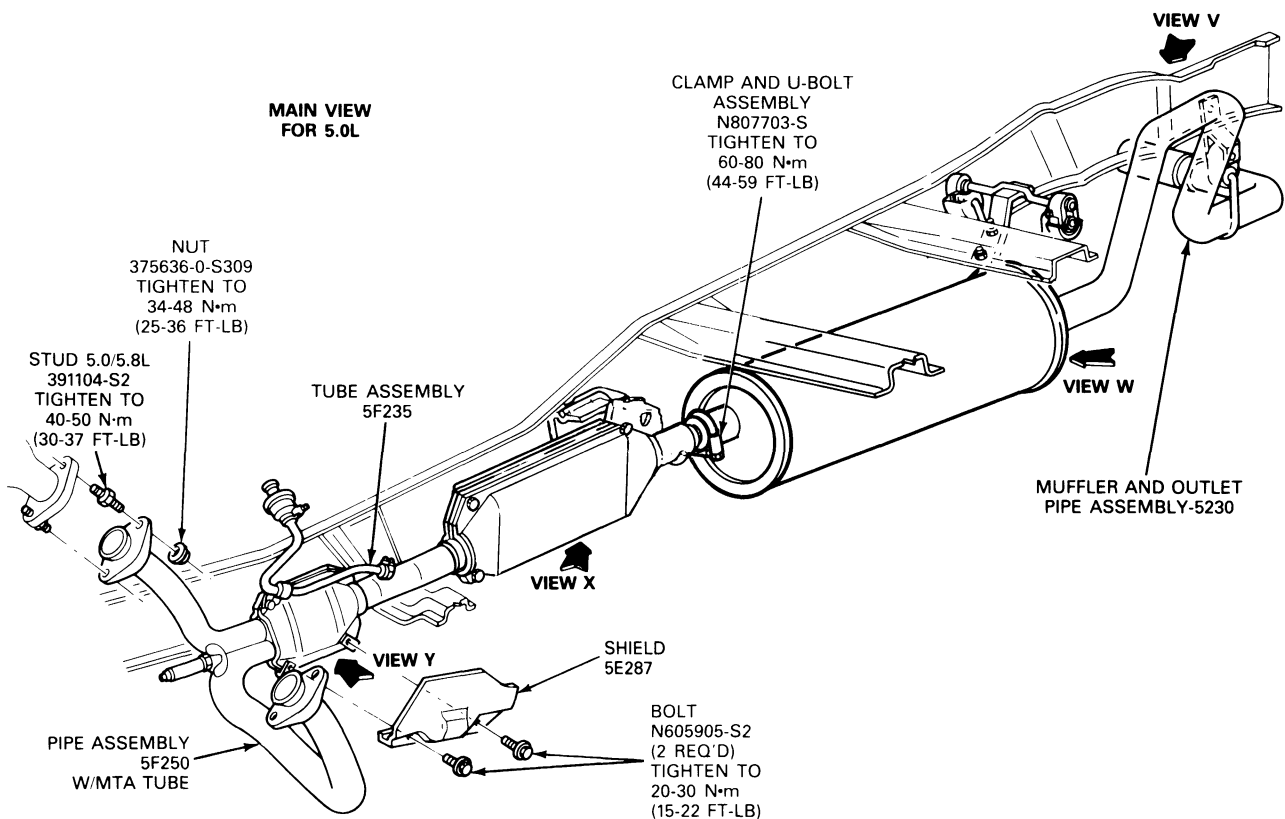
Exhaust System, Bronco, F-150-250-350 Regular Cab, SuperCab and Chassis Cab, 4x2 and 4x4, 4.9L MFI Engine



U2209-G

REMOVAL AND INSTALLATION (Continued)

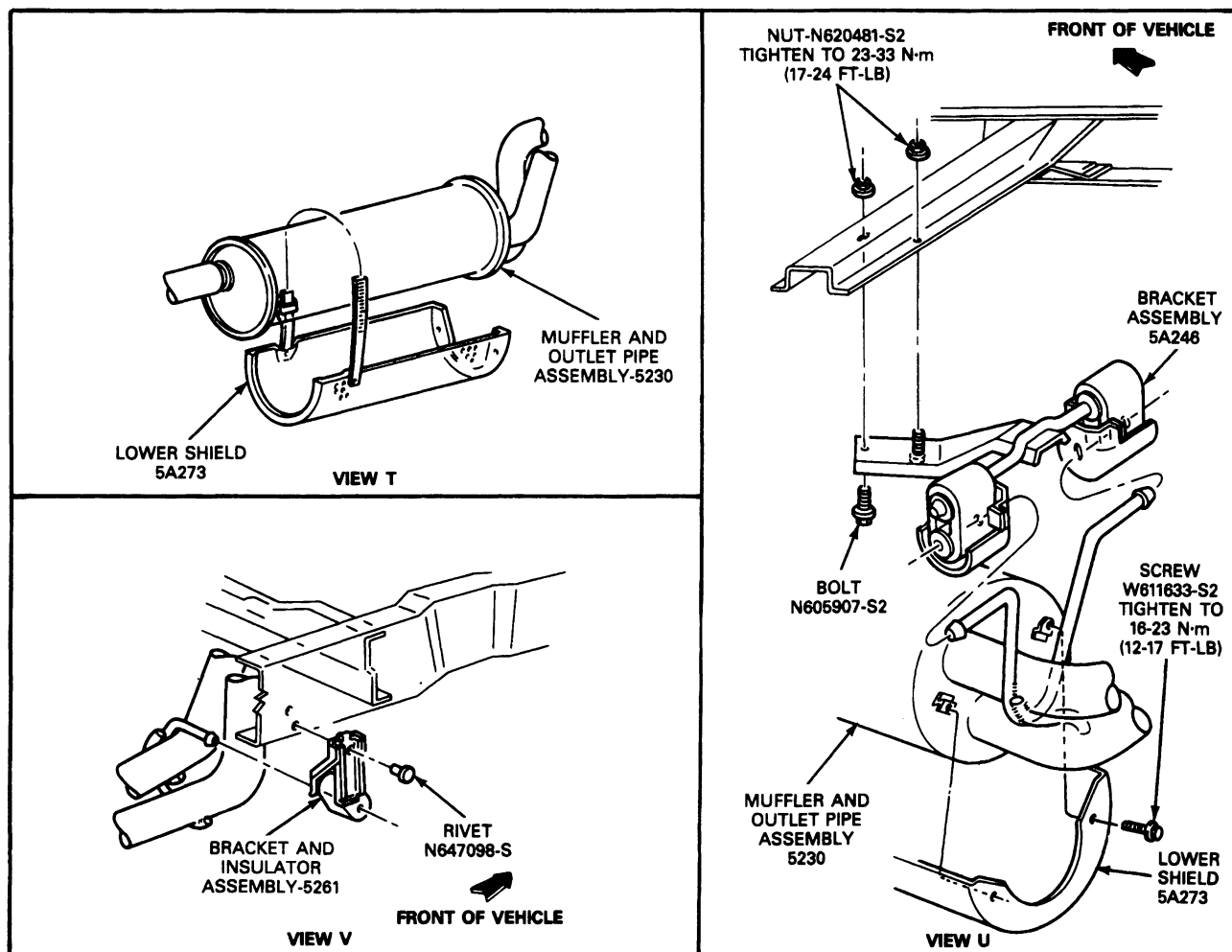
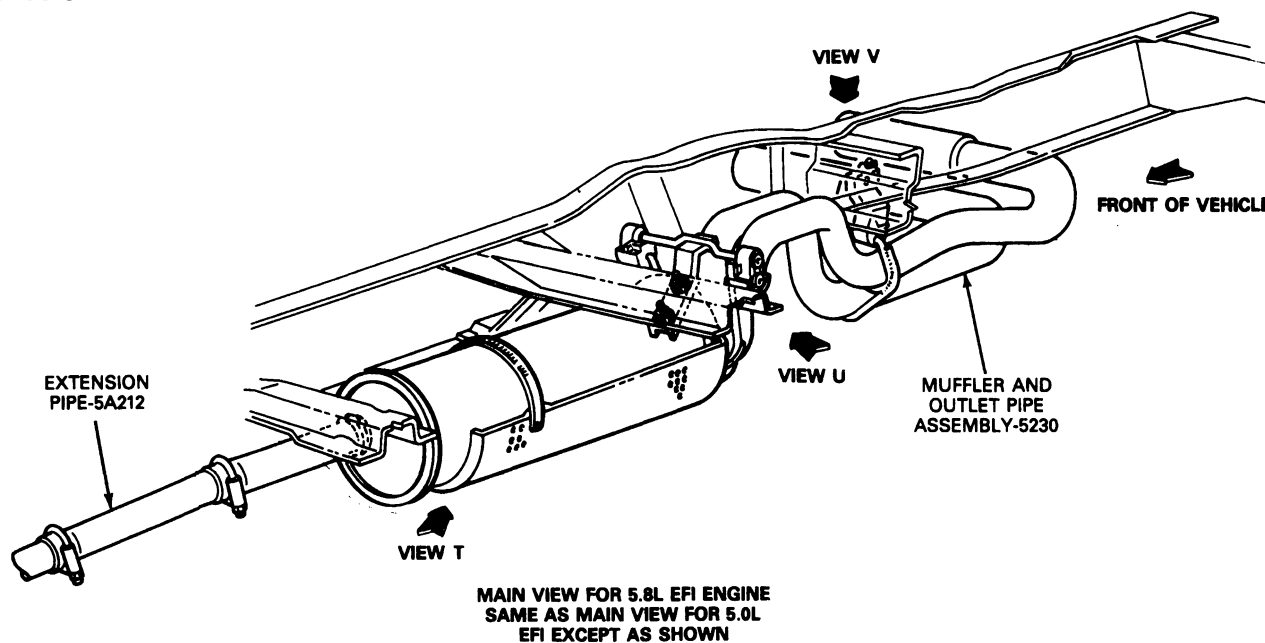
Exhaust System, Bronco, F-150-250-350 Regular Cab and SuperCab, 4x2 and 4x4, 5.0L MFI Engine



U2210-F

REMOVAL AND INSTALLATION (Continued)

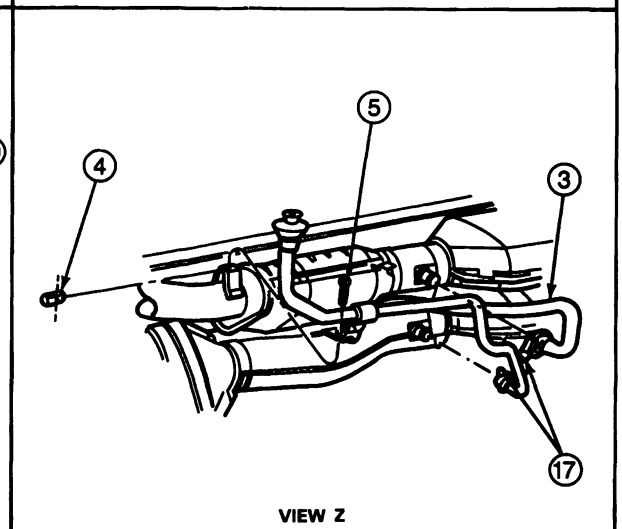
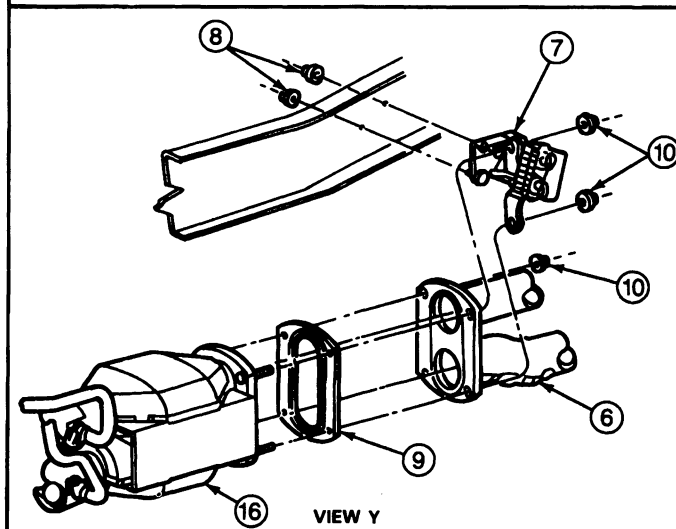
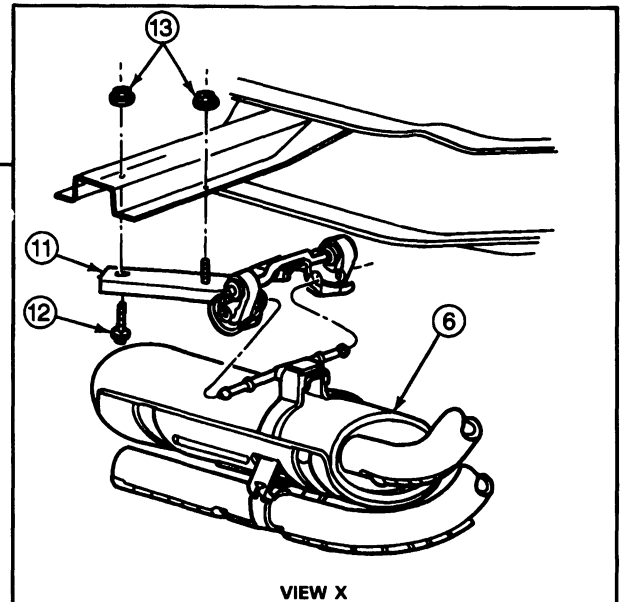
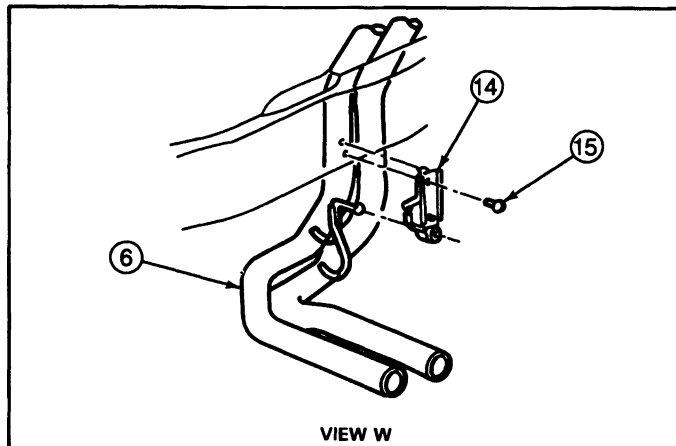
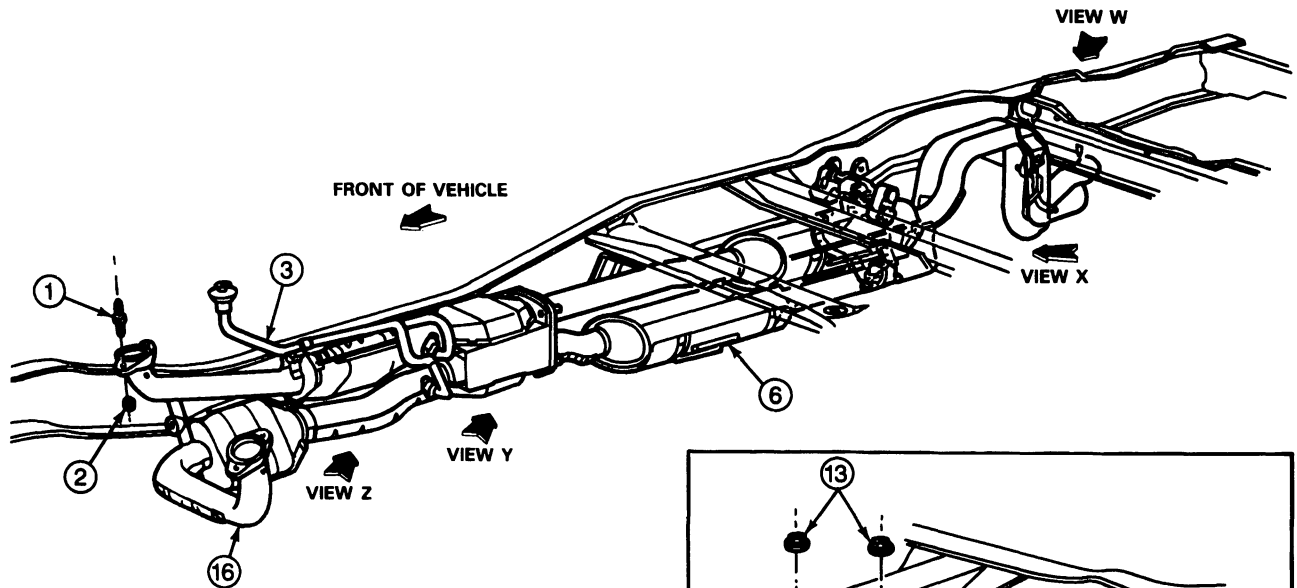
Exhaust System, Bronco, F-150-250-350 Regular Cab and SuperCab, 4x2 and 4x4, 5.8L MFI Engine, Under 8500 GVW



U2211-F

REMOVAL AND INSTALLATION (Continued)

Exhaust System, Lightning, 5.8L MFI Lightning Engine



U2437-A

REMOVAL AND INSTALLATION (Continued)

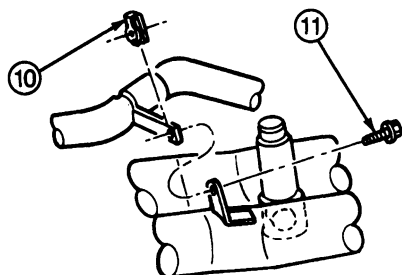
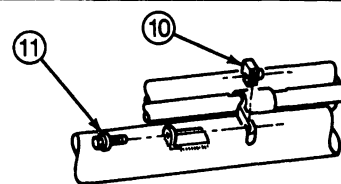
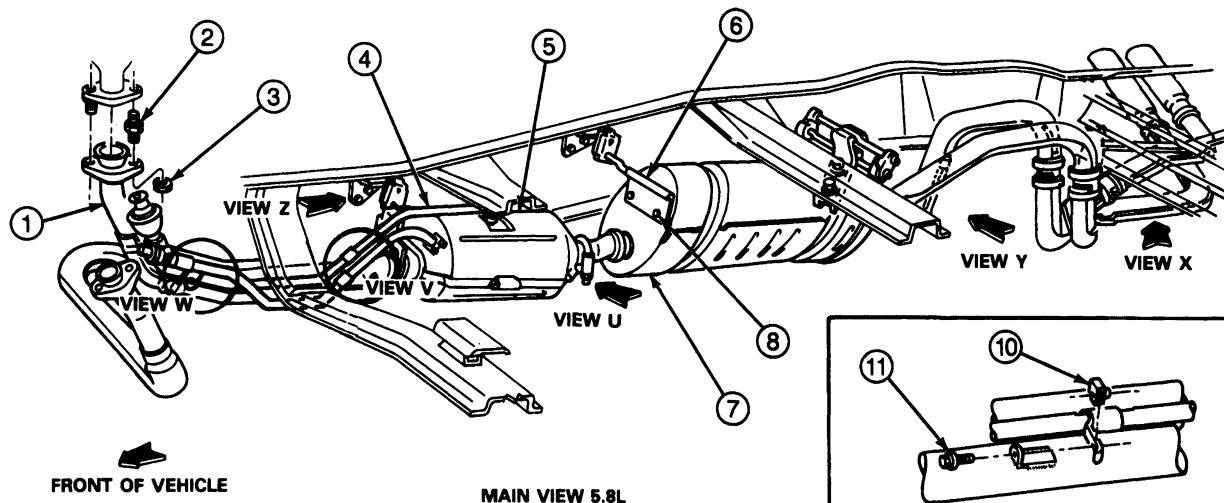
Item	Part Number	Description
1	391104-S2	Stud, 40-50 N·m (30-37 Ft-Lb)
2	375636-S309	Nut, Attaches Converter Assembly to Manifold, 34-46 N·m (25-34 Ft-Lb)
3	9J454	Tube Assembly
4	N623332-S2	Nut, M6-1.0
5	N605892-S2	Bolt, Attaches Tube to Converter, 8-11 N·m (71-97 In-Lb)
6	5K214	Muffler and Outlet Pipe Assembly
7	5A242	Bracket and Insulator Assembly

(Continued)

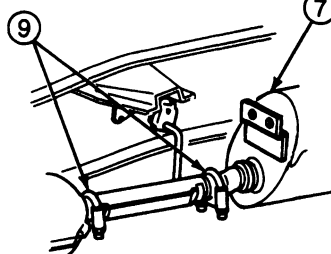
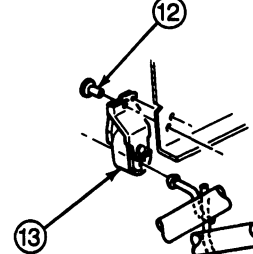
Item	Part Number	Description
8	N620481-S2	Nut, M8-1.25, Attaches 5A242 to Frame, 17-23 N·m (13-17 Ft-Lb)
9	5E241	Gasket
10	N620482-S2	Nut, M8-1.25, 34-46 N·m (25-34 Ft-Lb)
11	5A246	Bracket and Insulator Assembly
12	N605907-S2	Bolt, M8-1.25 x 30
13	N620481-S2	Nut, M8-1.25, 17-23 N·m (13-17 Ft-Lb)
14	5261	Rear Hanger Assembly
15	N647098-S	Rivet, 10 x 30 Solid
16	5F250	Converter Assembly
17	N802597-S2	Clamp, Attaches 9J454 to 5F250, 13-17 N·m (10-13 Ft-Lb)

REMOVAL AND INSTALLATION (Continued)

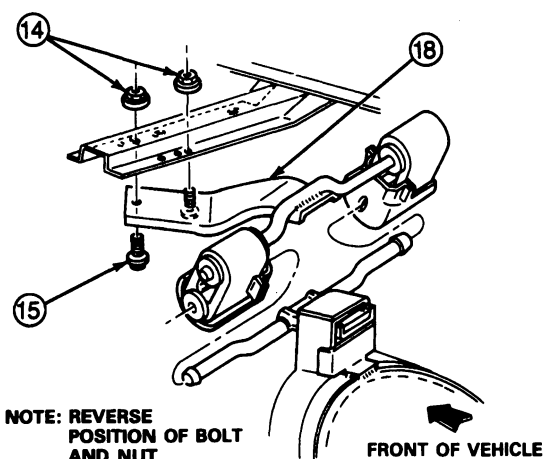
Exhaust Systems, F-250-350, F-Super Duty Regular Cab, SuperCab and Chassis Cab, 4x2 and 4x4, 5.8L MFI Engine, Over 8500 GVW



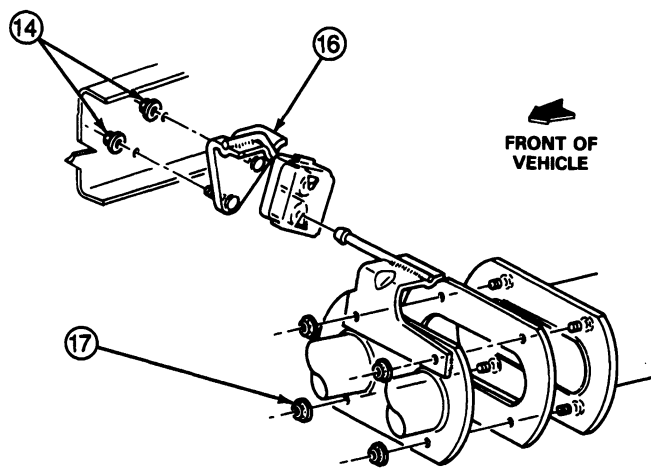
VIEW IN CIRCLE V

4085 MM WHEELBASE
VIEW U

VIEW X



VIEW Y



VIEW Z

U2213-G

Item	Part Number	Description
1	5246	Inlet Pipe Assembly
2	391104-S2	Stud, 40-50 N-m (30-37 Ft-Lb)

(Continued)

Item	Part Number	Description
3	375636-S7	Nut, 34-46 N-m (24-34 Ft-Lb)
4	5F235	Tube Assembly
5	5E212	Converter Assembly

(Continued)

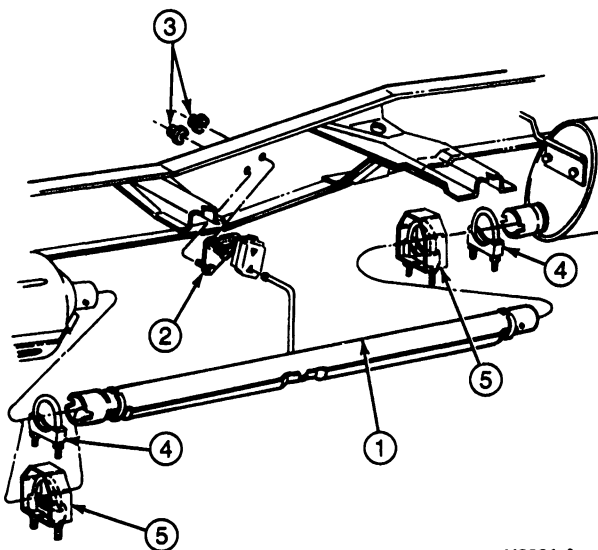
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
6	5A205	Bracket Assembly
7	5K214	Muffler and Outlet Pipe Assembly
8	611633	Screw, 16-23 N-m (12-17 Ft-Lb)
9	N807703-S	Clamp and U-Bolt Assembly 60-80 N-m (44-59 Ft-Lb)
10	N623332-S2	Nut, 3 Required
11	N605893-S2	Bolt, 8-11 N-m (6-8 Ft-Lb)

(Continued)

Item	Part Number	Description
12	N647098-S	Rivet
13	5260	Bracket and Insulator Assembly
14	N620481-S2	Nut, 22-33 N-m (16-24 Ft-Lb)
15	N605907-S2	Bolt
16	5260	Bracket and Insulator Assembly
17	N620482-S2	Nut, 34-46 N-m (18-36 Ft-Lb)
18	5A246	Bracket and Insulator Assembly

**F-350 Crew Cab, 4x2 and 4x4, 5.8L MFI, 7.5L MFI
(Same as F-350 Except as Shown)**

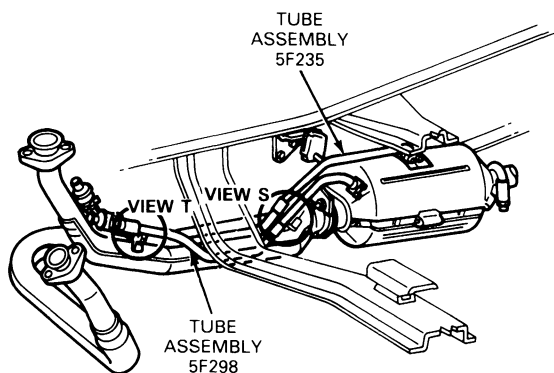


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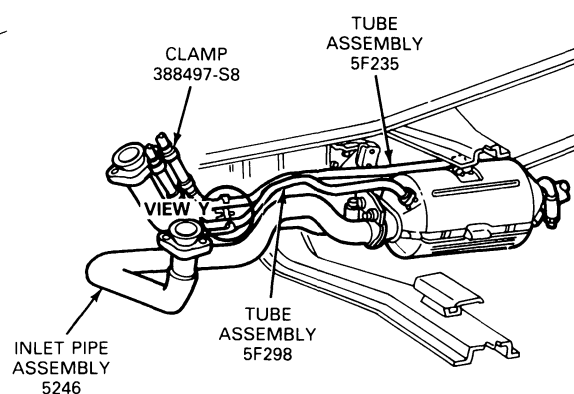
Item	Part Number	Description
1	5A212	Pipe, Exhaust
2	5A242	Bracket and Insulator Assembly
3	N620481-S2	Nut M8 x 1.25 22-33 N-m (16-24 Ft-Lb)
4	N807703-S	60-80 N-m (44-59 Ft-Lb)
5	5A281	Clamp Assembly, Muffler Inlet Pipe

REMOVAL AND INSTALLATION (Continued)

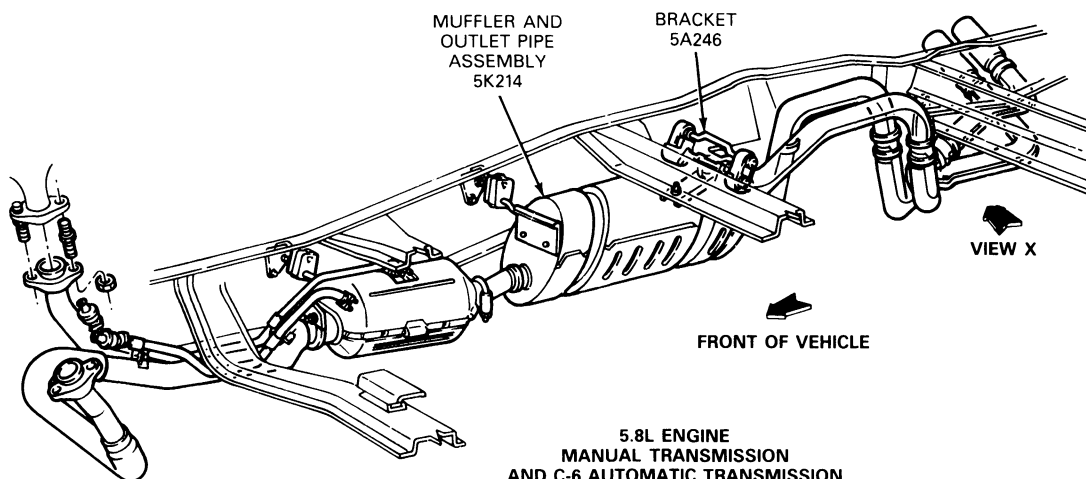
Exhaust System, F-250-350, F-Super Duty Regular Cab, SuperCab and Chassis Cab, 4x2 and 4x4 and 7.5L MFI Engine, Over 8500 GVW (Continued)



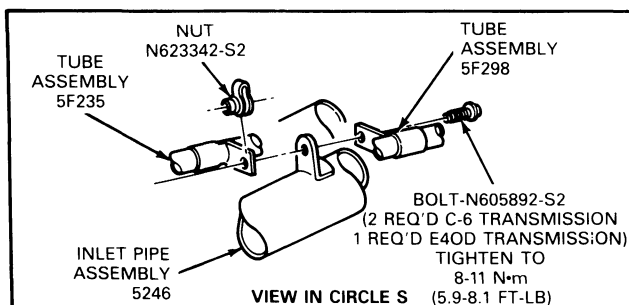
**5.8L/7.5L DUAL MTA
W/MANUAL TRANSMISSION AND C6**



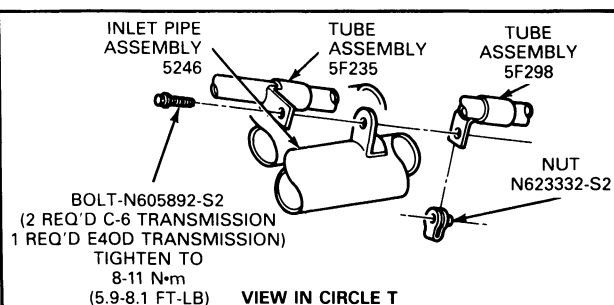
**5.8L/7.5L EFI DUAL MTA
W/E40D TRANSMISSION**



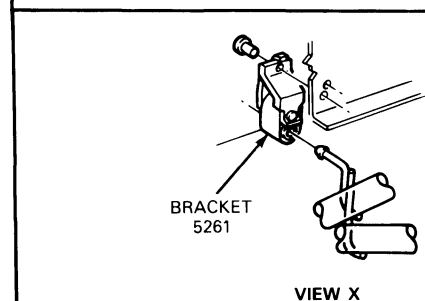
**5.8L ENGINE
MANUAL TRANSMISSION
AND C-6 AUTOMATIC TRANSMISSION**



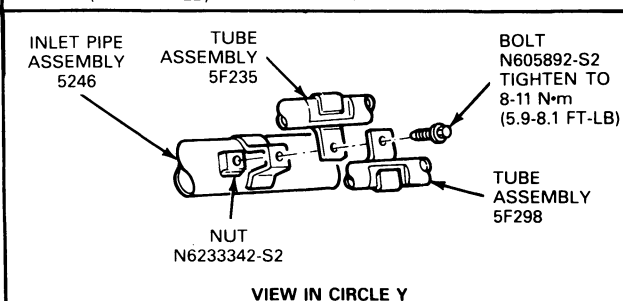
VIEW IN CIRCLE S



VIEW IN CIRCLE T



VIEW X

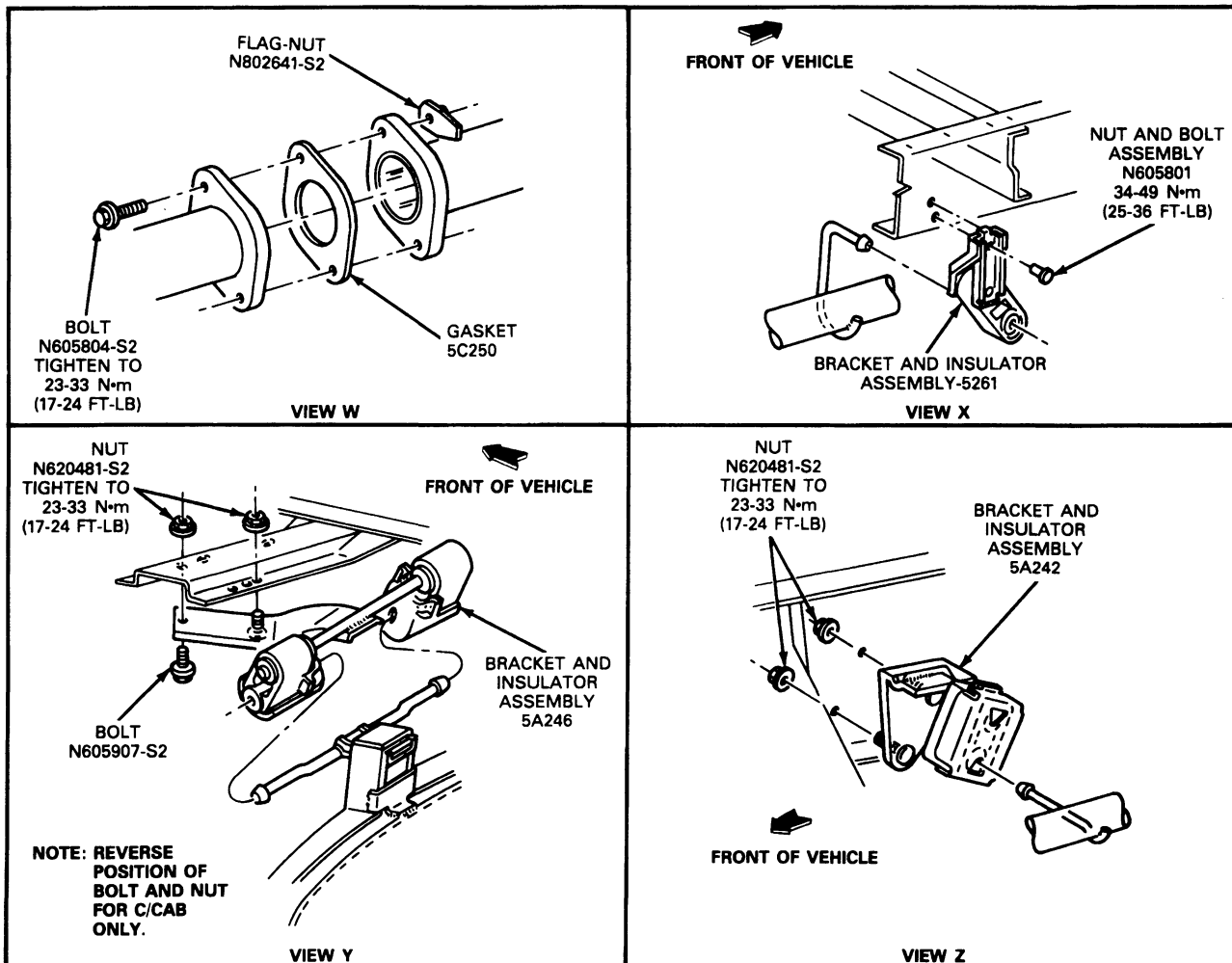
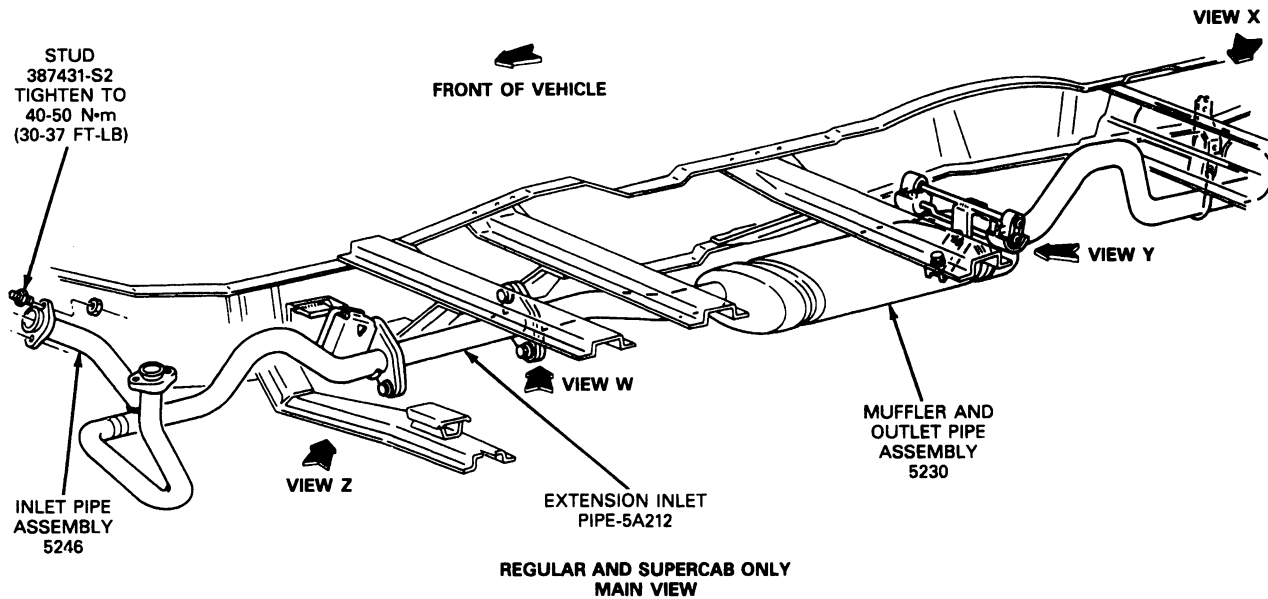


VIEW IN CIRCLE Y

U2404-D

REMOVAL AND INSTALLATION (Continued)

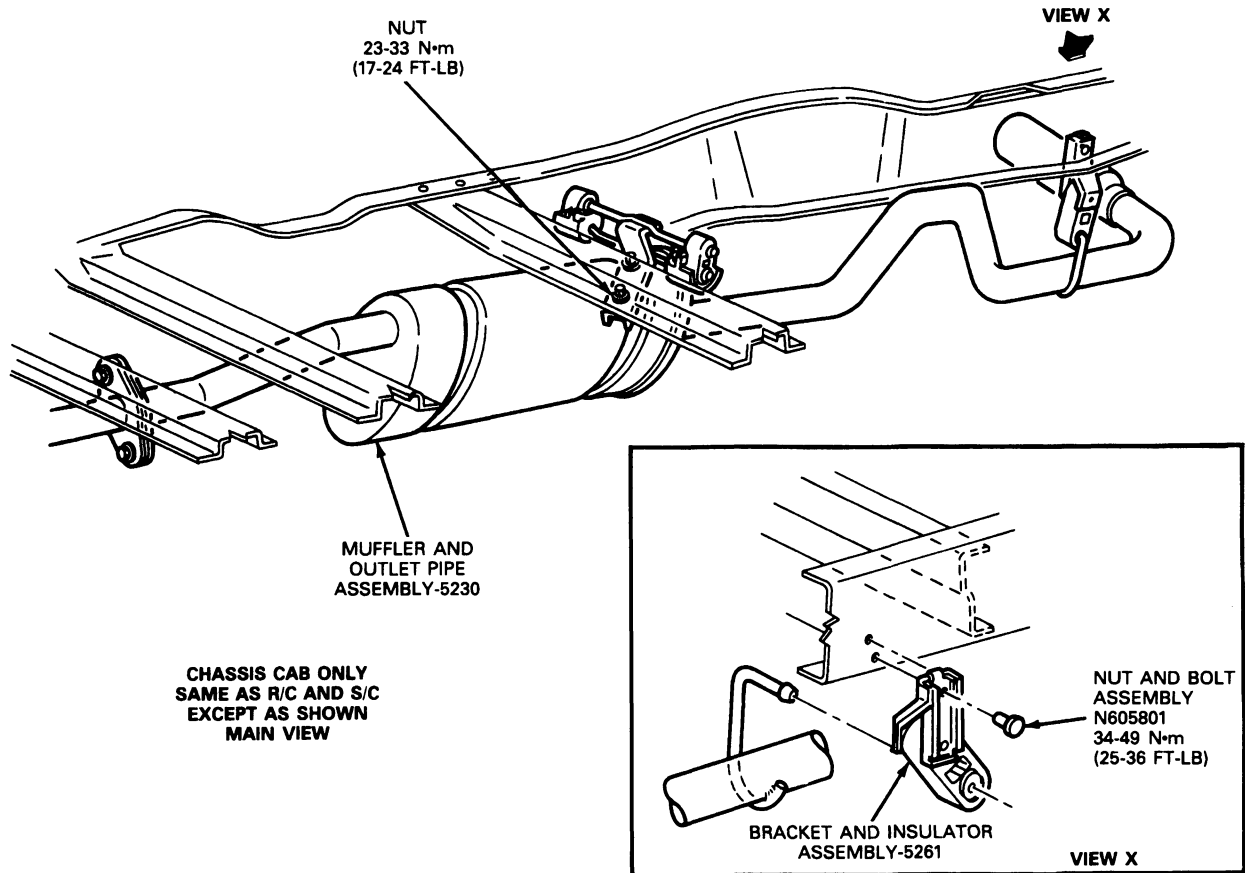
F-250, F-350 and F-Super Duty Regular Cab and SuperCab, 7.3L Diesel Engine Exhaust System



U2214-G

REMOVAL AND INSTALLATION (Continued)

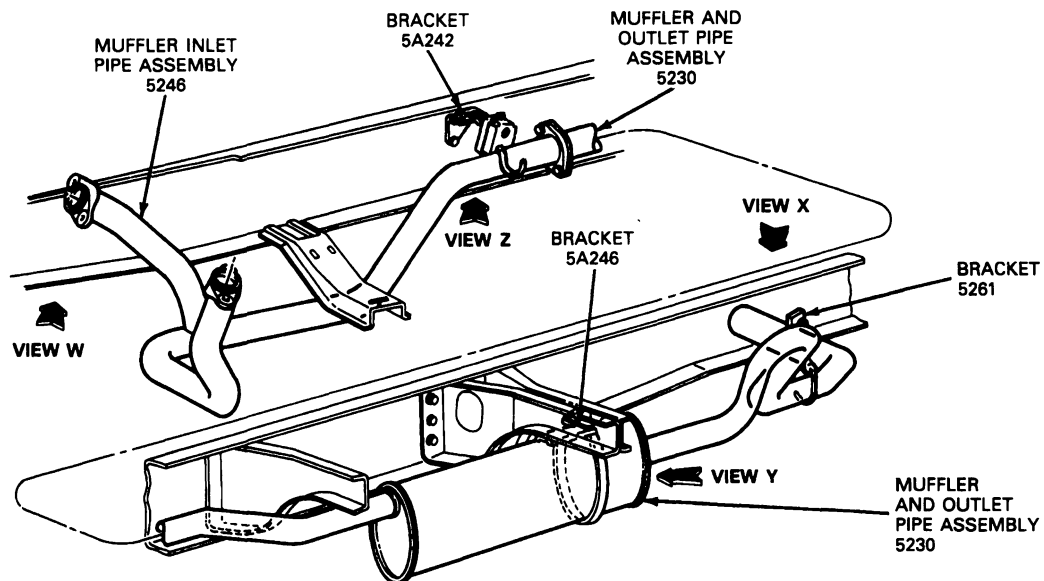
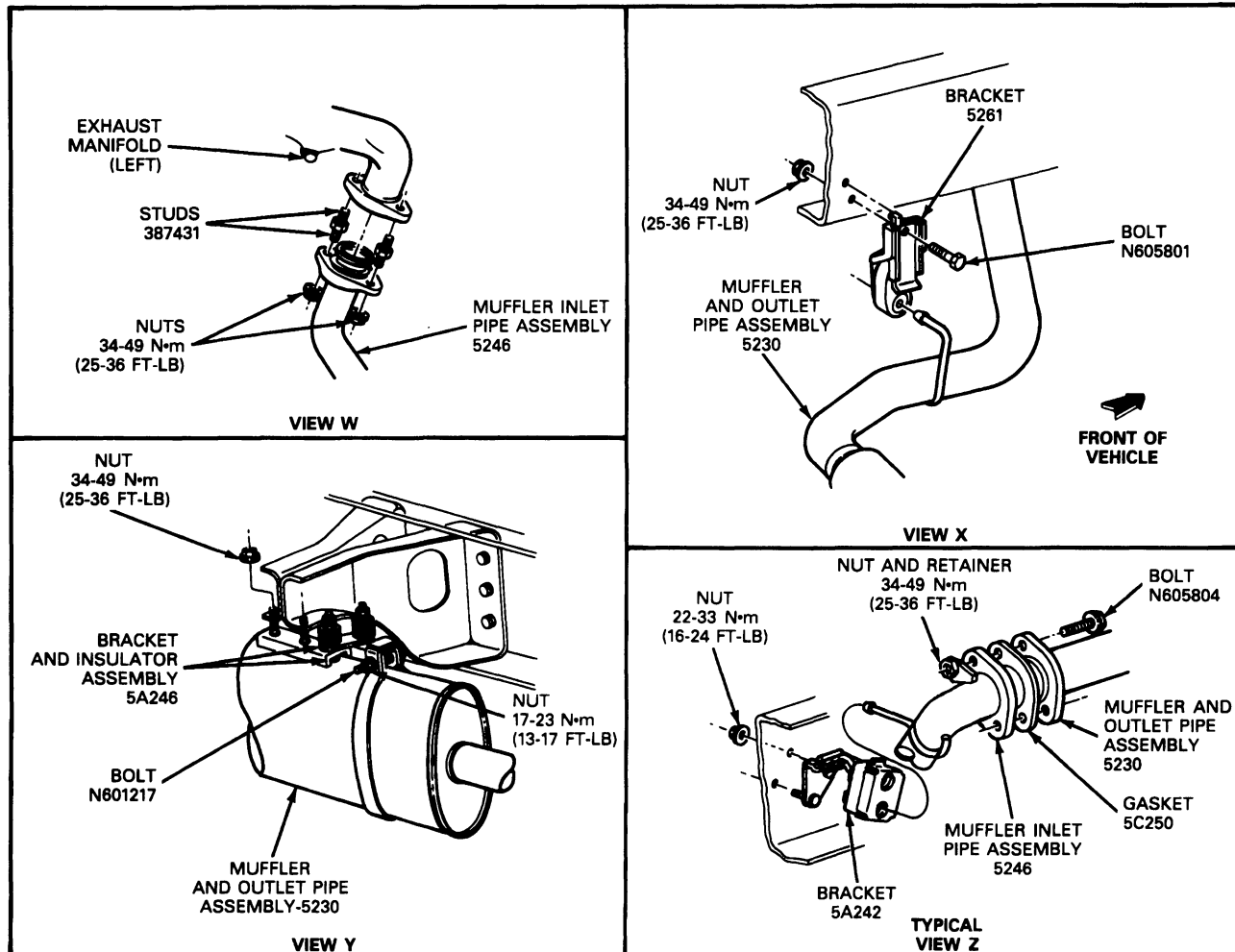
F-250 H.D. and F-250-350 and F-Super Duty Chassis Cab, 7.3L Diesel Engine Exhaust System



U2215-G

REMOVAL AND INSTALLATION (Continued)

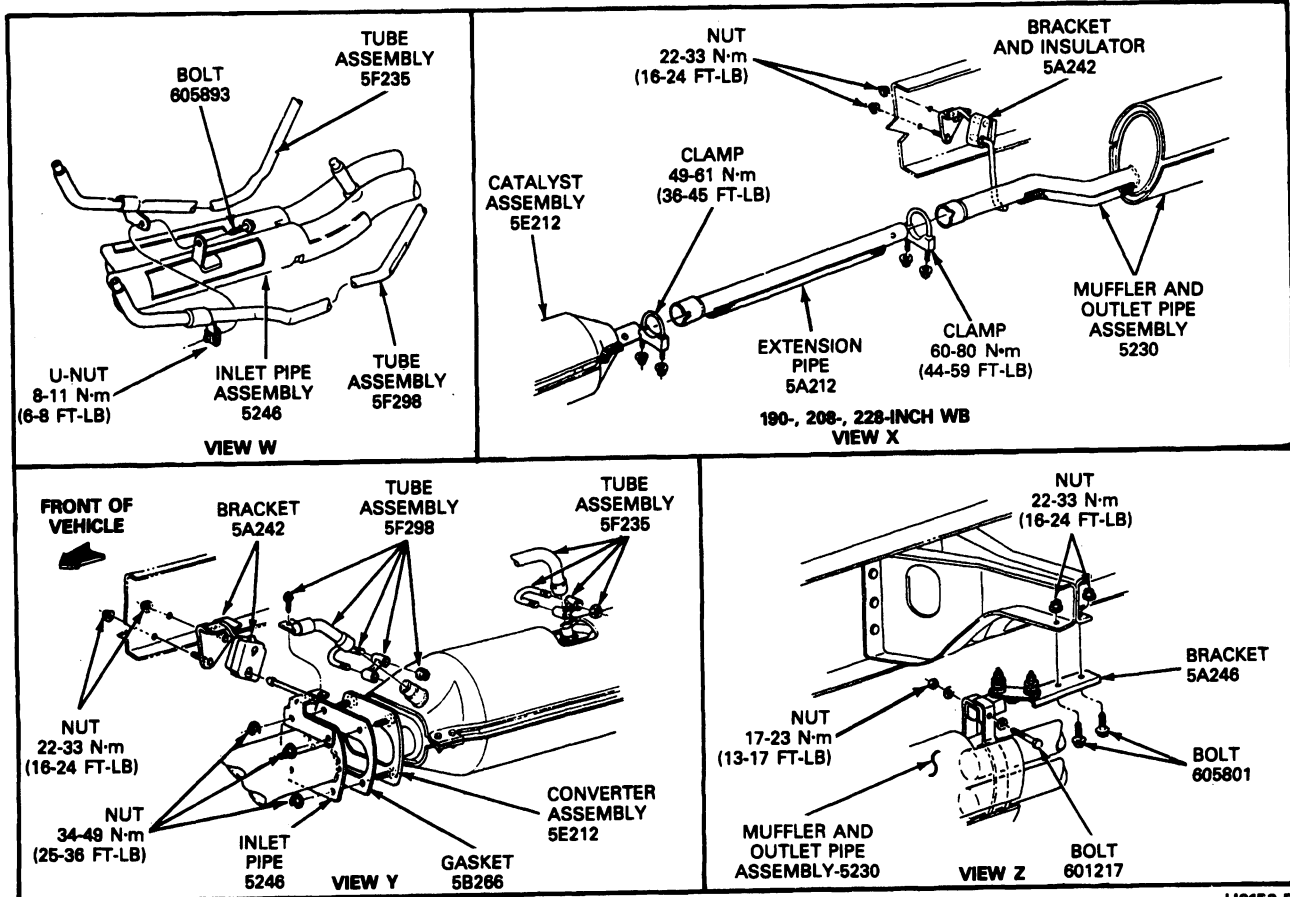
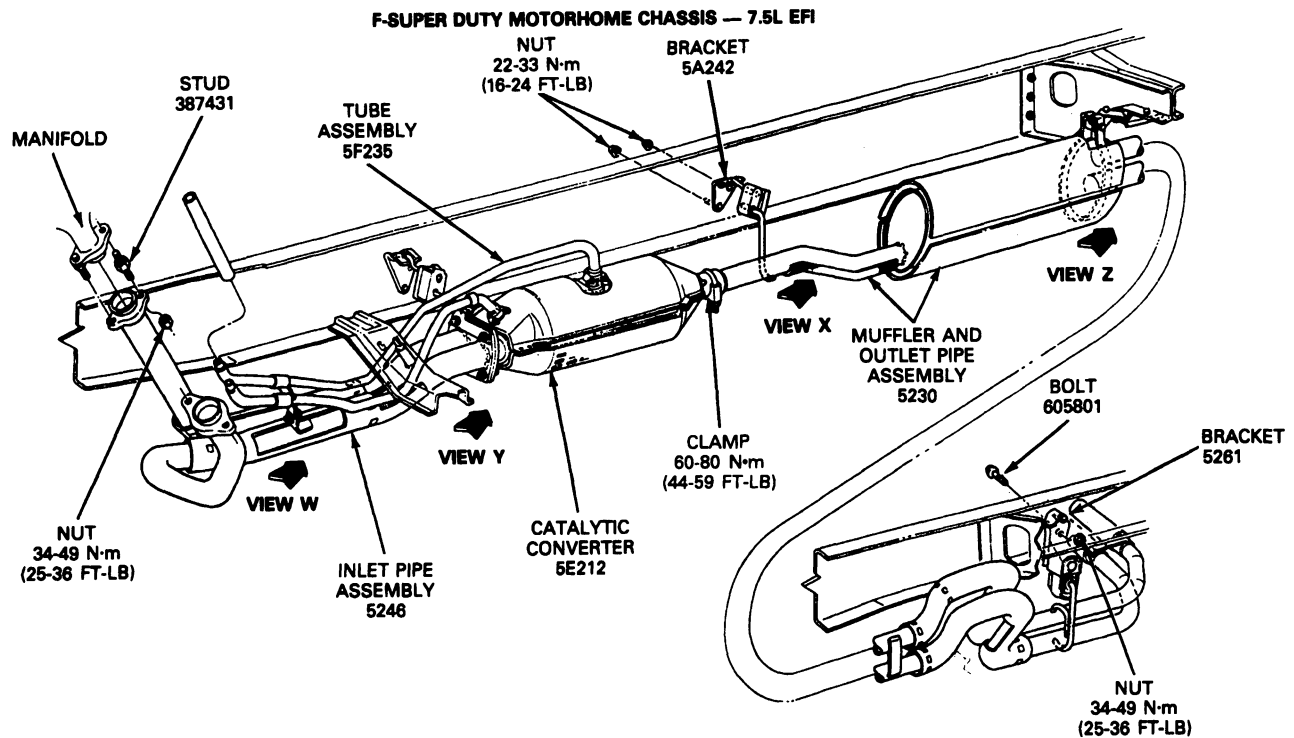
F-Super Duty Commercial Chassis Vehicles, 7.3L Diesel

7.3L DIESEL WITH M50 D
MANUAL TRANSMISSION

U1995-C

REMOVAL AND INSTALLATION (Continued)

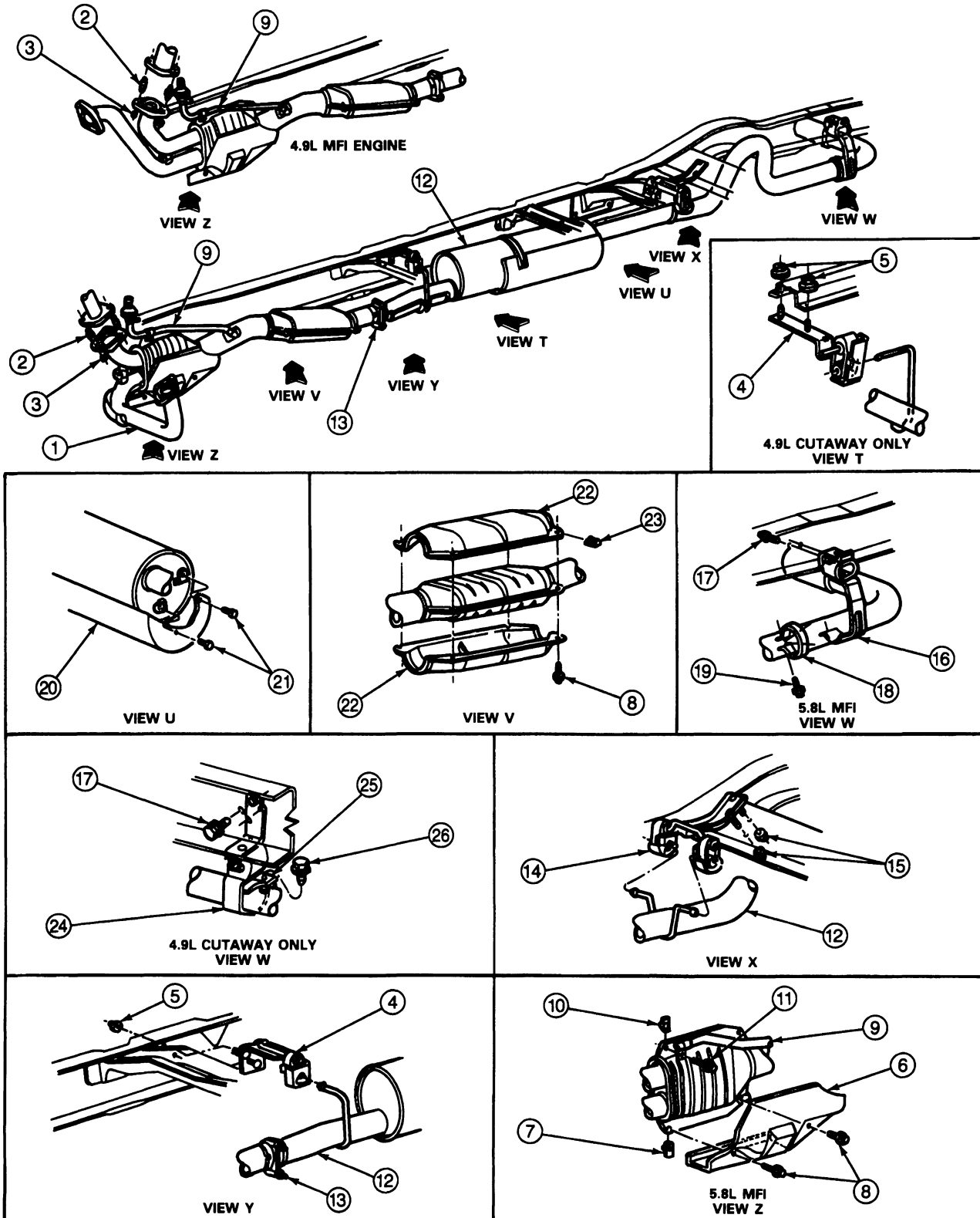
F-Super Duty Motorhome Chassis Vehicles, 7.5L MFI



U2152-D

REMOVAL AND INSTALLATION (Continued)

Exhaust Systems, E-150-250-350 4.9L (300 CID) MFI and 5.8L (351 CID) MFI Engine Under 8500 GVW



U2438-A

REMOVAL AND INSTALLATION (Continued)

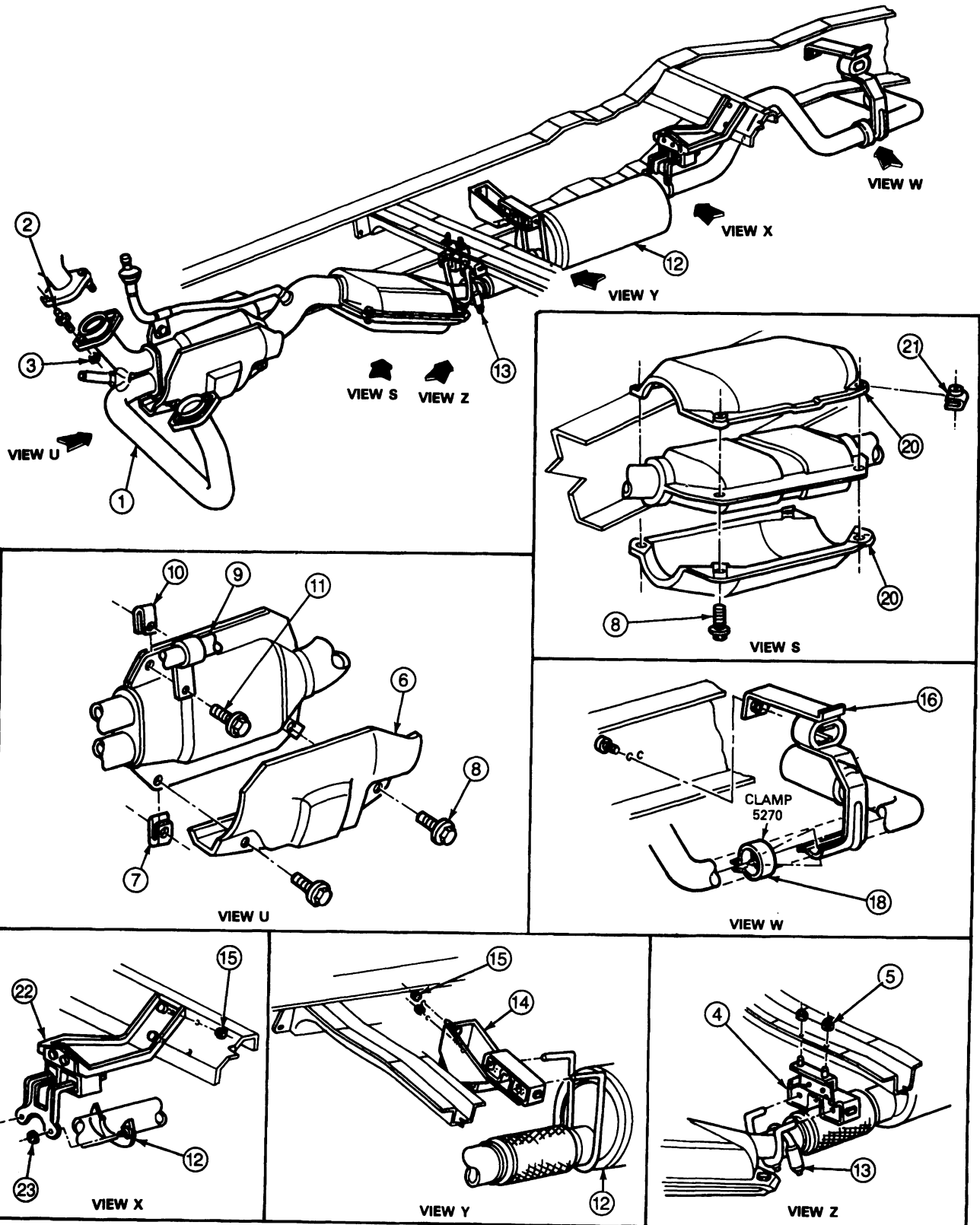
Item	Part Number	Description
1	5F250	Pipe Assembly
2	391104-S2	Stud, 40-50 N-m (30-37 Ft-Lb)
3	375636-S309	Nut, 7 / 16-14 34-46 N-m (25-36 Ft-Lb)
4	5A242	Bracket and Insulator Assembly
5	379930-S2	Nut, Attaches 5A242 to Crossmember or Frame 17-23 N-m (13-17 Ft-Lb)
6	5E287	Shield
7	N803714-S100	Nut
8	N605905-S2	Bolt, Attaches 5E287 to 5F250 20-30 N-m (15-22 Ft-Lb)
9	5F235	Tube Assembly 13-17 N-m (10-13 Ft-Lb)
10	N803714-S100	Nut
11	N605905-S2	Bolt, Attaches 5F235 to 5F250, 13-17 N-m (10-13 Ft-Lb)
12	5K214	Muffler and Outlet Pipe Assembly
13	N807703	Clamp and U-bolt Assembly Attaches 5K214 to 5F250 60-80 N-m (44-59 Ft-Lb)

(Continued)

Item	Part Number	Description
14	5A246	Bracket and Insulator Assembly
15	379930-S2	Nut, Attaches 5A246 to Crossmember, 17-23 N-m (13-17 Ft-Lb)
16	5261	Bracket and Insulator Assembly
17	56722-S2	Bolt, Attaches 5261 to Frame 17-23 N-m (13-17 Ft-Lb)
18	5270	Clamp
19	387482-S2	Screw, Attaches 5270 to 5261 and 5K214 10-15 N-m (89-133 In-Lb)
20	5A273	Shield
21	N611633-S2	Screw, Attaches 5A273 to 5K214 17-23 N-m (13-17 Ft-Lb)
22	5K283	Shield
23	N800296-S100	U-Nut, M8-1.25, Attaches 5K283 to 5F250
24	5261	Bracket and Insulator Assembly
25	5266	Bracket
26	56323-S100	Bolt, Attaches 5K214 to 5261 17-23 N-m (13-17 Ft-Lb)

REMOVAL AND INSTALLATION (Continued)

Exhaust System Installation, E-150 5.0L MFI



U2983-B

REMOVAL AND INSTALLATION (Continued)

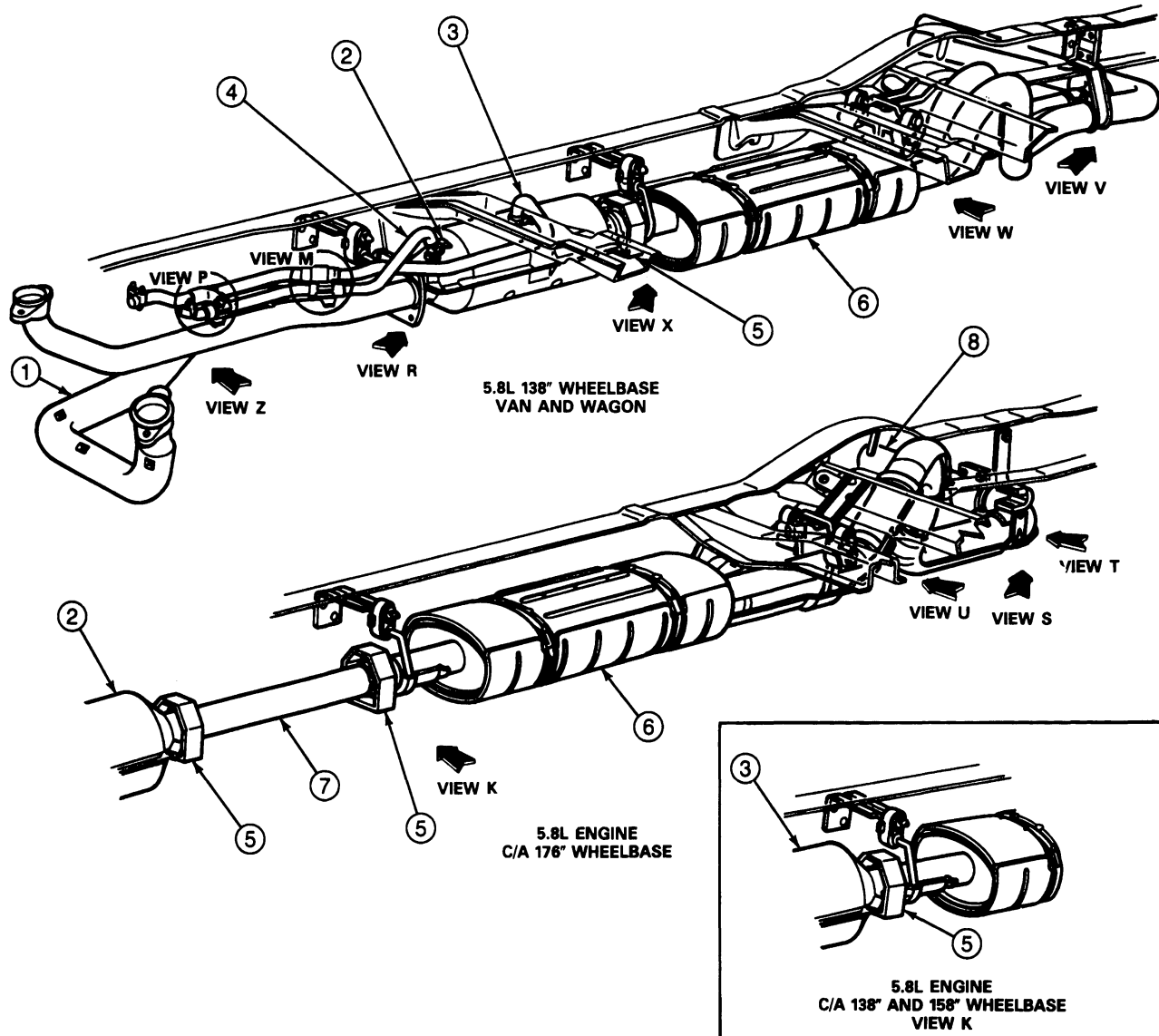
Item	Part Number	Description
1	5F250	Pipe Assembly, with MTA Tube
2	391104-S2	Stud 40-50 N-m (30-37 Ft-Lb)
3	375636-S309	Nut 7 / 16-14 34-49 N-m (25-36 Ft-Lb)
4	5A242	Bracket and Insulator Assembly
5	379930-S2	Nut 16-23 N-m (12-17 Ft-Lb)
6	5E287	Shield
7	N8037 14-S100	Nut
8	N605905-S2	Bolt 20-30 N-m (15-22 Ft-Lb)
9	5F235	Tube Assembly 11-18 N-m (97-159 In-Lb)
10	N8037 14-S100	Nut
11	N605905-S2	Bolt 20-30 N-m (15-22 Ft-Lb)

(Continued)

Item	Part Number	Description
12	5K214	Muffler and Outlet Pipe Assembly
13	N807703	Clamp and U-Bolt Assembly 60-80 N-m (44-59 Ft-Lb)
14	5291	Muffler Inlet, Support Bracket
15	379930-S2	Nut 16-23 N-m (12-17 Ft-Lb)
16	5261	Muffler Bracket and Insulator Assembly
17	56722-S2	Nut 16-23 N-m (12-17 Ft-Lb)
18	5270	Clamp (2.25)
19	387482-S2	Screw 10-15 N-m (7-11 Ft-Lb)
20	5K283	Shield
21	N800296-S100	U-Nut
22	5A246	Muffler Hanger, Support Bracket
23	N620482-S2	Nut 24-34 N-m (18-25 Ft-Lb)

REMOVAL AND INSTALLATION (Continued)

Exhaust Systems, E-250-350 5.8L (351 CID) MFI Engine



U2439-A

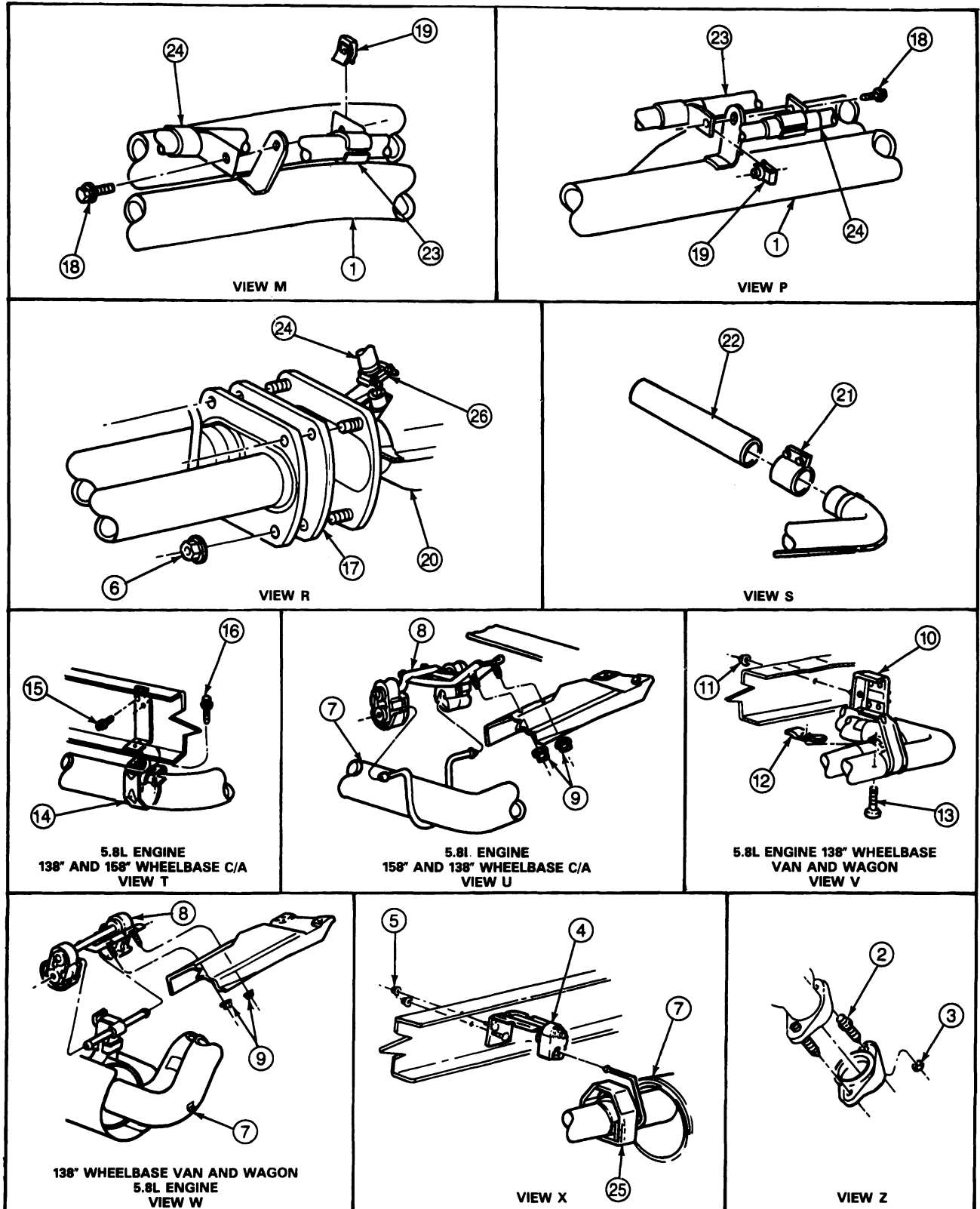
Item	Part Number	Description
1	5246	Inlet Pipe Assembly
2	5E212	Converter Assembly
3	5F235	Tube Assembly
4	5F298	Tube Assembly

(Continued)

Item	Part Number	Description
5	5A281	Clamp Assembly, Muffler Inlet Pipe 60-80 N-m (44-59 Ft-Lb)
6	5K214	Muffler and Outlet Pipe Assembly
7	5A212	Pipe Extension
8	5B201	Tailpipe Extension

REMOVAL AND INSTALLATION (Continued)

Exhaust Systems, E-250-350 5.8L (351 CID) MFI Engine (Continued)



U2440-A

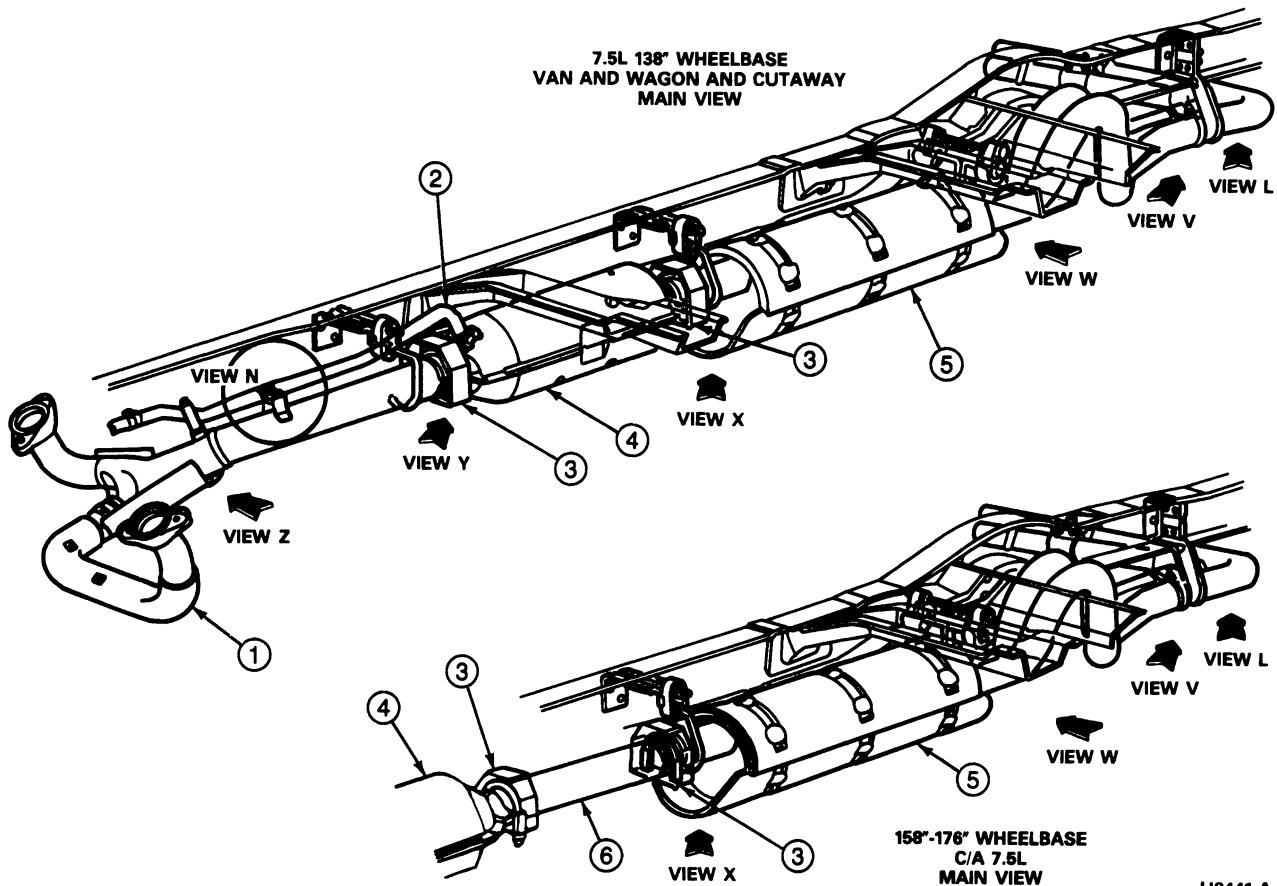
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	5246	Inlet Pipe Assembly
2	391104-S2	Stud Short End in Manifold 40-50 N-m (30-37 Ft-Lb)
3	375636-S309	Nut, Attaches 5246 to Manifold 34-46 N-m (25-36 Ft-Lb)
4	5A242	Bracket and Insulator Assembly
5	379930-S2	Nut, 17-23 N-m (13-17 Ft-Lb) Attaches 5A242 to Frame
6	N620482-S2	Nut, 35-48 N-m (26-35 Ft-Lb) Attaches 5E212 to 5246
7	5K214	Muffler and Outlet Pipe Assembly
8	5A246	Bracket and Insulator Assembly
9	379930-S2	Nut, 17-23 N-m (13-17 Ft-Lb) Attaches 5A246 to Crossmember
10	5261	Bracket and Insulator Assembly
11	379930-S2	Nut, Attaches 5261 to Frame 17-23 N-m (13-17 Ft-Lb)
12	5266	Bracket

(Continued)

Item	Part Number	Description
13	58624-S2	Bolt, Attaches 5K214 to 5261
14	5261	Bracket and Insulator Assembly
15	381877-S2	Bolt, Attaches 5261 to Frame 17-23 N-m (13-17 Ft-Lb)
16	56323-S100	Bolt, Attaches 5K214 to 5261 17-23 N-m (13-17 Ft-Lb)
17	5B266	Gasket
18	N605892-S2	Bolt, 8-11 N-m (71-97 In-Lb)
19	N623332-S2	Nut, Attaches 5F235 and 5F298 to 5246
20	5E212	Converter Assembly
21	5B201	Muffler Outlet Pipe Clamp
22	5263	Muffler Outlet Pipe Extension
23	5F235	Tube Assembly
24	5F298	Tube Assembly
25	5A281	Muffler, Inlet Pipe Clamp Assembly 60-80 N-m (44-59 Ft-Lb)
26	—	Clamp, 8-11 N-m (71-97 In-Lb)

Exhaust Systems, E-250-350 and 7.5L (460 CID) MFI Engine



U2441-A

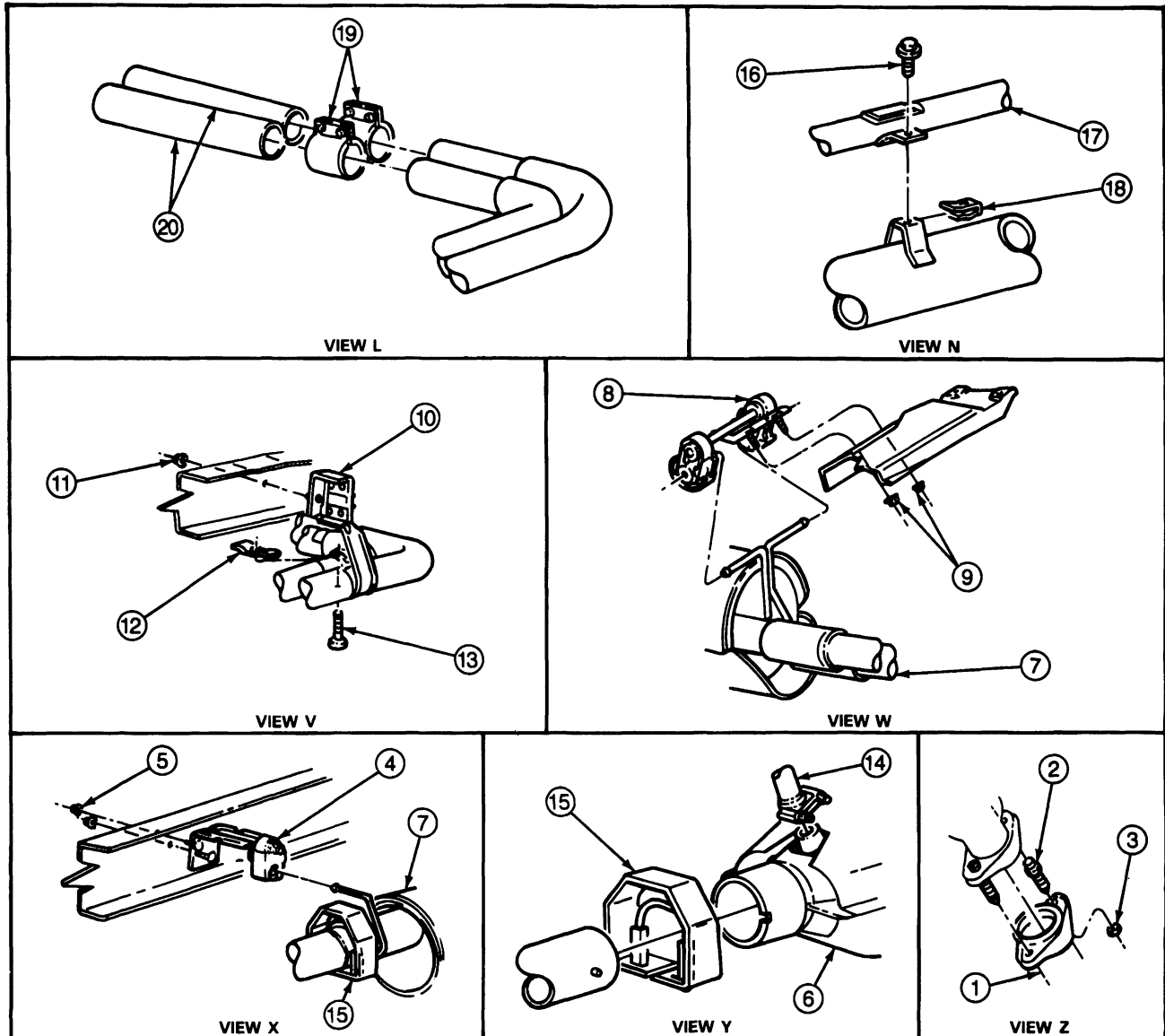
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	5246	Inlet Pipe Assembly
2	5F298	Tube Assembly
3	5A281	Muffler Inlet Pipe Clamp Assembly

(Continued)

Item	Part Number	Description
4	5E212	Converter Assembly
5	5K214	Muffler and Outlet Pipe Assembly
6	5A212	Pipe Extension

Exhaust Systems, E-250-350 and 7.5L (460 CID) MFI Engine (Continued)



U2442-A

Item	Part Number	Description
1	5246	Inlet Pipe Assembly
2	391104-S2	Stud, Short End to Manifold 40-50 N-m (30-37 Ft-Lb)

(Continued)

Item	Part Number	Description
3	375636-S309	Nut, Attaches 5246 to Manifold 34-46 N-m (25-36 Ft-Lb)
4	5A242	Bracket and Insulator Assembly

(Continued)

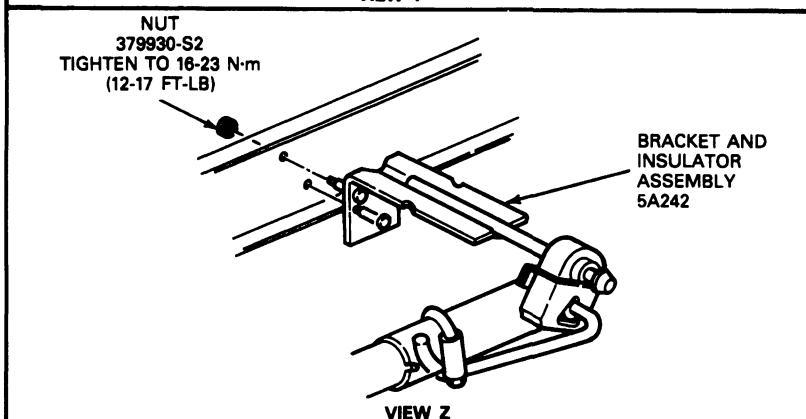
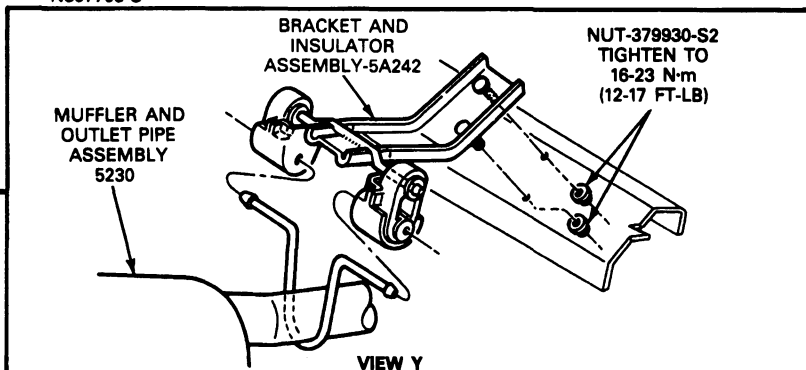
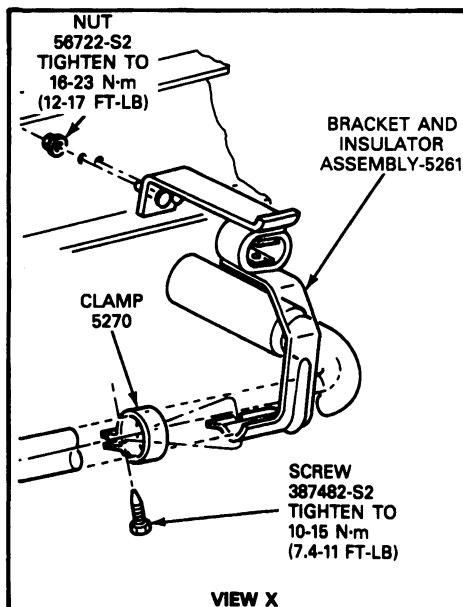
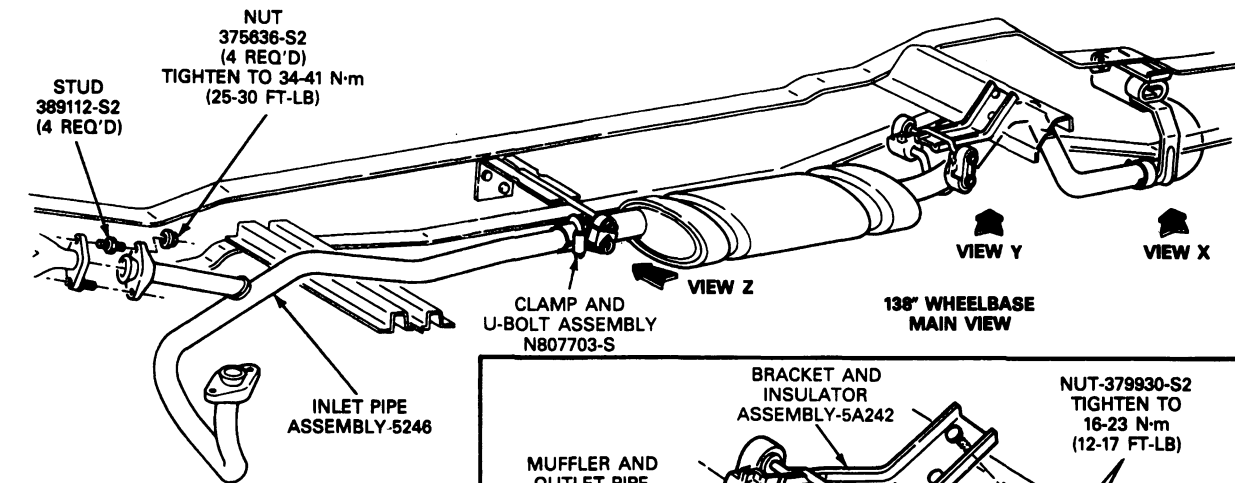
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
5	379930-S2	Nut, Attaches 5A242 to Frame 17-23 N·m (13-17 Ft-Lb)
6	5E212	Converter Assembly
7	5K214	Muffler and Outlet Pipe Assembly
8	5A246	Bracket and Insulator Assembly
9	379930-S2	Nut, Attaches 5A246 to Crossmember, 17-23 N·m (13-17 Ft-Lb)
10	5261	Bracket and Insulator Assembly

(Continued)

Item	Part Number	Description
11	379930-S2	Nut, Attaches 5261 to Frame 17-23 N·m (13-17 Ft-Lb)
12	5266	Bracket
13	58624-S2	Bolt
14	5F298	Tube Assembly
15	5A281	Muffler Inlet Pipe Clamp Assembly 60-80 N·m (44-59 Ft-Lb)
16	N605892-S2	Bolt, 8-11 N·m (71-97 In-Lb)
17	5F298	Tube Assembly
18	N623332-S2	Nut, Attaches 5F298 to 5246
19	5B201	Muffler Outlet Pipe Clamp
20	5263	Muffler Outlet Pipe Extension

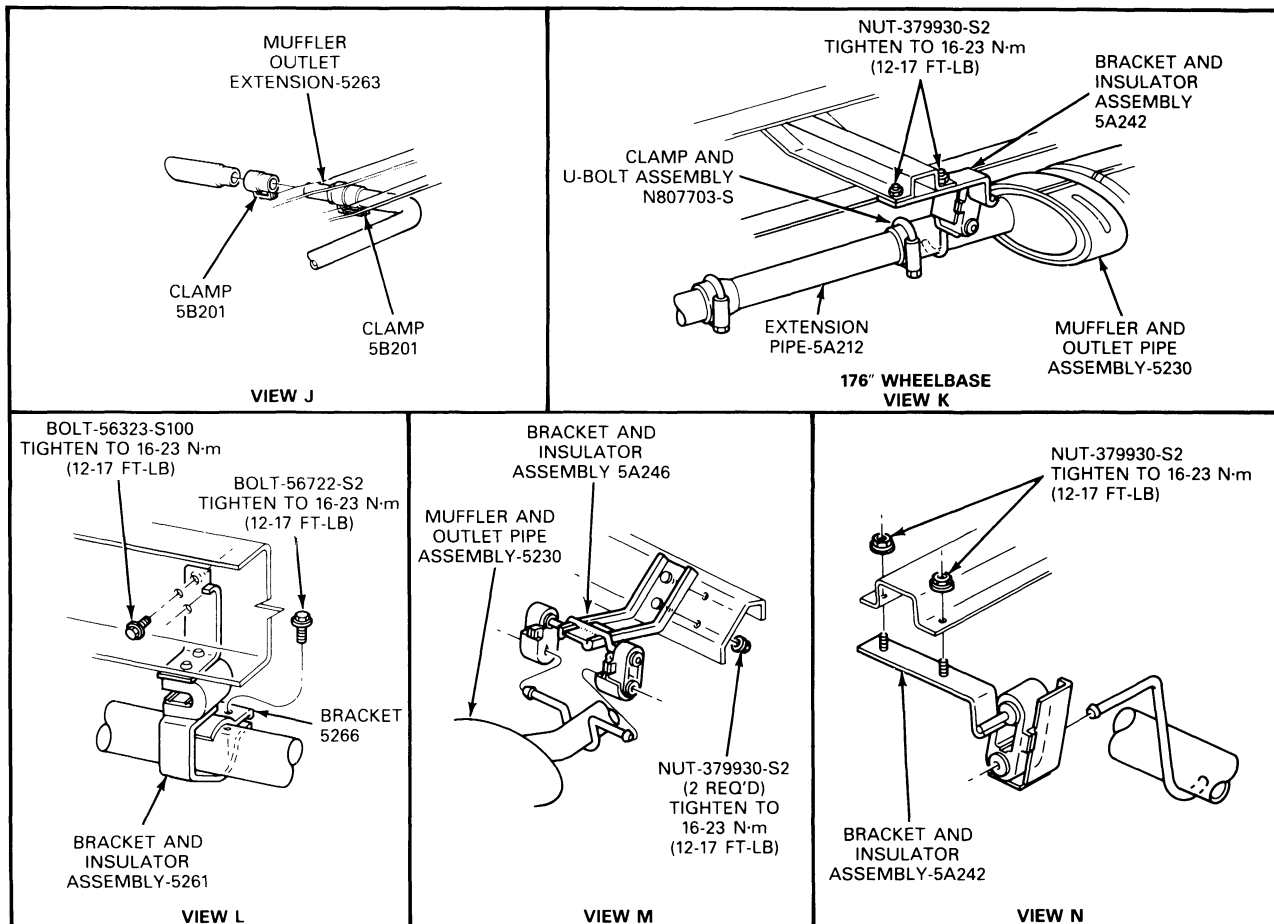
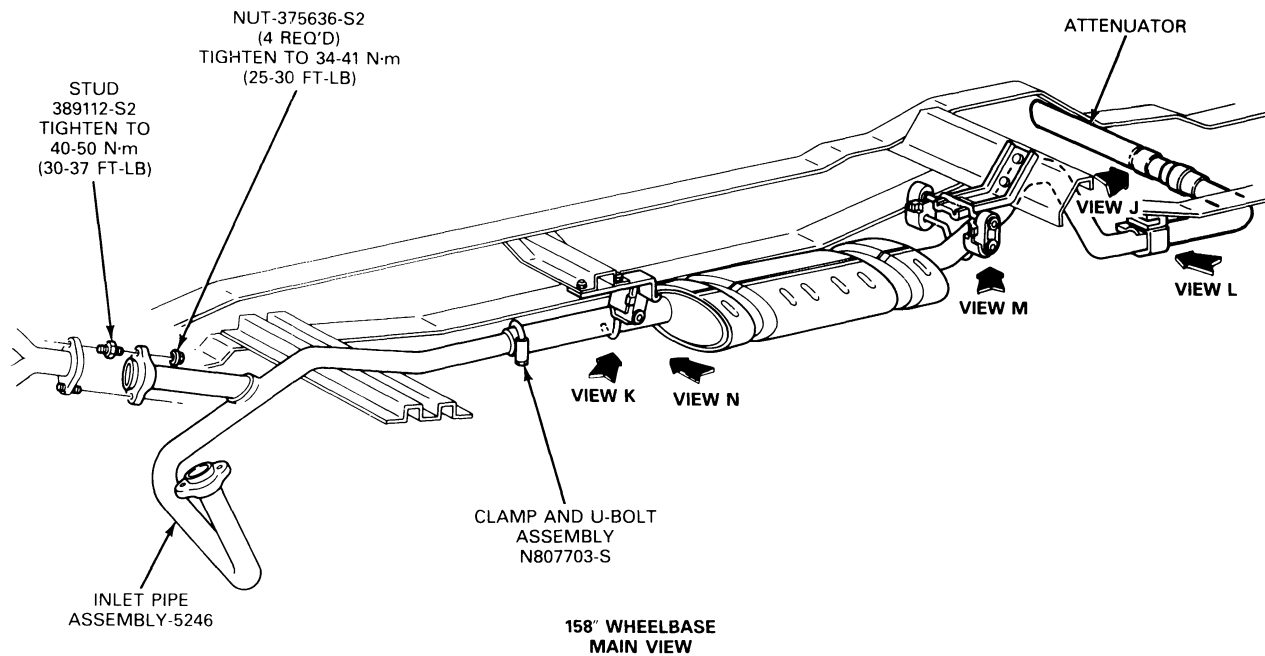
Exhaust Systems, E-250 Heavy Duty, E-350 7.3L Diesel Engine



U2220-F

REMOVAL AND INSTALLATION (Continued)

Exhaust Systems, E-250 Heavy Duty, E-350 7.3L Diesel Engine (Continued)



U2221-F

ADJUSTMENTS

Inspect inlet pipes, outlet pipes and mufflers for cracked joints, broken welds and corrosion damage that would result in a leaking exhaust system. Inspect the clamps, brackets and insulators for cracks and stripped or badly corroded bolt threads. When pipe clamp(s) are loosened and / or removed to replace a shield, pipe or muffler, replace the clamp(s) if there is reasonable doubt that its service life is limited.

NOTE: Because mufflers are designed without drain holes, it is normal for a certain amount of moisture and staining to be present around the muffler seams. The presence of soot, surface rust, or moisture does not indicate a damaged muffler and should not constitute the basis for replacement.

Muffler clamps can be broken due to over-tightening. When attempting to eliminate exhaust leaks at joints, the muffler clamp should be tightened to specification. Do not over-tighten bolts or nuts to correct a leak. If this does not eliminate the leak, the clamp should be loosened, rotated approximately one-quarter turn, and then retightened to the specification.

The exhaust system, including heat shields, must be free of leaks, binding, grounding and excessive vibrations.

These conditions are usually caused by loose, broken or misaligned clamps, shields, brackets or pipes. If any of these conditions exist, check the exhaust system components and alignment. Align or replace as necessary.

Exhaust System Alignment

Perform the following procedure to align the complete exhaust system:

1. Loosen the pipe connection clamps and the pipe support bracket clamps. Loosen the inlet pipe-to-exhaust manifold attaching nuts.
2. Work from the front and progressively align the exhaust system components and hangers to eliminate any interferences. Make sure that aligning tabs (if used) are fully engaged in their mating slots.
3. Then working from the rear forward, retighten clamps to specifications. Finally, tighten the exhaust manifold to inlet pipe attaching nuts alternately and equally to specifications so that the pressure on the ball flange will be uniform.

Heat Shield Inspection

Raise the vehicle on a hoist. Heat shields are positioned on the underside of the catalytic converter and the muffler assembly. Shields should be free from random bends which would bring any part of the shield in soft contact with the converter or muffler assembly causing a rattle.

CAUTION: The shield must be cleaned of any combustible matter.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N-m	Ft-Lb
Band Clamps (to Secure Heat Shields)	7	60
Bronco, F-150-250-350, 4.9L MFI, 5.0L MFI, 5.8L MFI U/8500		
Stud, Manifold	40-50	30-37
Nut, Y-Pipe-to-Manifold	34-46	25-34
Bolt, Heat Shield-to-Front Converter	20-30	15-22
U-Bolt Clamp Nuts	60-80	44-59
Bolt, Lower Shield-to-Rear Converter Heat Shield	20-30	15-22
Nuts, Bracket Assembly-to-Crossmember	23-33	17-24
Bolt, Air Tube-to-Converter	13-17	10-13
Screw, Lower Shield-to-Muffler	16-23	12-17
F-250-350, F-Super Duty, 5.8L MFI, 7.5L MFI Over 8500 GVWR		
Stud, Manifold	40-50	30-37
Nut, Y-Pipe-to-Manifold	34-46	24-36
Screw, Bracket-to-Muffler	16-23	12-17
U-Bolt Clamp Nuts	60-80	44-59
Bolt, Tube Assembly-to-Inlet Pipe	8-11	6-8
Nut, Bracket Assemblies-to-Crossmember or Frame	22-33	16-24
Nut, Bracket-to-Converter	34-49	18-36
F-250-350, F-Super Duty, 7.3L Diesel		
Stud, Manifold	40-50	30-37
Nut, Y-Pipe-to-Manifold	34-46	25-36
Nuts, Bracket-to-Crossmember or Frame	23-33	17-24
Bolt, Extension Pipe-to-Muffler Inlet Pipe	23-33	17-24
F-Super Duty Commercial Chassis, 7.3L Diesel		
Stud, Manifold	40-50	30-37
Nut, Y-Pipe-to-Manifold	34-46	25-36
Nut, Bracket-to-Frame, Y-Pipe	22-33	16-24
Nut, Inlet Pipe-to-Muffler	34-46	25-36
Nut, Muffler Clamp-to-Bracket	17-23	13-17
Nut, Bracket-to-Crossmember	34-46	25-36
Nut, Bracket-to-Frame, Muffler Inlet Pipe	22-33	16-24
F-Super Duty Motorhome, 7.5L MFI		
Stud, Manifold	40-50	30-37
Nut, Y-Pipe-to-Manifold	34-46	25-36
U-Nut, Tube Assembly-to-Muffler Inlet Pipe	8-11	6-8
Nut, Bracket-to-Frame, Converter	22-33	16-24
Nut, Bracket-to-Converter	34-46	25-36
U-Clamp Nuts, Extension Pipe	46-64	36-45
Nut, Bracket-to-Frame, Muffler Inlet Pipe	22-33	16-24

(Continued)

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Ft-Lb
Nut, Muffler Clamp-to-Bracket	17-23	13-17
Nut, Bracket-to-Crossmember	22-33	16-24
E-150-250-350, 4.9L MFI, 5.0L MFI, 5.8L MFI, 7.5L MFI		
Stud, Manifold	40-50	30-37
Nut, Y-Pipe-to-Manifold	34-46	25-36
Nut, Bracket-to-Crossmember or Frame	17-23	13-17
Bolt, Shield-to-Converter	20-30	15-22
Screw, Tube Assembly-to-Converter U-Clamp Nut	13-17	10-13
Nut, Bracket-to-Crossmember	60-80	44-59
Bolt, Bracket-to-Frame	17-23	13-17
Screw, Clamp-to-Tailpipe	10-15	93-133 In-Lb
Bolt, Muffler Outlet Pipe-to-Bracket	17-23	13-17
E-250 H.D., E-350, 7.3L Diesel		
Stud, Manifold	40-50	30-37
Nut, Y-Pipe-to-Manifold	34-46	25-30
Nut, Bracket-to-Frame	16-23	12-17
Screw, Clamp-to-Bracket, Tailpipe	10-15	8-11
Nut, Bracket-to-Crossmember	16-23	12-17
Lightning		
Stud, Manifold	40-50	30-37
Nut, Converter-to-Manifold	34-46	25-36
Bolt, Tube-to-Converter	8-11	71-97 In-Lb
Nut, Bracket-to-Frame or Crossmember	17-23	13-17
Clamp, Tube-to-Converter	13-17	10-13

TORQUE LIMITS — EXHAUST SYSTEM BOLTS AND NUTS

Bolt or Nut Diameter	Class 9.8 (Grade 5)	Class 10.9 (Grade 8)
8mm (5 / 16 inch)	20-27 N-m (14-19 Ft-Lb)	26-35 N-m (20-25 Ft-Lb)
10mm (3 / 8 inch)	37-50 N-m (28-36 Ft-Lb)	47-64 N-m (34-47 Ft-Lb)
12mm (7 / 16 inch)	65-90 N-m (48-66 Ft-Lb)	80-110 N-m (59-80 Ft-Lb)

UNLESS OTHERWISE SPECIFIED, TORQUE RANGES MAY BE USED FOR FITTING OR FASTENER DIAMETERS AS INDICATED.

SPECIAL SERVICE TOOLS/EQUIPMENT

ROTUNDA EQUIPMENT

Tool Number	Description
059-00008	Vacuum Gauge
059-00007	Tachometer

GROUP

10

FUEL

SECTION TITLE	PAGE	SECTION TITLE	PAGE
THROTTLE LINKAGE	10-02-1	FUEL TANK, PUMP, LINES AND FILTERS, DIESEL ENGINES	10-01B-1
FUEL TANK, PUMP, LINES AND FILTERS, GASOLINE ENGINES	10-01A-1	SPEED CONTROL	10-03-1

SECTION 10-01A Fuel Tank, Pump, Lines and Filters, Gasoline Engines

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION AND OPERATION		REMOVAL AND INSTALLATION (Cont'd.)	
Electric Fuel Delivery Module (FDM) and Sender Assembly	10-01A-3	Fuel Filler Cap	10-01A-49
Electronic Fuel Injection (MFI)	10-01A-2	Fuel Line Illustrations, Bronco	10-01A-41
Fuel Delivery Module (FDM)	10-01A-10	Fuel Line Illustrations, E-Series	10-01A-34
Fuel Delivery Module (FDM) Control	10-01A-4	Fuel Line Illustrations, F-Series	10-01A-19
Fuel Filters	10-01A-2	Fuel Pump, Bronco, F-150-250-350, F-Super Duty and E-150-250-350	10-01A-25
Fuel Lines	10-01A-7	Fuel Pump, Units with Plastic Locking Ring, F-350 Chassis Cab	10-01A-26
Fill Control/Vent	10-01A-9	Fuel System Pressure Relief	10-01A-14
Tank Vapor Valve, Rollover Valve Assembly	10-01A-9	Fuel Tanks, Bronco	10-01A-42
Vapor Vent, In-Tank Venting	10-01A-9	Fuel Tanks, E-Series	10-01A-37
Fuel Tank Draining	10-01A-10	Aft-of-Axle Fuel Tank, E-Series Cutaway	10-01A-37
Fuel Tank Filling	10-01A-10	Midship Fuel Tank, E-150-250-350	10-01A-39
Gasoline Octane Rating	10-01A-10	In-Line Fuel Filter	10-01A-17
Inertia Switch	10-01A-11	Metal Spring-Lock Connectors	10-01A-15
MFI Fuel System Pressure and Flow Test Equipment	10-01A-11	Organizer Assemblies, E-150-250-350	10-01A-18
Pressure and Vacuum Relief System	10-01A-10	Spring Lock Coupling Safety Clip Installation	10-01A-16
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VEHICLE APPLICATION

E-150-250-350, F-150-250-350, F-Super Duty and Bronco Vehicles with Gasoline Engines

DESCRIPTION AND OPERATION

Electronic Fuel Injection (MFI)

F-Series, Bronco, and Econoline vehicles are equipped with Multiport Fuel Injection (MFI) engines. Separate electronically controlled injectors are mounted in the intake manifold on the runner for each cylinder.

Each injector is mounted so that it sprays fuel into the cylinder head intake port of its cylinder. The injectors are supplied fuel under high pressure through an engine-mounted fuel distribution manifold which also has a fuel pressure regulator. The fuel pressure regulator controls the pressure of fuel going into the injectors and returns excess fuel to the fuel tanks.

For a description of the operation of the injectors and fuel manifold, refer to Section 03-04A, for 5.0L and 5.8L; Section 03-04B, for 4.9L; or 03-04C, for 7.5L.

On all vehicles, an electric fuel pump located in a modular in-tank reservoir (FDM) in the fuel tank supplies fuel under high pressure to the fuel distribution manifold.

All vehicles have an in-line fuel filter mounted on the frame rail under the vehicle.

WARNING: TANK-TO-INJECTOR FUEL LINES REMAIN UNDER HIGH PRESSURE AFTER THE SYSTEM IS SHUT OFF. DEPRESSURIZE THE FUEL LINE SYSTEM AT THE SCHRADER VALVE LOCATED ON THE ENGINE FUEL RAIL BEFORE DISCONNECTING ANY FUEL LINE. WITHOUT DEPRESSURIZING THE SYSTEM AS DESCRIBED IN THIS SECTION CAN RESULT IN INJURY FROM FUEL BEING SPRAYED UNDER PRESSURE. ALSO, FUEL SPRAYED UNDER PRESSURE IS AN OBVIOUS FIRE HAZARD.

Fuel Filters

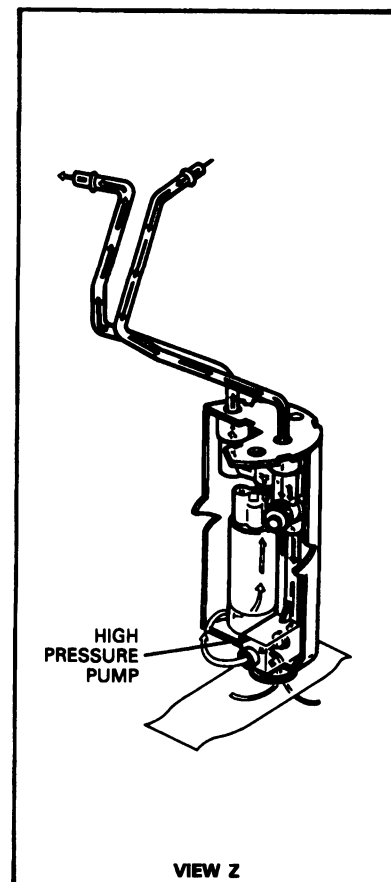
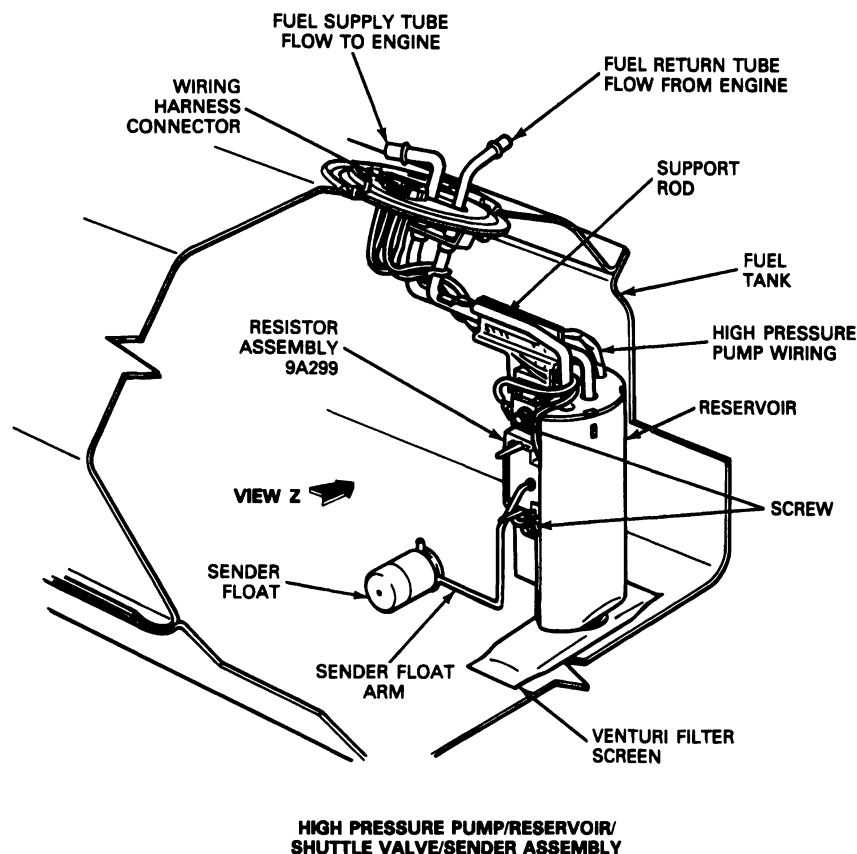
The in-line fuel filter provides filtration to protect the small metering orifices of the injector nozzles. The filter assembly (F-Series and Bronco) and filter pump assembly (E-Series) is located on the left frame rail.

NOTE: The fuel filter should be changed at 24,000 km (15,000 miles) or 15-month intervals, and each time a fuel delivery module is replaced. When the filter needs to be replaced, proceed to Fuel Filter, In-Line Type, 4.9L HS, 5.0L, 5.8L and 7.5L MFI Engines in the Removal and Installation portion of this section.

If the fuel delivery module is replaced, or the fuel system is contaminated with particles, the fuel filter should be replaced. If contamination of fuel is suspected, refill tank(s) with clean fuel, not fuel from tanks.

DESCRIPTION AND OPERATION (Continued)**Electric Fuel Delivery Module (FDM) and Sender Assembly**

The electric fuel delivery system used on the 4.9L, 5.0L, 5.8L and 7.5L Multiport Fuel Injection (MFI) engines consists of a fuel delivery module (FDM) assembly. The FDM unit includes a high pressure fuel pump, venturi jet pump, supply check valve, and a shuttle selector valve located internally to an in-tank reservoir assembly mounted from the fuel tank sender assembly flange.



V7911-8

The following provides a brief description and function of each of the FDM internal components.

High Pressure Fuel Pump: The high pressure fuel pump is located inside the flange-mounted reservoir assembly internal to the fuel tank.

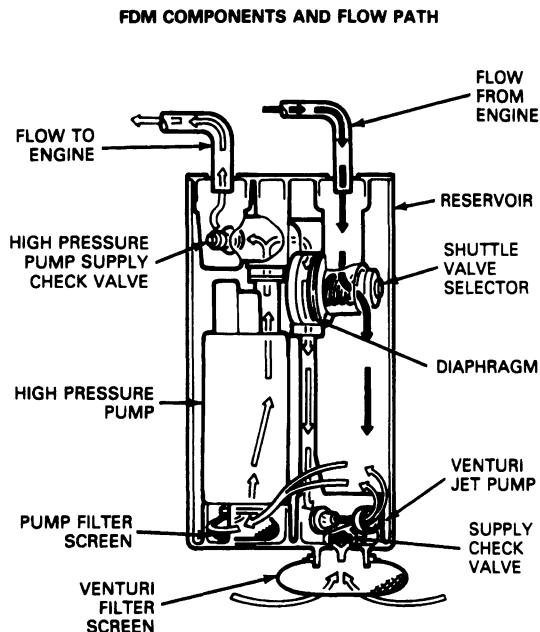
Shuttle Selector Valve: The shuttle selector valve opens the return line to the tank and the return flow is directed to the appropriate tank on vehicles equipped with dual tanks.

Supply Check Valve: The supply check valve, which is normally closed, opens when the outlet pressure from the energized pump exceeds the opposing check valve spring force. When the pump is de-energized (i.e., engine is shut off), the supply check valve closes to maintain pump prime and fuel supply line pressure.

Venturi Jet Pump: A portion of the high pressure flow from the pump is diverted to operate the venturi jet pump. The venturi pump draws fuel from the tank into the fuel delivery module reservoir to augment the engine return flow. This process ensures an adequate fuel supply to the pump during extreme vehicle maneuvers and steep vehicle attitudes with low-tank fill levels.

DESCRIPTION AND OPERATION (Continued)

The inlet of the venturi pump has a nylon filter on it to prevent dirt and other particulate matter from entering the system. Water in the fuel tank can pass through the filter without restriction.



V7913-B

The in-tank mounted high pressure fuel pump is capable of supplying 105 liters (27.7 gallons) of fuel per hour at a working pressure of 270.0 kPa (39 psi) for the 5.0L, 5.8L and 7.5L MFI engines. The pump can supply 90 liters (23.7 gallons) per hour at 380 kPa (55 psi) for the 4.9L MFI engine. The pump has an internal pressure relief valve to provide overpressure protection in the event the fuel flow becomes restricted. Overpressure is restricted to 850 kPa (123 psi) and reduced fuel flow will result. The system pressure is controlled by a pressure regulator on the engine.

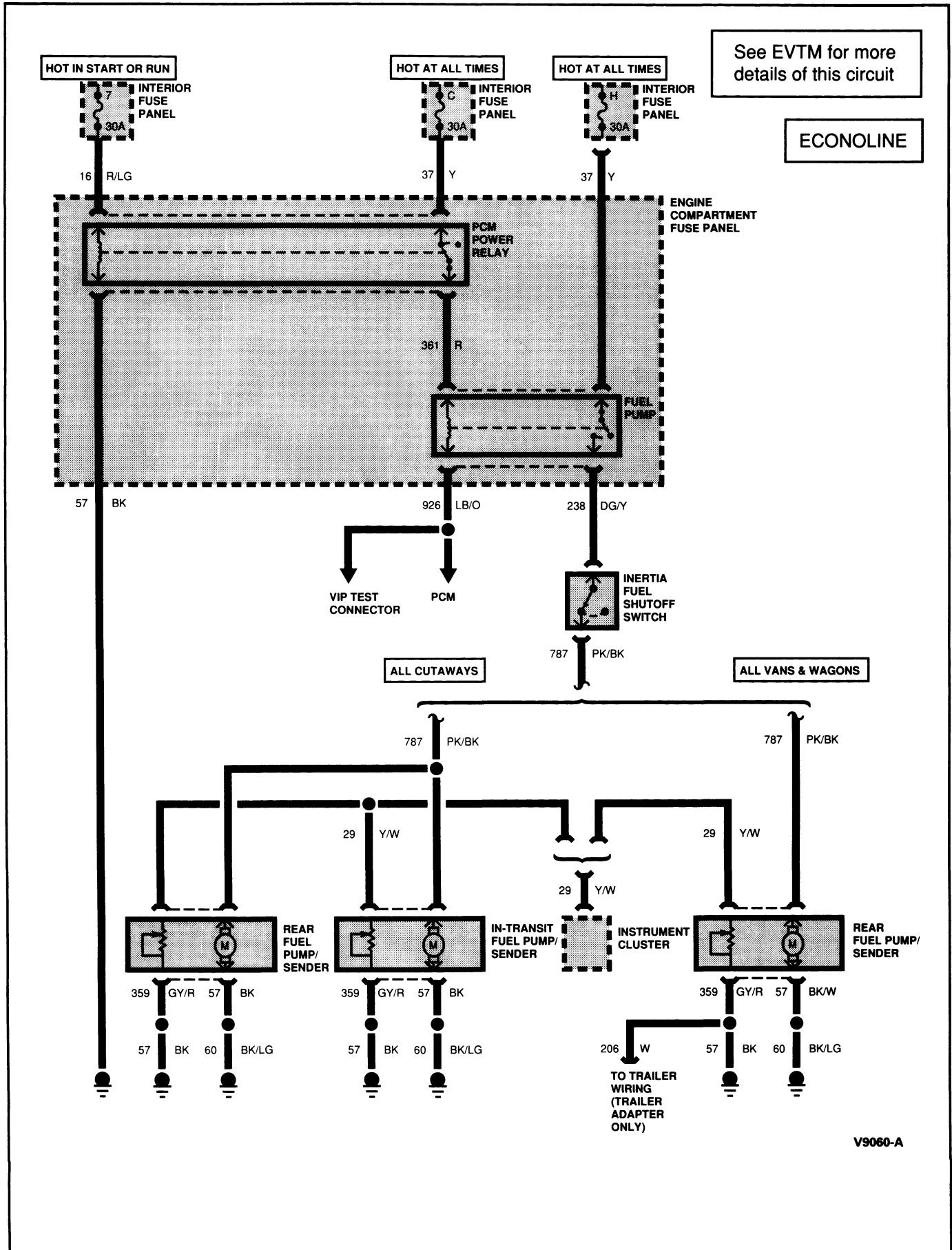
Fuel Delivery Module (FDM) Control

When the ignition switch is turned to the ON position, the Electronic Engine Control (EEC) power relay is energized and provides power to both the fuel pump relay and a timing device in the Powertrain Control Module (PCM). Fuel pump power is provided through the contacts of the fuel pump relay and the inertia switch. If the ignition switch is not turned to the START position within approximately one second, the timing device in the PCM will open the ground circuit (No. 97 T/LG) to the fuel pump relay. Opening the ground circuit de-energizes the fuel pump relay (opening its contacts), which de-energizes the fuel pumps. This circuitry pressurizes the fuel system.

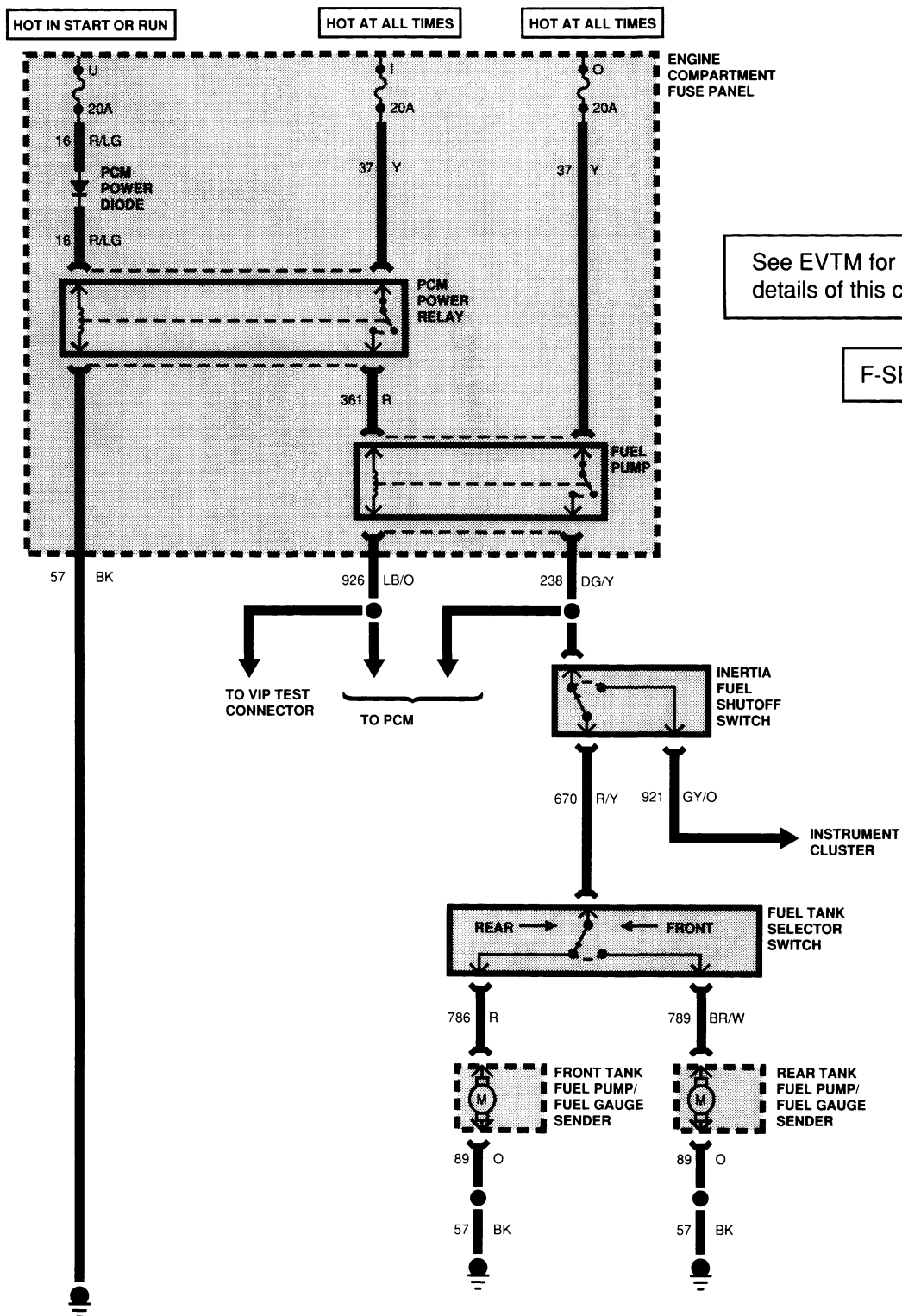
When the ignition switch is turned to the START position, the PCM energizes the fuel pump relay to provide fuel while cranking.

After the engine starts, the ignition switch is returned to the ON position, the power to the fuel pump is supplied through the fuel pump relay. The PCM senses speed and shuts off the fuel pump by opening the ground circuit, Circuit 97 (T-LG), to the fuel pump relay if the engine stops or engine speed drops below 120 rpm.

DESCRIPTION AND OPERATION (Continued)

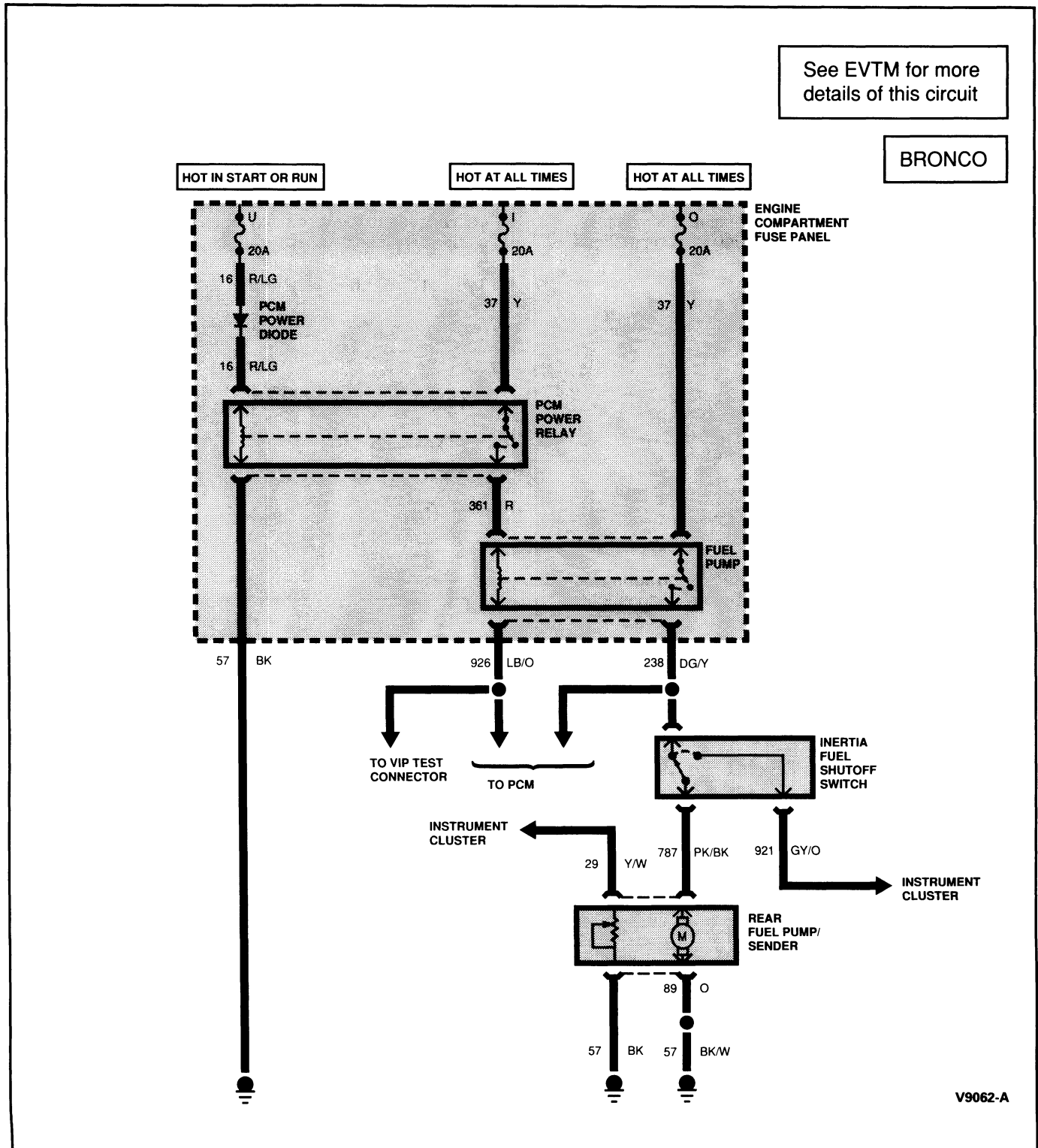


DESCRIPTION AND OPERATION (Continued)



V9061-A

DESCRIPTION AND OPERATION (Continued)

**Fuel Lines**

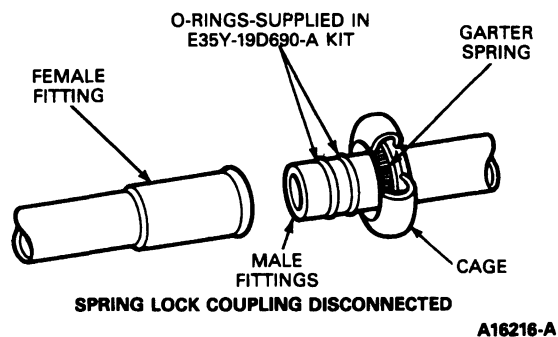
Steel, and Teflon® with braided covering fuel tubes with one of two types of quick-connect couplings are used on all F-, B- and E-Series MFI vehicles. Some tubes on vehicles are part of an organizer assembly.

The two types of quick-connect couplings are called push connect fittings and metal spring lock connectors.

DESCRIPTION AND OPERATION (Continued)

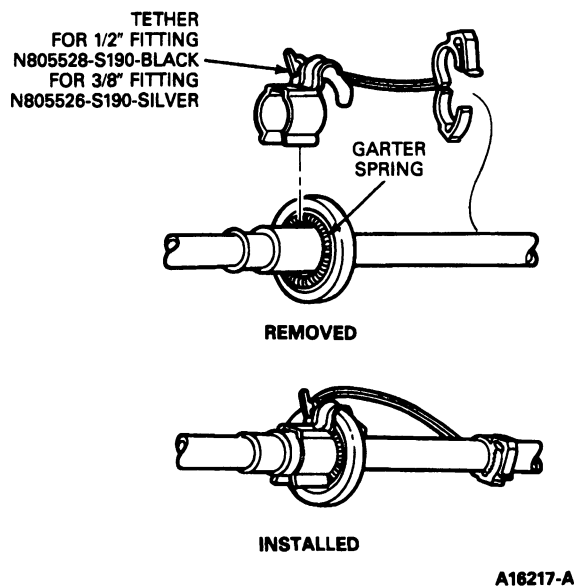
Metal Spring Lock Connectors

Spring lock fittings have a bead formed in one tube which is retained by a garter spring inside a cage on the other tube. Sealing is by O-rings on the cage side. These couplings are connected by pushing the two sides together until the garter spring clicks. They are disconnected by the use of special tools. Connecting and disconnecting instructions are in the Removal and Installation portion of this section. This type of connector is used for fuel line-to-engine fuel manifold connections and sometimes for fuel filter connections.



A tether is used for additional protection on spring lock connectors. It must be unclipped before disconnecting.

Spring Lock Coupling Tether



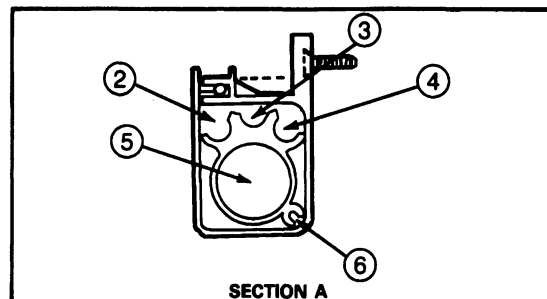
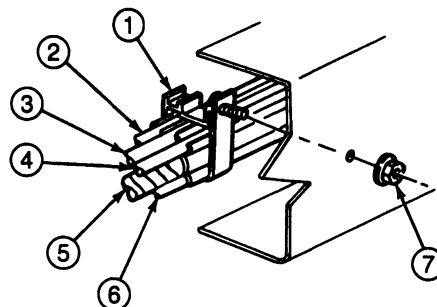
Metal Push Connect Fittings

Push connect fittings consist of a tube (with a formed bead), a body, O-rings, retainer and safety retaining clip (redundant). The fittings are disconnected and connected by use of special tools and instructions are in the Removal and Installation portion of this section.

Organizer Assembly

On all vehicles, rear fuel lines are part of an organizer assembly. The organizer assembly consists of an extruded plastic tube through which electrical wires pass and onto which fuel supply, fuel vapor, fuel return, and brake lines snap. The organizer assembly is retained to the frame by plastic clips with studs moulded in. The studs are attached to the frame by nuts. It is not necessary to remove the plastic clips to gain access to the wires and tubes because the plastic clips can be snapped open and closed.

Typical Organizer Assembly, E-150-250-350



A16218-B

Item	Part Number	Description
1	9S293	Organizer Assembly, Fuel, Brake and Electrical
2	—	Fuel Vapor Line
3	—	Fuel Return Line
4	—	Fuel Supply Line
5	—	Electrical
6	—	Brake Line
7	N620480-S2	Nut 8-10 N·m (6-7 Ft·Lb)

TA16218A

DESCRIPTION AND OPERATION (Continued)

Safety Precautions For Servicing Fuel Lines

WARNING: TANK-TO-INJECTOR FUEL LINES REMAIN UNDER HIGH PRESSURE AFTER THE SYSTEM IS SHUT OFF. DEPRESSURIZE THE FUEL LINE SYSTEM AT THE SCHRADER VALVE LOCATED ON THE ENGINE FUEL RAIL BEFORE DISCONNECTING ANY FUEL LINES. DISCONNECTING FUEL LINES WITHOUT DEPRESSURIZING THE SYSTEM AS DESCRIBED IN THIS SECTION CAN RESULT IN INJURY FROM FUEL BEING SPRAYED UNDER PRESSURE. ALSO, FUEL SPRAYED UNDER PRESSURE IS AN OBVIOUS FIRE HAZARD.

- Disconnect vehicle battery.
- Keep all flame, burning tobacco products, and sparks from grinders and other power tools away from vehicle when servicing fuel system.
- Keep the front end of the vehicle higher than the rear when servicing fuel lines. If the fuel lines are disconnected with the front of the vehicle lower than the rear, fuel can syphon out through the lines.

CAUTION: Only Ford Motor Company approved fuel lines and O-rings should be used for repair or replacement because substitute materials may leak or deteriorate rapidly from contact with fuel. Never substitute hose clamps for approved fittings on nylon fuel lines as they may pull loose because of the fuel pressure.

Fill Control/Vent

Fill limiting is accomplished through fill pipe configuration and/or external vent lines within the fill pipe and tank. The vent system is designed to permit at least 10 percent tank volume air space when the tank is filled to capacity. This air space provides for thermal expansion of fuel as well as being an aid to the in-tank vapor vent system.

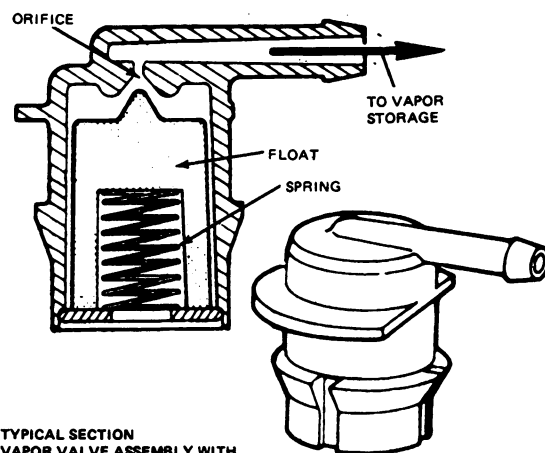
Vapor Vent, In-Tank Venting

This system provides a vapor space above the gasoline surface in the fuel tank. This area is sufficient to permit adequate breathing space for the tank vapor valve assembly under static and most dynamic conditions. This is accomplished by the tank vapor valve assembly that is centrally located on the upper surface of the tank.

Tank Vapor Valve, Rollover Valve Assembly

All fuel tank vapor valves make use of a small orifice that tends to allow only vapor and not fuel to pass into the line running forward to the vapor storage canister. This assembly mounts directly to the fuel tank using a rubber seal.

Fuel vapors trapped in the sealed fuel tank are vented through the orificed vapor valve assembly in the top of the tank. The vapors leave the valve assembly through a single vapor line and continue to the carbon canister for storage, until they are purged to the engine.

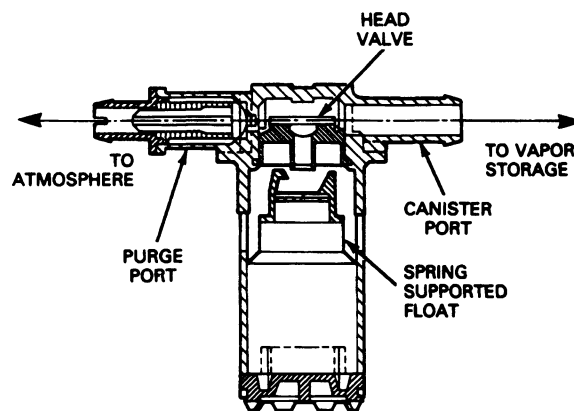


TYPICAL SECTION
VAPOR VALVE ASSEMBLY WITH
FLOAT VALVE AND INTERNAL SPRING

V1780-1E

Mechanical Rollover Valve, 5.8L MFI and 7.5L MFI Engine

The vapor valve assembly mounted on the top of the fuel tank is used to control the flow of fuel vapor entering the fuel tank vapor delivery line which conducts vapor forward to the canister in normal circumstances. If, due to extreme conditions, excessive pressure is generated inside the tank, the purge port opens up, allowing fuel vapor to escape to the atmosphere, and stabilizes pressure inside the tank. The valve assembly has a head valve which prevents the fuel tank from overfilling during refueling. The valve assembly also has a spring supported float assembly, which prevents liquid fuel from entering the vapor delivery line during severe handling, steep grades or in the event of vehicle rollover.



V7470-1A

DESCRIPTION AND OPERATION (Continued)**Pressure and Vacuum Relief System****Fuel Fill Cap**

The fuel fill cap is sealed and includes a built-in pressure-vacuum relief valve. Fuel system vacuum relief is provided after 3.5 kPa (0.50 psi) and pressure relief after 11.0 kPa (1.6 psi). Under normal operating conditions, the fill cap operates as a check valve, allowing air to enter the tank as fuel is used, while preventing vapors from escaping the tank through the cap.

NOTE: Use of an aftermarket fuel fill cap other than an authorized Ford / Motorcraft service part could result in damage to the fuel system or improper system operation if not properly designed / manufactured for pressure vacuum relief. Customer warranty is void for fuel tank and / or fuel system damage resulting from the use of such caps.

Fuel Line Routings

Refer to the illustrations throughout this section for fuel line routings and tank installations.

Gasoline Octane Rating

Vehicles equipped with catalytic converters must use **UNLEADED GASOLINE ONLY** (as specified on the fuel gauge or adjacent to the fuel filler opening). Leaded gasoline can damage the catalytic converter and affects other emission components. When the engine is adjusted to recommended specifications, you may use a gasoline with a minimum octane rating as designated by any of the following numbers:

- Research Octane Number (RON) ..91
- Average of Research Octane Number and Motor Octane Number
- (Antiknock Index).....87

Octane rating and unleaded gasoline availability may vary between gasoline stations.

Fuel Tank Filling

The filler tube openings for the fuel tanks on trucks with multiport fuel injection (MPI) engines have been made smaller to prevent accidental filling with other than unleaded fuel. Gasoline pumps in the United States and Canada dispensing unleaded fuel are equipped with nozzles to accommodate the smaller filler opening on the filler neck.

Expansion of fuel due to temperature increases, or overfilling ("topping off") causes fuel overflow at the filler cap when the vehicle is standing or the cap is removed. To minimize this condition, it is recommended that the amount of fuel put in the tank when filling be limited to the automatic pump shutoff. If vehicle has two tanks, use fuel from both tanks after fill-up to reduce fuel levels.

Fuel Tank Draining

Use appropriate adapter to connect Rotunda Fuel Storage Tanker 034-00002 or equivalent suction pump, to the fuel hose (at the fuel pump to fuel tube connection) and drain the fuel tank.

Fuel Delivery Module (FDM)

Almost any electric fuel pump malfunction that can occur will result in a reduction of fuel flow and / or pressure. A reduction of fuel flow and / or pressure will be detected by a reduction in engine performance. This diagnostic procedure will concentrate on determining if the electric fuel pump system is operating properly. Other diagnostic procedures will cover the analysis of other malfunctions that can cause losses or reductions of engine performance.

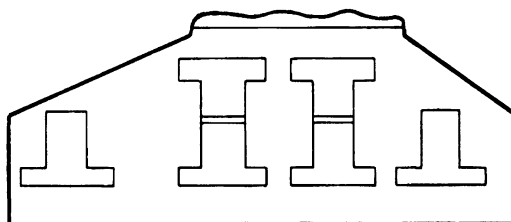
DESCRIPTION AND OPERATION (Continued)

The following diagnostic procedures are to be performed to determine if the electric fuel pump(s) are operating correctly.

NOTE: If no pressure is detected in fuel lines during test procedure, fuel pump should not be powered in excess of three minutes to avoid possible overheating of pump.

HIGH PRESSURE PUMP (FDM) DIAGNOSIS GUIDE

Engine Condition	4.9L EFI	5.0L EFI	5.8L EFI	7.5L EFI
Engine Running	45-60 PSI	30-45 PSI	30-45 PSI	30-45 PSI
	310-415 kPa	210-310 kPa	210-310 kPa	210-310 kPa
Key ON Engine OFF	50-60 PSI	35-45 PSI	35-45 PSI	35-45 PSI
	345-415 kPa	210-310 kPa	210-310 kPa	210-310 kPa

SELF TEST CONNECTOR

FP LEAD
(SHORT END
OF CONNECTOR)

CV7917-D

MFI Fuel System Pressure and Flow Test Equipment

Use Adapter D85L-9974-B and Fuel Pressure Gauge T80L-9974-B to test the MFI Fuel System electric fuel pump.

Inertia Switch

In the event of a collision, the electrical contacts in the inertia switch open and the fuel pump automatically shuts off. The fuel pump will shut off even if the engine does not stop running. The engine, however, will stop a few seconds after the fuel pump stops. It is not possible to restart the engine until the inertia switch is manually reset.

CAUTION: Do not reset the inertia switch until the complete fuel system has been inspected for leaks.

To reset the inertia switch, depress the button on top of the switch.

Switch Location

On F-Series the switch is on the right cowl panel just forward of the door below the instrument panel.

On E-Series the switch is on the passenger side cowl panel, just forward of the right front door.

WARNING: IF YOU SEE OR SMELL GASOLINE AT ANY TIME OTHER THAN DURING FUELING, DO NOT RESET THE SWITCH.

DESCRIPTION AND OPERATION (Continued)

FUEL DELIVERY MODULE (FDM) DIAGNOSIS GUIDE — TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	CHECK STATIC FUEL PRESSURE		
	<ul style="list-style-type: none"> Check for adequate fuel supply. Key off. Install fuel pressure gauge. Install test lead to FP lead of VIP test connector. Turn key to RUN position. Ground test lead to run fuel pump. Refer to Fuel Pressure Specification Table and check to determine if pressure is within acceptable limits using Fuel Pressure Gauge T80L-9974-B or equivalent connected to Schrader valve on EFI fuel rail. Is fuel check OK? 	Yes No	GO to A5. GO to A2.
A2	HYDRAULIC CIRCUIT CHECK		
	<ul style="list-style-type: none"> Pressure low but greater than 20.7 kPa (3 psi) (indicates fuel pump is running but not enough pressure). Is hydraulic check OK? 	Yes No	GO to A3. GO to A4.
A3	HYDRAULIC CIRCUIT CHECK		
	<ul style="list-style-type: none"> Plugged fuel line filter (replace filter and check again for proper pressure). Kinked / restricted fuel lines (visual inspection). Low voltage to fuel pump (should be within 0.5 volts of battery voltage at connector). Disconnect return fuel line and note if fuel is being returned during this low pressure condition. If fuel is being returned, replace or adjust pressure regulator. Is hydraulic check OK? 	Yes No	If service was required and made, GO to A1. If no service was required, REPLACE complete FDM unit and GO to A1.
A4	ELECTRICAL CIRCUIT CHECK		
	<ul style="list-style-type: none"> Inertia switch open? (reset switch as required). Wiring at fuel pump / tank connector loose or open? Fuel pump ground connection at chassis loose or defective? Improper fuel pump relay operation (should operate when FP (test) lead is grounded with ignition key in RUN position). EEC relay not operating if Fuel Pump Relay doesn't operate? 	Yes No	SERVICE all electrical problems and RETURN to A1. If no electrical defects have been found, and pump still won't run, REPLACE pump and RETEST per A1.
A5	CHECK VALVE TEST		
	<ul style="list-style-type: none"> Remove ground from test lead and note pressure on gauge. Does pressure remain within 20.7 kPa (2 psi) of indicated value (key on, engine off) for 3 minutes after lead is ungrounded? 	Yes No	GO to A8. GO to A6.
A6	CIRCUIT LEAK CHECK		
	<ul style="list-style-type: none"> Fuel lines or connectors leaking? Disconnect fuel return line and plug engine side. Momentarily activate fuel pump by grounding test lead. Raise pressure to approximate operating pressure. Repeat A5. If pressure holds, replace regulator and repeat A5. 	Yes No	If service was made, GO to A1. If pressure decays rapidly GO to A7. If unit still fails, there may be a leaking fuel injector or rail. CORRECT these problems and GO to A5.
A7	CHECK VALVE TEST (FDM)		
	<ul style="list-style-type: none"> Pressure does not hold? Pressure decays rapidly enough that needle movement can be observed. 	Yes No	If equipped with single tank, replace FDM unit. If equipped with dual tanks GO to A8. GO to A10.

DESCRIPTION AND OPERATION (Continued)

FUEL DELIVERY MODULE (FDM) DIAGNOSIS GUIDE — TEST A (Continued)

TEST STEP		RESULT	ACTION TO TAKE
A8	CHECK VALVE TEST (FDM)		
	<ul style="list-style-type: none"> ● Re-connect fuel supply line to the filter. ● Remove fuel supply line from sender port of midship tank. ● Change pressure gauge from 5 / 16 inch to 3 / 8 inch adaptor to fit fuel line quick-connector. ● Connect gauge to end of supply line removed from midship sender. ● Move the tank selector switch to REAR tank position. ● Turn ignition switch to RUN position and hold until fuel pump shuts itself off (approximately one second). ● Turn ignition switch OFF. ● Observe pressure gauge. ● Does pressure hold steady? 	Yes No	Requires further testing. GO to A9 . REPLACE aft-of-axle FDM unit and GO to A9 .
A9	CHECK VALVE TEST (FDM)		
	<ul style="list-style-type: none"> ● Remove gauge from fuel supply line. ● Install 3 / 8 inch right-angle quick-connector to pressure gauge. ● Connect gauge to midship tank FDM supply port. ● Move the tank selector switch to the FRONT tank position. ● Turn ignition switch to RUN position and hold until fuel pump shuts itself off (approximately one second). ● Turn ignition switch OFF. ● Observe pressure gauge. ● Does pressure hold steady? 	Yes No	Midship FDM unit is OK. REMOVE test gauge and CONNECT fuel supply line. GO to A1 . REPLACE midship FDM unit and GO to A1 .
A10	ENGINE ON TEST		
	<ul style="list-style-type: none"> ● If engine is MFI (fuel rail injectors), disconnect and plug the vacuum line connected to the pressure regulator. ● Start engine and run at idle. Is fuel pressure as indicated in chart for key on, engine off? 	Yes No	GO to A12 . GO to A11 .
A11	IDLE ENGINE REPAIR		
	<ul style="list-style-type: none"> ● Fuel filter restricted (replace)? ● Improper fuel regulator adjustment? ● Fuel line restricted? ● Improper voltage to fuel pump (battery voltage at pump connections)? 	Yes No	If defect has been found and serviced, GO to A1 . If no defect is found, REPLACE fuel pump and GO to A1 .
A12	HIGH SPEED TEST		
	<ul style="list-style-type: none"> ● With engine running at idle and vacuum line disconnect if necessary from A10, note fuel rail pressure. ● Rapidly accelerate engine and watch fuel pressure. Does pressure remain within 5 psi of starting pressure? <p>NOTE: Road testing vehicle while monitoring pressure may give a better test under load conditions.</p>	Yes No	Fuel pump is OK. If problem persists, CONSULT other parts of the manual. DISCONNECT test connections and RECONNECT vacuum lead if removed for test. GO to A11 .

TV7918D

REMOVAL AND INSTALLATION

Fuel System Pressure Relief

CAUTION: Fuel supply lines on 4.9L MFI, 5.0L MFI, 5.8L MFI and 7.5L MFI engines will remain pressurized for some period of time after the engine is shut off. This pressure must be relieved before servicing of the fuel system.

Before opening the fuel system on vehicles with MFI engines, relieve fuel pressure as follows:

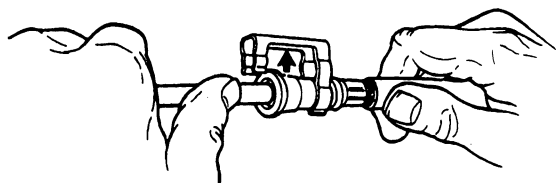
1. Locate and disconnect the electrical connection to either the fuel pump relay, the inertia switch or the in-line high pressure fuel pump.
2. Crank engine for approximately ten seconds.
NOTE: Engine may start and run for a short time. If so, crank engine an additional five seconds after engine stalls.
3. Connect the electrical connector that was disconnected in Step 1.
4. Disconnect battery ground cable.

Stainless Steel Fittings

CAUTION: Discharge fuel system before disconnecting coupling.

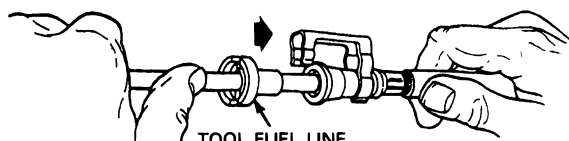
Removal

1. Open safety clip.



V9067-A

2. Fit Tool T90T-9550-B (5/16-inch) or T90T-9550-C (3/8-inch) to coupling so that tool can enter female fitting.

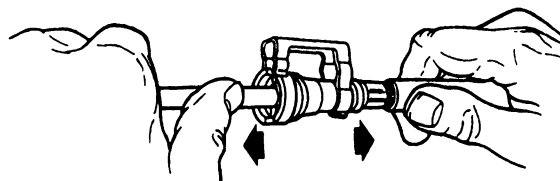


TOOL FUEL LINE
DISCONNECT TOOL
T90T-9550-B 5/16-INCH (GRAY)
T90T-9550-C 3/8-INCH (BLUE)
T90T-9550-S SET OF BOTH TOOLS

V9068-A

3. Push the tool into female fitting to release the retaining fingers from the formed male tube end.

4. Pull male and female fittings apart.



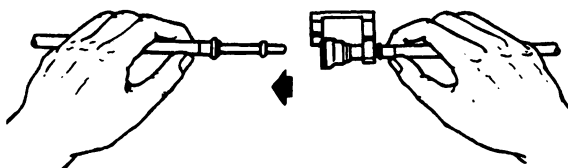
V9069-A

5. Remove the tool from the disconnected fitting.
6. Inspect the fitting for any internal parts that may have been damaged. Fuel tube should be replaced if internal parts are damaged.

Installation

1. Align the fitting and tube axially.

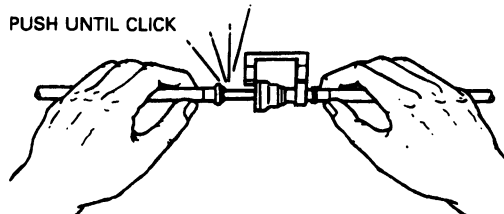
QUICK CONNECT
COUPLING (STEEL TUBES)



V9070-A

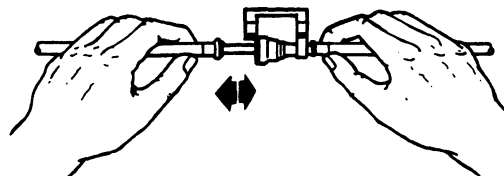
2. Push the tube into the fitting. When properly engaged, a definite "click" will be heard.

PUSH UNTIL CLICK



V9071-A

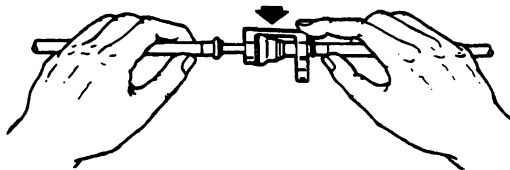
3. Pull on the fitting to make sure it is fully engaged.



V9072-A

REMOVAL AND INSTALLATION (Continued)

4. Lock assembly with safety clip.



V9073-A

Metal Spring-Lock Connectors

The tools will not always fit over the shielded line. To accommodate the shielding, the hole in the tubing end of the tool must be enlarged. To do this, clamp the tool closed and drill out the existing hole with 5/8-inch bit. Be careful to drill only the tubing hole and not the working end of the hole.

Removal and Installation

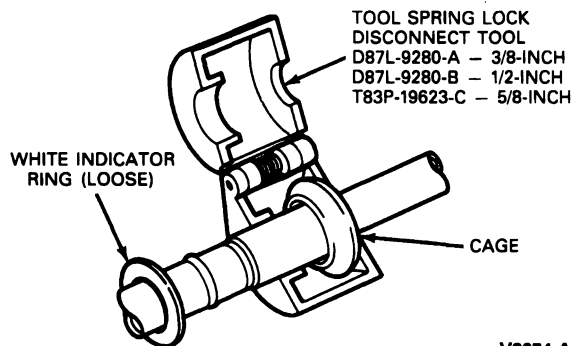
NOTE: Metal safety clips are used on metal tubes with metal spring-lock connectors. Both types are illustrated.

Disconnecting Spring Lock Coupling

CAUTION: Discharge fuel system before disconnecting coupling.

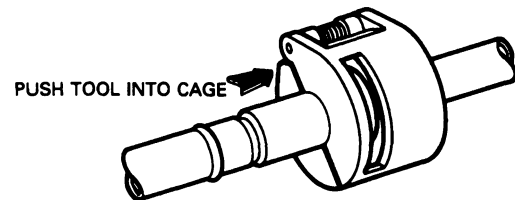
NOTE: Before disassembly, locate white indicator ring which may have slipped down length of fuel line.

1. Fit tool to coupling so that tool can enter cage to release the garter spring.



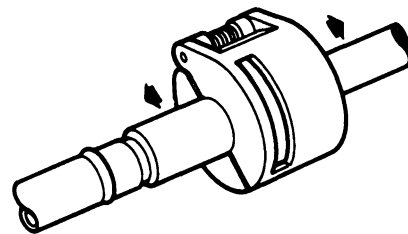
V9074-A

2. Push the tool into the cage opening to release the female fitting from the garter spring.



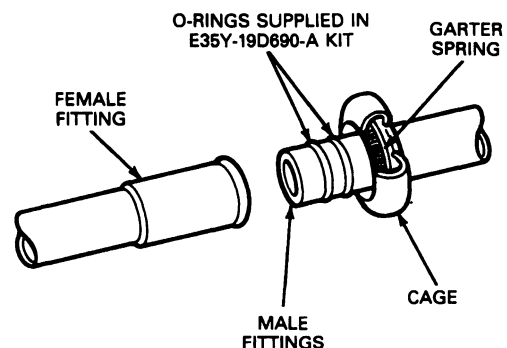
V9075-A

3. Pull the coupling male and female fittings apart.



V9130-A

4. Remove the tool from the disconnected spring lock coupling.



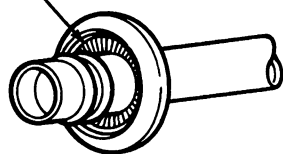
V9131-A

REMOVAL AND INSTALLATION (Continued)

Connecting Spring Lock Coupling

1. Check for missing or damaged garter spring. If spring is damaged or missing remove damaged spring with small hooked wire and install a new spring.

GARTER SPRING

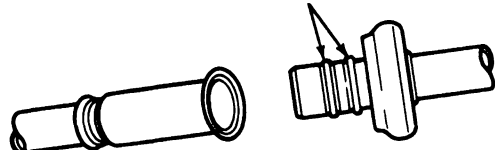


REPLACEMENT GARTER SPRINGS
 3/8 INCH — E1ZZ-19E576-A
 1/2 INCH — E1ZZ-19E576-B
 ALSO AVAILABLE IN
 E35Y-19D690-A KIT

V9132-A

2. Clean fittings and install new O-rings. Use only specified O-rings supplied in E35Y-19D690-A kit. Lubricate with clean refrigerant oil. Insert white indicator ring into cage on male fitting. Assemble fitting together by pushing with a slight twisting motion.

O-RINGS

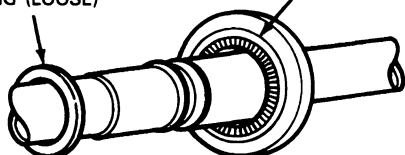


V9133-A

3. White indicator ring will pop free of cage on male fitting when fully joined. This indicates that garter spring inside cage of male fitting is properly seated over lip of female connector.

WHITE INDICATOR RING (LOOSE)

GARTER SPRING

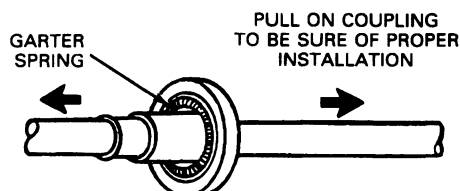


V9134-A

Spring Lock Coupling Safety Clip Installation

1. Visually check to be sure garter spring is over flared end of female fitting.

2. Pull on connector opposite to the direction of installation to verify that the connector is locked in place. If connector is not locked in place, refer to Connecting Spring Lock Connector procedure in this section.



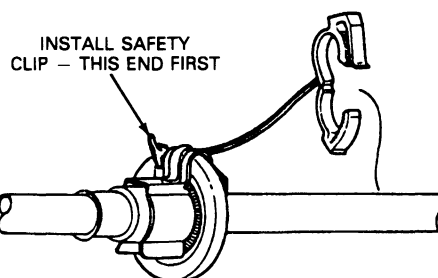
PULL ON COUPLING
 TO BE SURE OF PROPER
 INSTALLATION

SPRING LOCK COUPLING — FOR FUEL LINE TO
 ENGINE FUEL RAIL CONNECTIONS

V9135-A

3. Install large end of clip to garter spring side of fuel line making sure that clip is properly positioned. Refer to the following illustration.

NOTE: The black 12.7mm (1/2-inch) clip fits the fuel supply line. The silver 9.5mm (3/8-inch) clip fits fuel return line.



INSTALL SAFETY
 CLIP — THIS END FIRST

FUEL COUPLING
 SAFETY CLIP

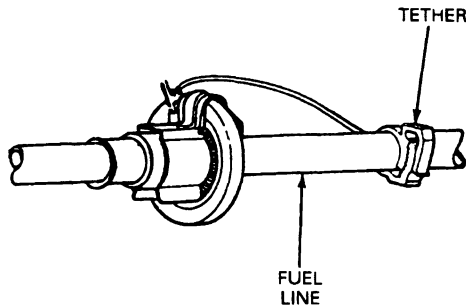
FOR 1/2" FITTING
 N805528-S190
 BLACK

FOR 3/8" FITTING
 N805526-S190
 SILVER

V9136-A

REMOVAL AND INSTALLATION (Continued)

4. Attach the tether to the fuel line and snap shut.



V9137-A

Vapor Hoses**Removal**

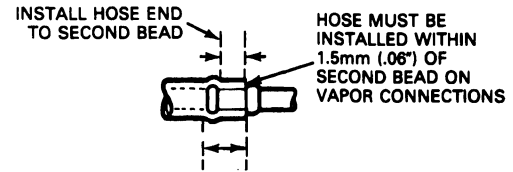
To disconnect a hose from any component, refer to the following:

1. Securely grip component with one hand, and hose with the other hand as close as possible to connection.
2. Sharply twist hose along its axis to "break" the temporary bond between hose and component. (No adhesive is used to make hose connections during vehicle assembly, but natural aging of the connections causes a temporary bond to exist.)
3. It is important to "break free" the hose at its connection point as indicated in Step 2. If the joint is stubborn and the above method does not work, grip the hose with a pair of pliers directly over the joint and twist again.
4. Once the hose / component joint has been broken, disconnect by securely gripping the component with one hand and hose with the other. Twist hose and at the same time pull apart.

WARNING: MOST CONNECTIONS IN THE EVAPORATIVE EMISSION SYSTEM ARE VERY SECURE. A STRONG PULLING AND SIMULTANEOUS TWISTING ACTION IS REQUIRED TO DISCONNECT. WHEN DISCONNECTION OCCURS, BOTH HANDS COULD SHARPLY AND UNCONTROLLABLY MOVE IN THE DIRECTION OF EACH HAND'S PULLING. BE CAREFUL THAT NO SHARP OR POSSIBLE DAMAGING OBJECTS ARE IN LINE WITH THE DIRECTION OF PULL TO PREVENT PHYSICAL INJURY AND/OR DAMAGE TO THE OBJECTS THAT WILL BE IMPACTED BY THE HANDS WHEN DISCONNECTION OCCURS.

Installation

1. To reconnect a hose to a component, wet the hose with water and push onto component.
2. Vapor hoses should be assembled with the minimum engagement shown in the following illustration.



V2351-D

In-Line Fuel Filter

CAUTION: If the fuel filter is being serviced with the rear of the vehicle higher than the front, or if the tank is pressurized, fuel leakage or siphoning from the tank fuel lines could occur. To prevent this condition, maintain the vehicle front end at or above the level of the rear of vehicle. Also, relieve tank pressure by loosening the fuel fill cap. Cap should be retightened after pressure is relieved. Depressurize the fuel line system at the Schrader valve on the engine fuel rail. If vehicle is warm, change the fuel filter before the pressure rebuilds.

Removal

1. Shut engine off. Depressurize fuel system. Refer to Fuel System Pressure Relief in this section.
2. Disconnect battery ground cable.
3. Raise vehicle on hoist. Refer to Section 00-02.
4. Remove filter-to-fuel line retainer clips.
5. Remove push connector fittings at both ends of the filter as outlined in this section.
6. On E-Series, push arms of bracket apart and pull out filter.

On F- and B-Series, remove two nuts from filter studs and remove filter and bracket assembly.

NOTE: On F- and B-Series, it may be necessary to unclip and move parking brake cable.

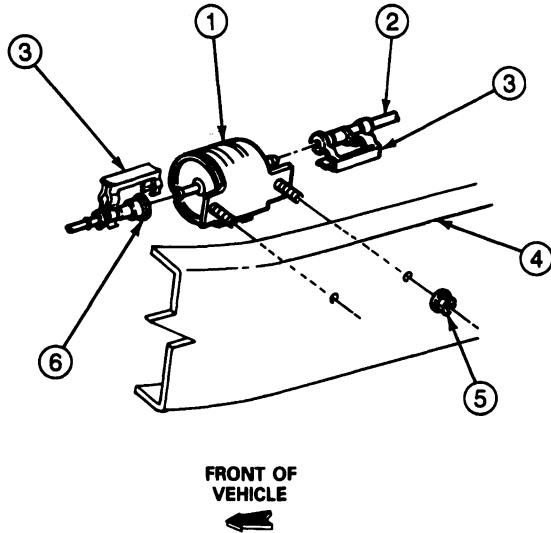
Installation

Note that the direction of the flow arrow points to the tab of the bracket against which the filter rests.

1. On E-Series vehicles, snap new filter into arms of bracket.
On F- and B-Series, install filter and bracket assembly and two nuts. Tighten nuts to 8-10 N-m (6-7 ft-lb).
2. Install push-connect fittings onto filter ends as outlined in this section.
3. Snap on filter-to-fuel line retainer clips. Long legs of clips go onto fuel lines.

REMOVAL AND INSTALLATION (Continued)

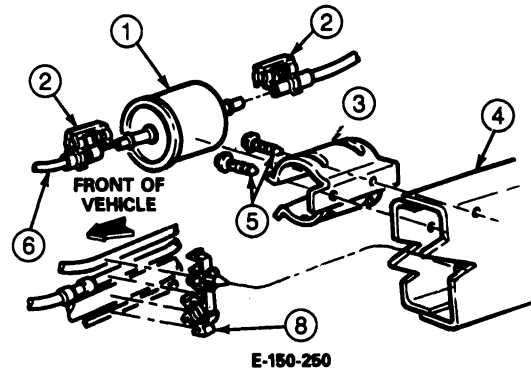
4. Lower vehicle and connect battery ground cable.
5. Turn ignition switch from OFF to RUN position several times without starting engine. Check for fuel leaks.

Fuel Filter Installation, F-Series and Bronco MFI Engines

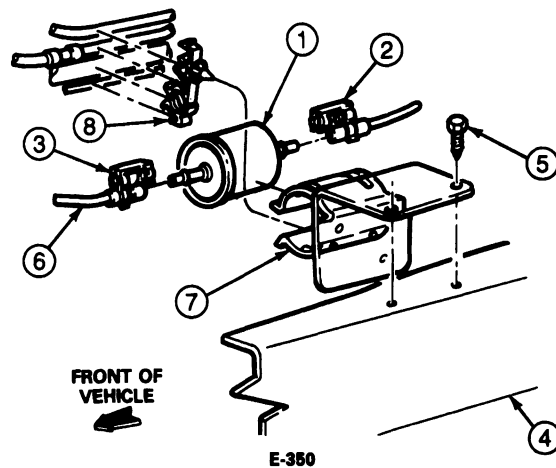
V8537-A

Item	Part Number	Description
1	9A335	Filter Assembly
2	9S278	Rear Fuel Tube Assembly
3	—	Clip
4	Ref.	Frame Rail
5	N620480-S2	Nut 8-10 N·m (6-7 Ft-Lb)
6	9J338	Front Fuel Tube Assembly

TV8537A

Fuel Filter Installation, E-Series MFI Engines

E-150-250



E-350

V8539-B

Item	Part Number	Description
1	9155	Filter
2	—	Clip
3	5361	Bracket
4	5005	Frame
5	W611645-S2	Screw 20-25 N·m (15-18 Ft-Lb)
6	9B325	Front Fuel Tube
7	9A335	Fuel Filter Bracket Assembly
8	9N589	Clip

TV8539A

Organizer Assemblies, E-150-250-350**Removal and Installation**

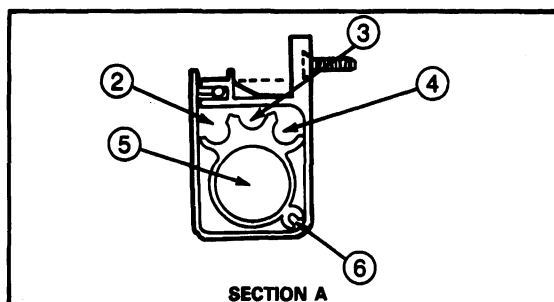
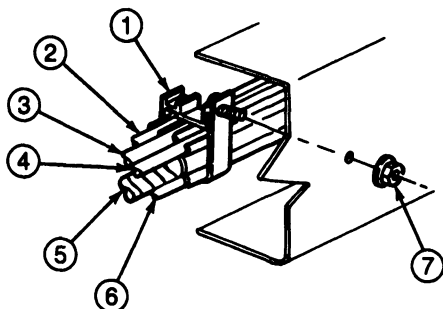
Either single lines and hoses may be removed from organizer assemblies or the entire assembly may be removed.

To remove a single line or hose, snap open organizer-to-frame clips. Disconnect line or hose ends. Snap line or hose out of organizer plastic core and remove. It may be necessary to remove some other lines to get one out.

REMOVAL AND INSTALLATION (Continued)

To remove the entire assembly: Disconnect battery ground cable. Disconnect all lines, hoses, and electrical connections going through organizer. Remove nuts retaining organizer assembly to frame. Remove assembly.

To install assembly, position organizer assembly on frame. Install organizer clip nuts and tighten to 8-10 N·m (6-7 ft·lb). Connect all hoses, lines, and wires.

Typical Organizer Assembly, E-150-250-350

A16218-B

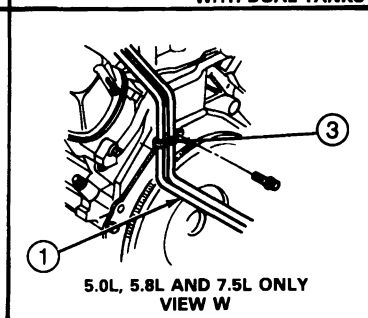
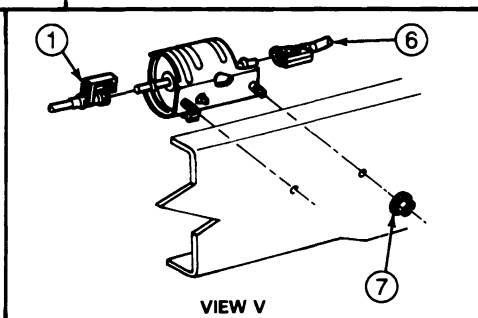
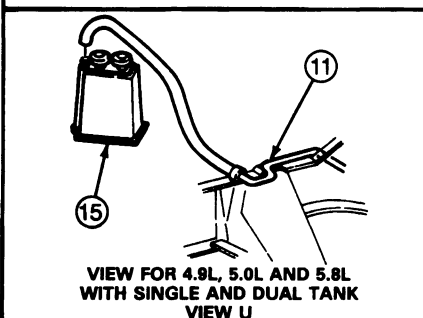
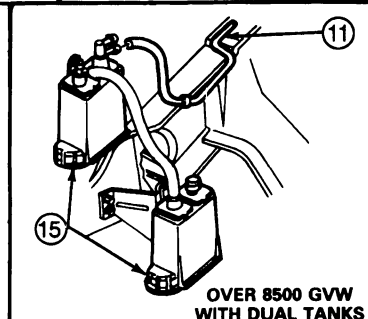
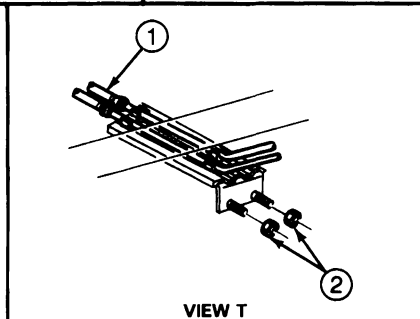
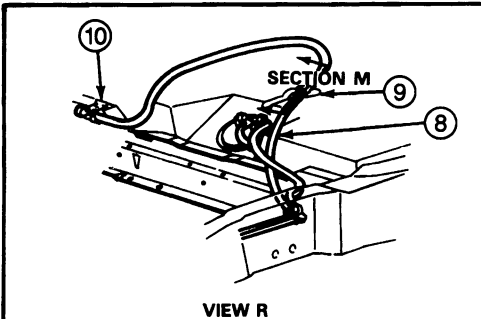
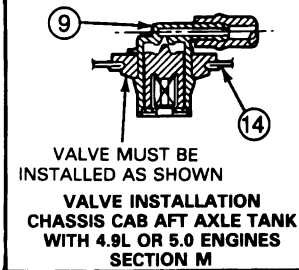
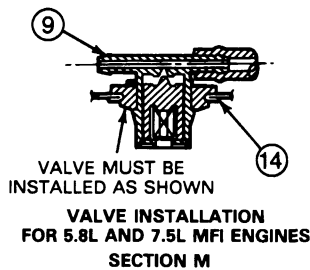
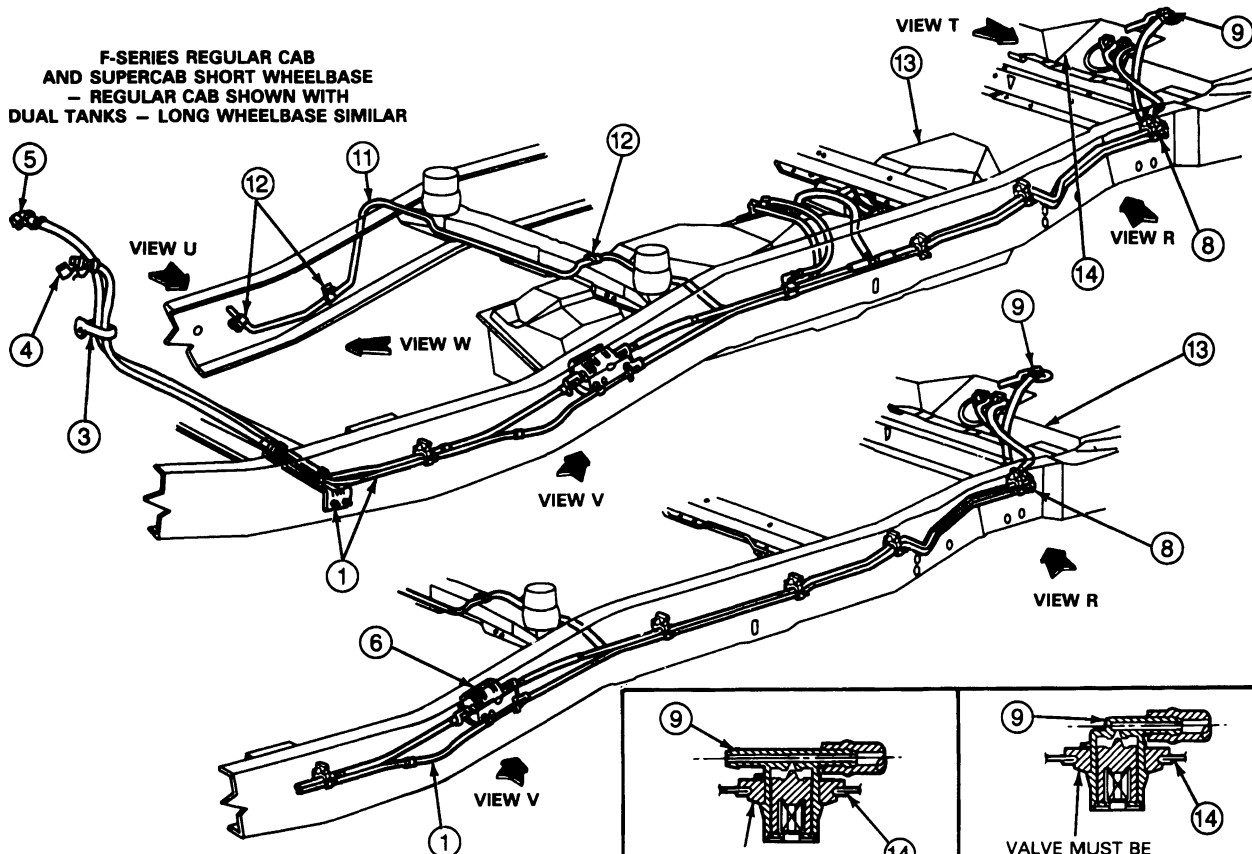
Item	Part Number	Description
1	9S293	Organizer Assembly, Fuel, Brake and Electrical
2	—	Fuel Vapor Line
3	—	Fuel Return Line
4	—	Fuel Supply Line
5	—	Electrical
6	—	Brake Line
7	N620480-S2	Nut 8-10 N·m (6-7 Ft·Lb)

TA16218A

Fuel Line Illustrations, F-Series

Refer to the following illustrations for fuel supply, return, and vapor line routing and component location. Refer to the first part of Removal and Installation in this section for servicing individual fuel line components.

REMOVAL AND INSTALLATION (Continued)

Fuel Line Installation, F-150-250-350, Regular Cab and SuperCab and F-Super Duty Chassis Cab with Dual and Aft-of-Axle Tanks

V7497-B

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9J338	Tube Assembly, Front Fuel Line
2	N620480-S2	Nut 11-15 N·m (8-11 Ft-Lb)
3	9D319	Bracket, Fuel Line Support
4	N805526-S190	Connector, Fuel Line Supply
5	N805528-S190	Connector, Fuel Line Return
6	9A335	Bracket Assembly, Fuel Filter
7	N620480-S2	Nut 8-10 N·m (6-7 Ft-Lb)
8	9S278	Tube Assembly, Rear Fuel Line

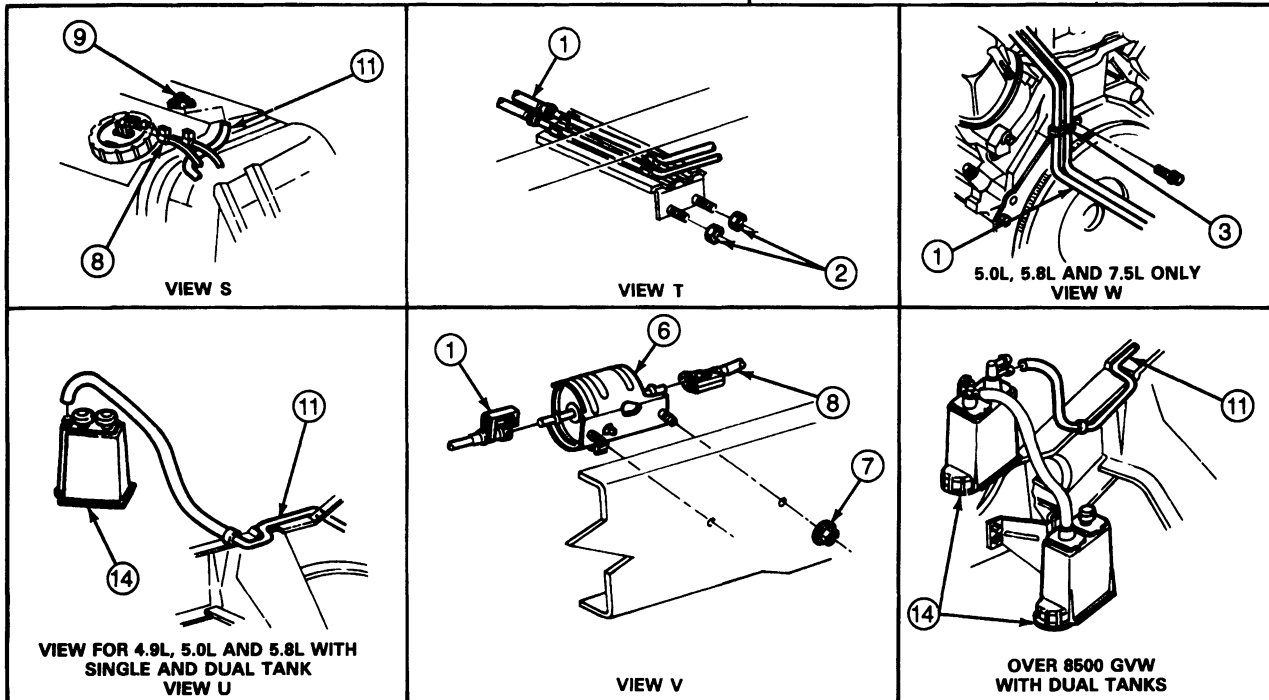
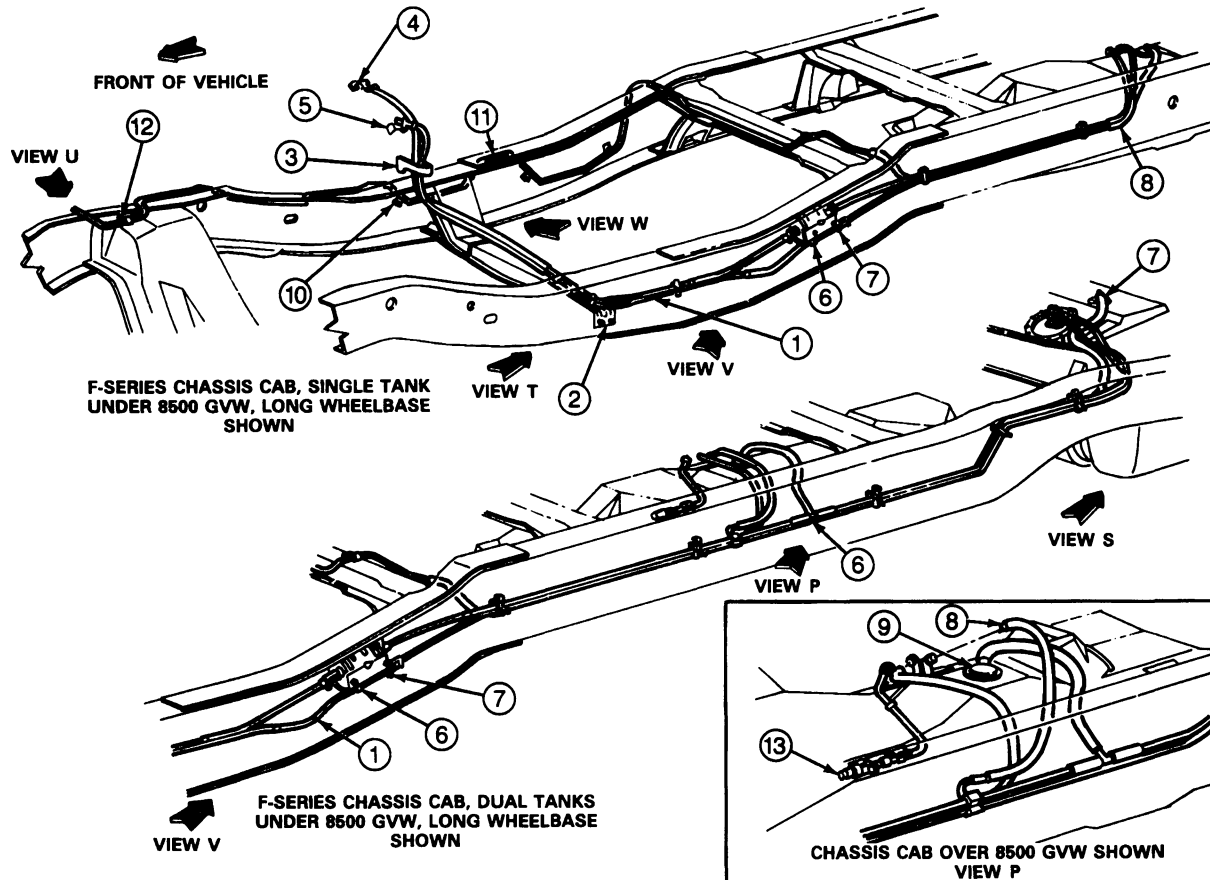
(Continued)

Item	Part Number	Description
9	9C987	Valve Assembly, Evaporative — 4.9L and 5.0L Engines
9	9B227	Hose and Valve Assembly, Evaporative — 5.8L and 7.5L Engines
10	370443-S32	Clip
11	9C016	Tube and Hose Assembly, Vapor Return
12	9F274	Clip Assembly, Fuel Line
13	9002	Tank Assembly
14	9104	Tank Assembly
15	9D653	Canister Assembly, Vapor

TV7497A

REMOVAL AND INSTALLATION (Continued)

Fuel Line Installation, F-350 and F-Super Duty Chassis Cab with Single and Dual Tanks



V8235-C

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9J338	Tube Assembly, Front Fuel Line
2	N620480-S2	Nut 11-15 N·m (8-11 Ft-Lb)
3	9D319	Bracket, Fuel Line Support
4	N805526-S190	Connector, Fuel Line Supply
5	N805528-S190	Connector, Fuel Line Return
6	9A335	Bracket Assembly, Fuel Filter
7	N620480-S2	Nut 8-10 N·m (6-7 Ft-Lb)
8	9S278	Tube Assembly, Rear Fuel Line

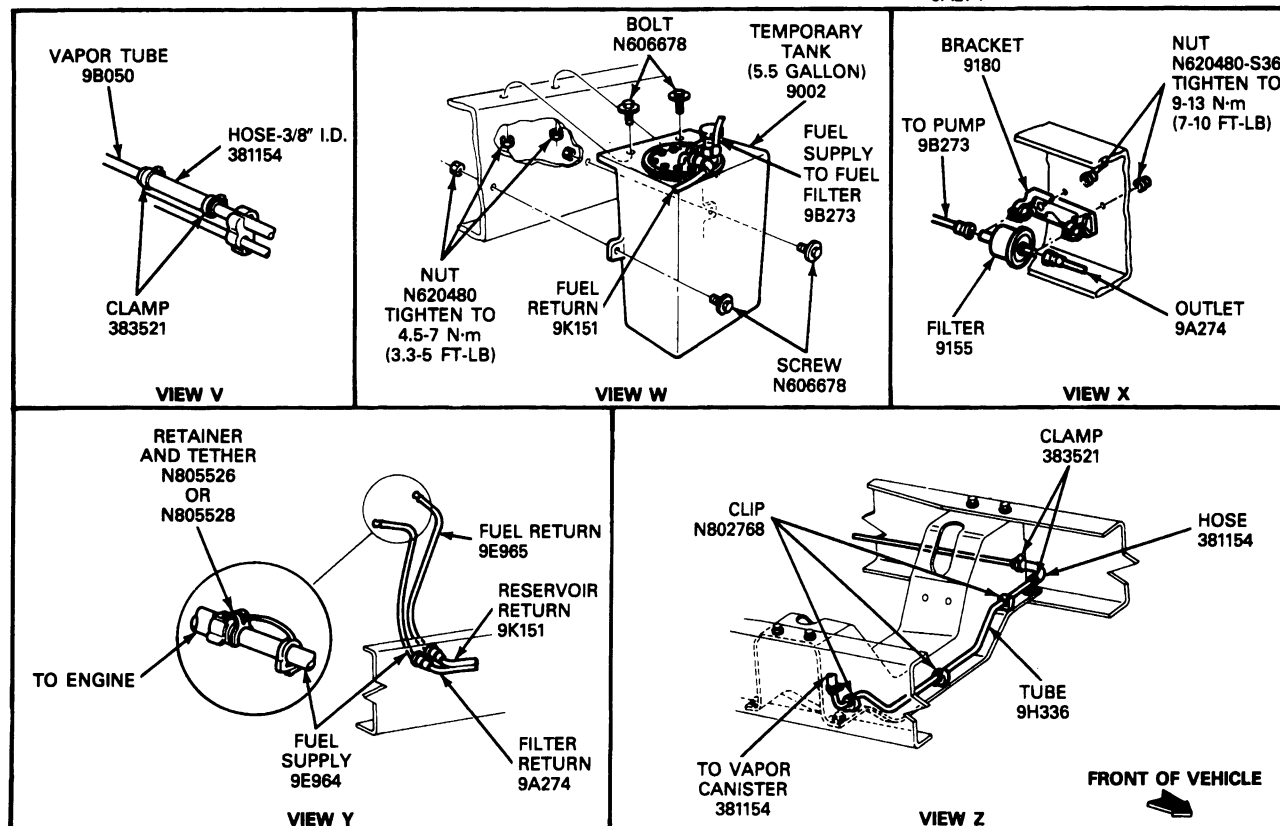
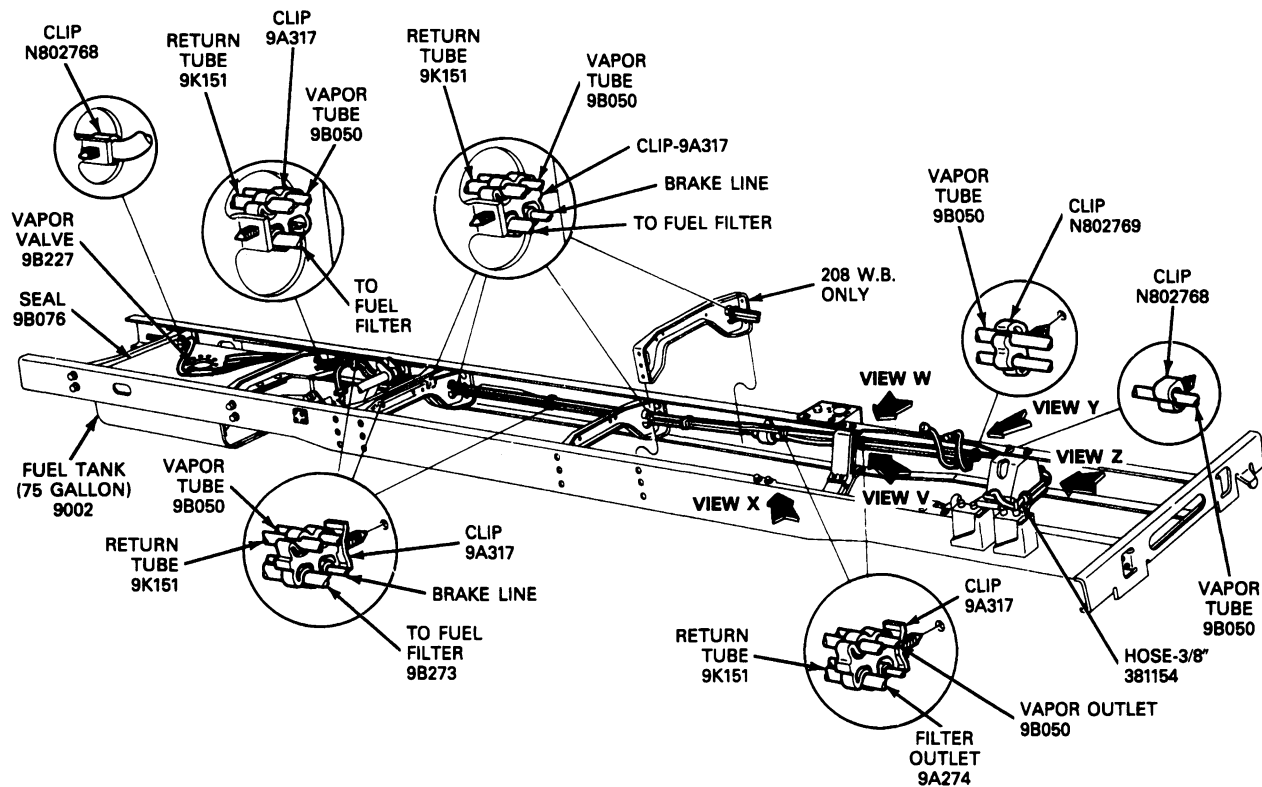
(Continued)

Item	Part Number	Description
9	9C987	Valve Assembly, Evaporation — 4.9L and 5.0L Engines
9	9B227	Hose and Valve Assembly, Evaporation — 5.8L and 7.5L Engines
10	370443-S32	Clip
11	9C016	Tube and Hose Assembly, Vapor Return
12	9F274	Clip Assembly, Fuel Line
13	9S303	Tube Assembly, Fuel Tank Auxiliary Drain
14	9D653	Canister Assembly, Vapor

TV8235A

REMOVAL AND INSTALLATION (Continued)

Fuel Lines, F-Super Duty Motorhome Chassis



V6297-C

REMOVAL AND INSTALLATION (Continued)**Fuel Pump, Bronco, F-150-250-350, F-Super Duty and E-150-250-350**

CAUTION: Fuel supply lines remain pressurized for long periods of time after the engine is shut down. This pressure must be relieved before the fuel system is serviced. Refer to Fuel System Pressure procedure described in this section.

Removal

1. Remove the fuel tank as described in this section.
2. Position fuel tank on a work bench and remove any dirt that has accumulated around the sender so that it will not enter the fuel tank.
3. Turn the fuel pump locking ring counterclockwise with Fuel Tank Lock Ring Wrench T74P-9275-A or equivalent and remove locking ring.

NOTE: On E-Series Cutaway vehicles the fuel pump is held in place by bolts.

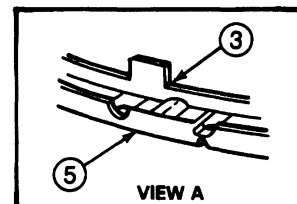
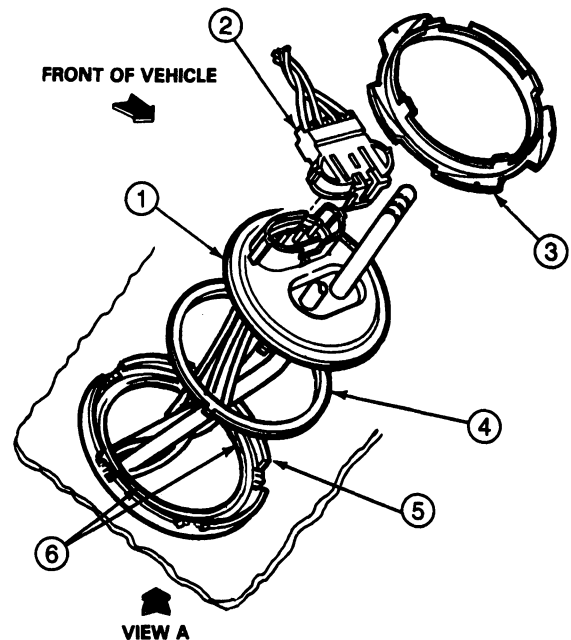
4. Remove the fuel pump from the fuel tank.
5. Remove seal gasket and discard.

Installation

1. Clean the fuel pump mounting flange and the fuel tank mounting surface and seal ring groove.
2. Put a light coating of Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent grease on a new seal ring to hold it in place during assembly and install it in the fuel ring groove.
3. Install fuel pump and sending unit assembly carefully to make sure that the filter is not damaged. Be sure that the tabs of the sender are positioned into slots of the fuel tank. Make sure ring remains in place.
4. Hold the fuel pump / sending unit and sealing gasket in place; install and rotate the locking ring clockwise until the stop is against the retainer ring tab.

NOTE: On E-Series Cutaway vehicles tighten the fuel pump retaining bolts to 9-11 N-m (7-8 ft-lb).

5. Install fuel tank as described in this section.

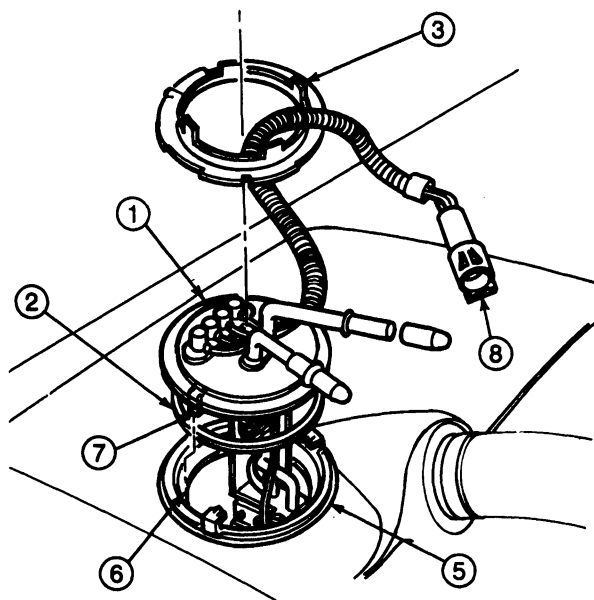
Fuel Delivery Module, F-150-250-350 and Bronco

V4838-F

Item	Part Number	Description
1	9H307	Fuel Delivery Module and Sender Assembly
2	14405 or 14406	Wiring Assembly
3	90383	Locking Ring (Using D84P-9275-A or Equivalent, Turn Until Tabs are Positioned Between Detent and Stop on Tank)
4	9417	Gasket
5	9002	Fuel Tank
6	—	Locking Slots — Part of Fuel Tank (Make Sure FDM Tabs are Seated in Slot)

REMOVAL AND INSTALLATION (Continued)

Fuel Delivery Module, E-150-250-350



K17091-A

Item	Part Number	Description
1	9H307	Fuel Delivery Module and Sender Assembly
2	9417	Gasket
3	90383	Locking Ring
5	—	Locating Tabs (Part of 9H307 or 9275 Fuel Pump and Sending Unit)
6	14405	Wiring Assembly
7	—	Locking Slots (Part of 9002 Fuel Tank)
8	14405 or 14406	Wiring Assembly (Aft of Axle Fuel Tank)

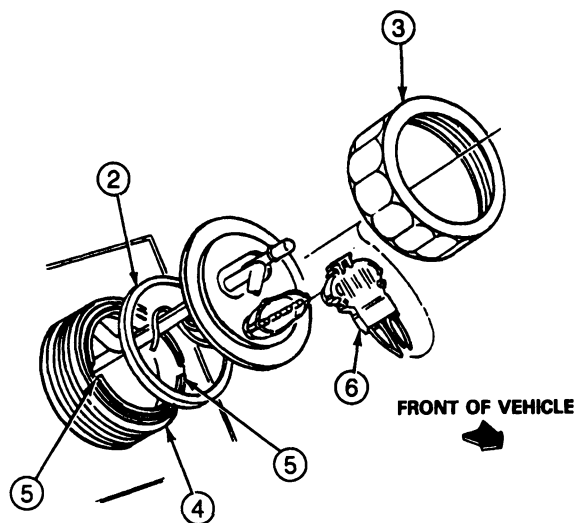
TK17091A

Fuel Pump, Units with Plastic Locking Ring, F-350 Chassis Cab

The fuel pump removal and installation procedure for units equipped with plastic locking rings is the same for units equipped with metal locking rings. The plastic locking ring on these units can be removed with a band-type oil filter wrench or equivalent by turning counterclockwise. When installing the plastic locking ring, tighten ring to 54-75 N·m (40-55 ft-lb).

Refer to Fuel Pump, F-150-250-350, Bronco and E-150-250-350 removal and installation procedures in this section.

Fuel Delivery Module, Units Secured with Plastic Locking Rings, F-350 Chassis Cab



K17093-A

Item	Part Number	Description
1	9H307	Fuel Pump and Sending Unit (Gasoline Engines)
1	9275	Fuel Pump and Sending Unit (Diesel Engine)
2	9417	Gasket
3	9A307	Locking Ring
4	9002	Fuel Tank
5	—	Locating Tabs (Part of 9H307 or 9275 Fuel Pump and Sending Unit)
6	14405 or 14406	Wiring Assembly

TK17093A

Steel Midship Fuel Tank, F-150-250-350 and F-Super Duty

NOTE: As there are different midship tank installations which are removed and installed essentially the same way, follow steps and refer to appropriate illustration for details.

Removal and Installation

1. Disconnect battery ground cable.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

2. Using Rotunda 034-00001 Fuel Storage Tanker or equivalent drain fuel tank. Drain both tanks on dual-tank vehicles.
3. Raise vehicle on hoist.

REMOVAL AND INSTALLATION (Continued)

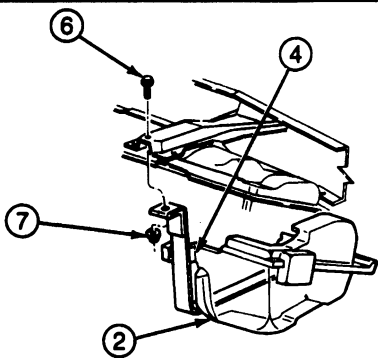
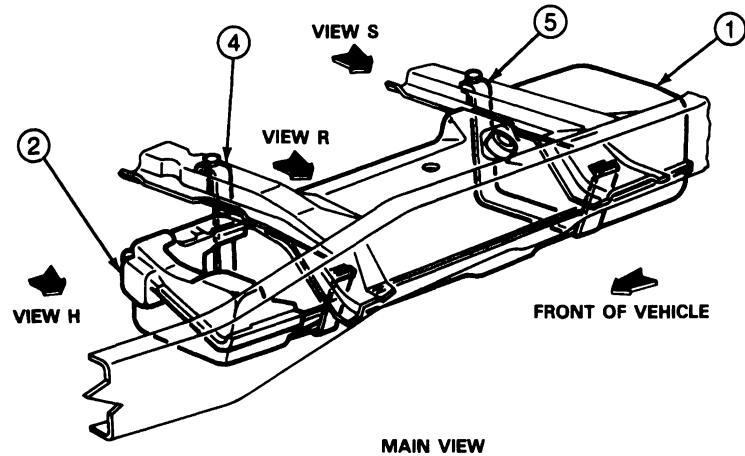
4. If equipped with skid plate, remove fasteners and remove skid plate assembly.
5. Loosen clamps and disconnect fuel filler hose and overflow hose at tank.
6. Position suitable jack under tank.
7. Remove nuts and bolts and lower straps. If necessary, turn strap approximately 30 degrees and remove.
8. Lower tank enough to gain access to fuel connections.

9. Disconnect fuel delivery module (FDM) electrical connector.
10. Disconnect fuel vapor hose(s) from port valve(s). If equipped, remove vent hose from clip on frame.
11. Disconnect fuel supply and return lines according to instructions for push connectors in this section.
12. Remove fuel tank from vehicle.

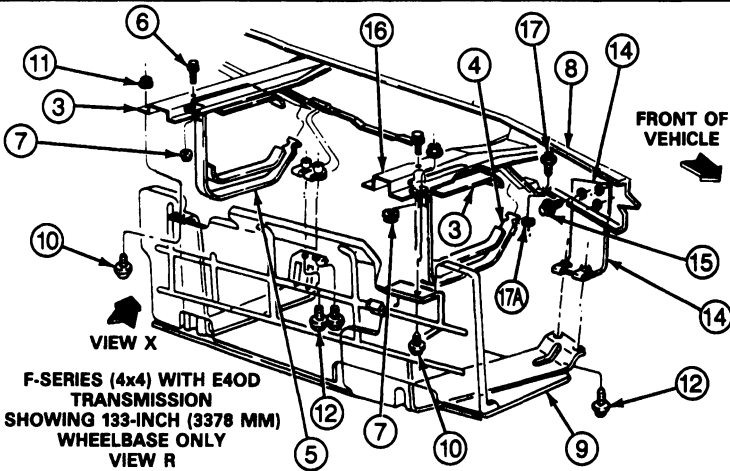
For installation follow removal procedures in reverse order. Refer to the following illustration for tightening specifications.

REMOVAL AND INSTALLATION (Continued)

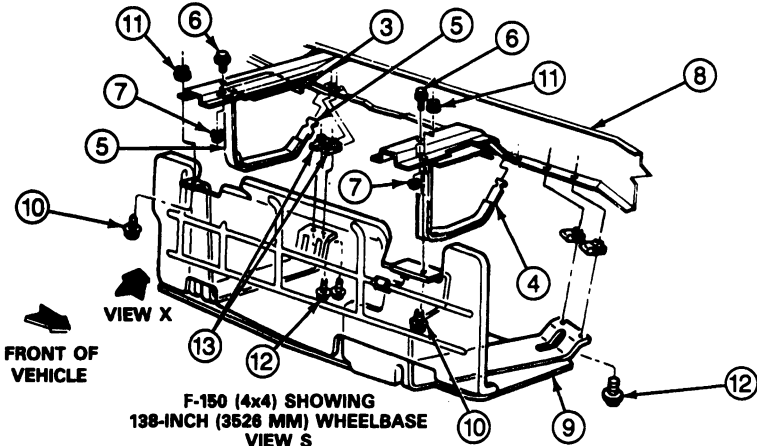
Midship Fuel Tank Installation, F-150-250-350 and F-Super Duty Chassis Cab, 116- and 138-Inch Wheelbase



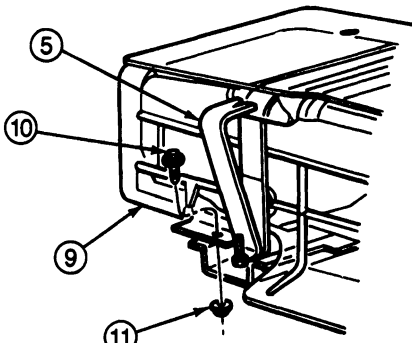
*USE ESB-M2G116-A ADHESIVE
TO ATTACH INSULATORS TO STRAPS
AND FRAME SUPPORTS
VIEW H



F-SERIES (4x4) WITH E40D
TRANSMISSION
SHOWING 133-INCH (3378 MM)
WHEELBASE ONLY
VIEW R



F-150 (4x4) SHOWING
138-INCH (3528 MM) WHEELBASE
VIEW S



VIEW X

V3062-K

Item	Part Number	Description
1	9002	Tank Assembly
2	9K014	Shield Assembly
3	9240	Insulator Upper

(Continued)

Item	Part Number	Description
4	9054	Strap, Front
5	9057	Strap, Rear
6	N802253-S2	Bolt

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
7	N620481-S	Nut 30-41 N·m (22-30 Ft-Lb)
8	5005	Frame Assembly
9	9A147	Skid Plate Heat Shield
10	N605906-S20	Bolt
11	N620481-S2	Nut 16-24 N·m (12-17 Ft-Lb)
12	N605906-S2	Bolt 16-24 N·m (12-17 Ft-Lb)

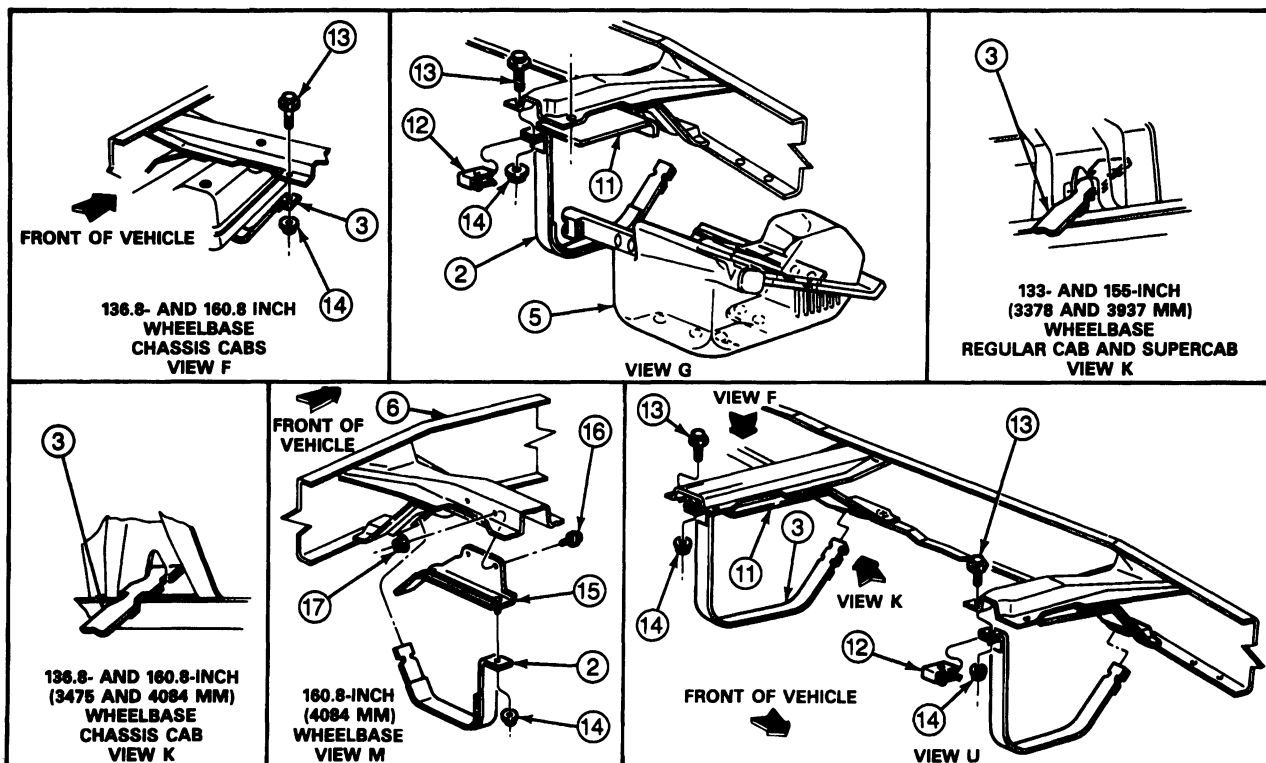
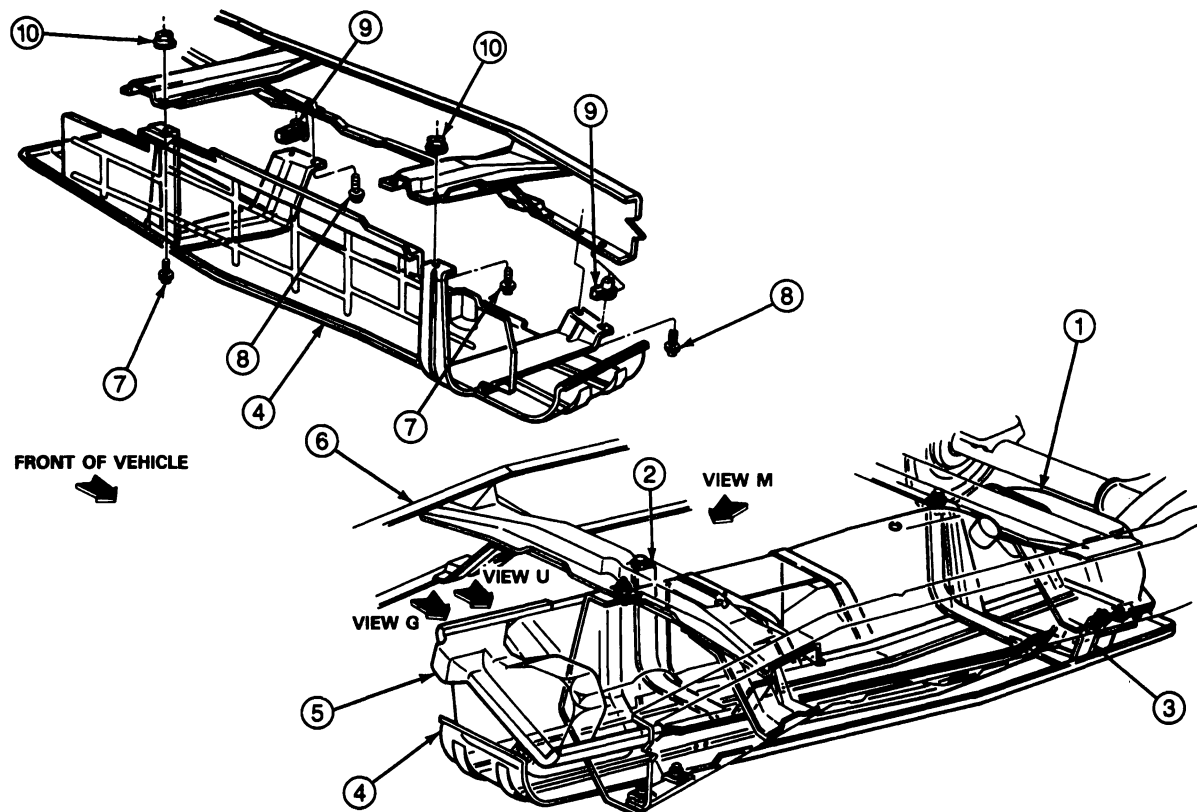
(Continued)

Item	Part Number	Description
13	N804340-S2	U-Nut
14	9C038	Bracket
15	N605906-S2	Bolt 16-24 N·m (12-17 Ft-Lb)
16	9061	X Member, Fuel Tank
17	N605919-S2	Bolt
17A	N620482-S56	Nut 35-49 N·m (26-36 Ft-Lb)

TV3052A

REMOVAL AND INSTALLATION (Continued)

Midship Fuel Tank Installation, F-150-250-350 and F-Super Duty Chassis Cab



V8232-B

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9002	Fuel Tank
2	9054	Strap, Front
3	9057	Strap, Rear
4	9A148	Skid Plate
5	9K014	Shield
6	5005	Frame Assembly
7	N605906-S2	Bolt
8	N605906-S2	Bolt 16-24 N-m (12-17 Ft-Lb)
9	N804340-S2	U-Nut

(Continued)

Item	Part Number	Description
10	N620481-S2	Nut 16-24 N-m (12-17 Ft-Lb)
11	9240	Insulator, Upper
12	N801107-S100	U-Nut
13	N802253-S2	Bolt 30-41 N-m (23-30 Ft-Lb)
14	N620482-S2	Nut 30-41 N-m (23-30 Ft-Lb)
15	9065	Bracket
16	N605906-S2	Bolt
17	N620481-S2	Nut 22-28 N-m (17-20 Ft-Lb)

TV8232A

Aft-of-Axle Fuel Tank**Removal and Installation**

1. Raise the rear of the vehicle.
2. To avoid electrical sparking at the tank, disconnect battery ground cable. Then disconnect the fuel delivery module connector (FDM) near the fuel tank.
NOTE: On vehicles equipped with EEC, when the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
3. Using Rotunda 034-00001 Fuel Storage Tanker or equivalent, drain fuel tank. Drain both tanks on dual tank vehicles.
4. Disconnect the fuel line push-connect fittings at the FDM.
5. Loosen the clamp on the fuel filler pipe. Disconnect the filler pipe hose by pulling along the rubber inner tube from the tank filler neck.
6. If removing the metal-type tank, support the tank and remove the bolts attaching the tank supports to the frame. Carefully lower the tank and disconnect the vent tube(s) from the vapor emission control valve in the top of the tank. Finish removing the filler pipe and filler pipe vent hose if not possible in Step 5. Remove the tank from under the vehicle.

7. If removing the plastic-type tank, support the tank and remove the bolts attaching the combination skid plate and tank support to the frame. Carefully lower the tank and disconnect the vent tube(s) from the vapor emission control valve in the top of the tank. Complete removing the filler pipe if not possible in Step 5. Remove the skid plate and tank from under the vehicle. Disassemble the skid plate from the tank.

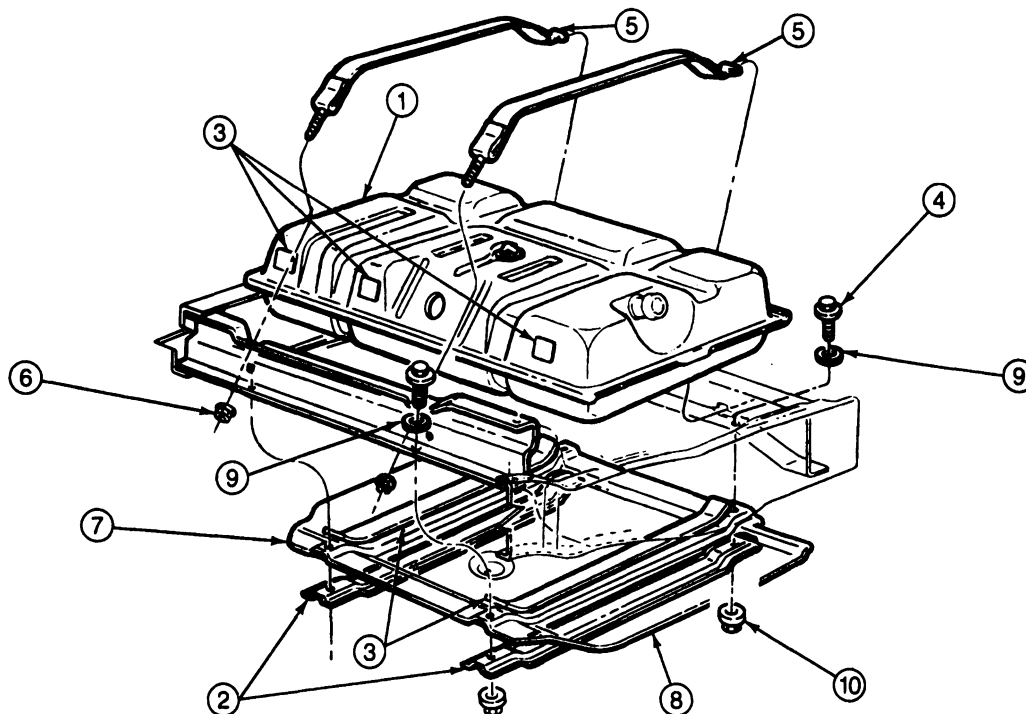
For installation, follow removal procedures in reverse order. Use a thread adhesive (such as Loctite™ or equivalent) on metal tank attaching nuts and bolts. Refer to the following illustrations for tightening specifications.

NOTE: When installing the fuel tank, grasp the three hoses about 300mm (12 inches) forward of the crossmember. Hold the hoses taut while installing the fuel tank. This will prevent the fuel lines from becoming kinked which will cause restricted fuel flow.

CAUTION: Care must be taken when installing the fuel tank to make sure the fuel lines do not become kinked.

REMOVAL AND INSTALLATION (Continued)

Steel Aft-of-Axle Tank Installation, F-150-250-350, 116-, 113-, 138- and 115-Inch Wheelbase



V3201-L

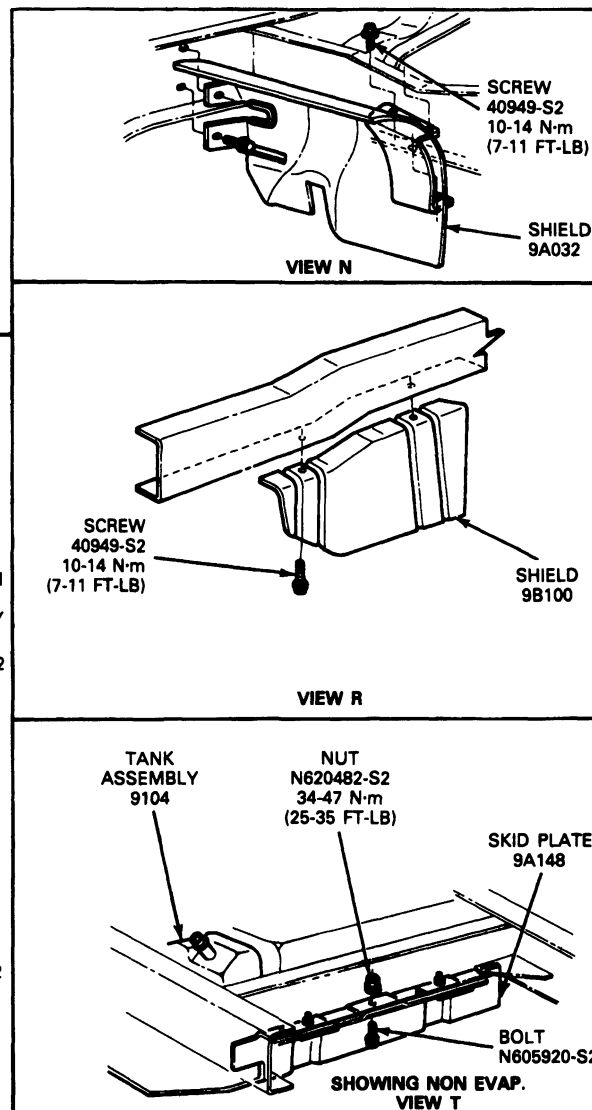
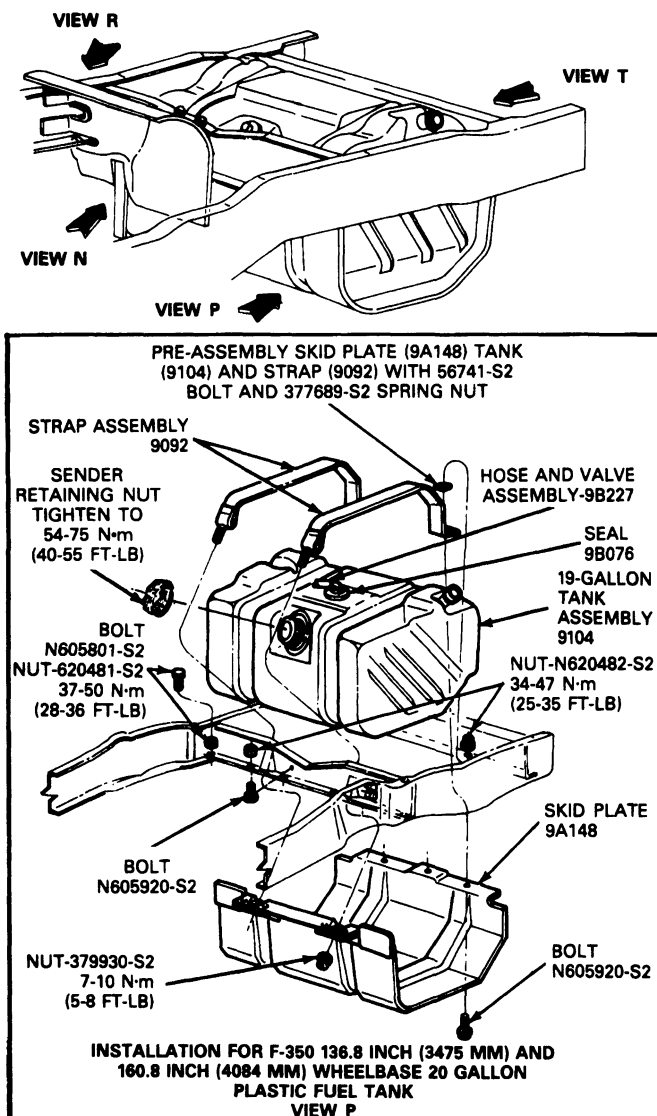
Item	Part Number	Description
1	9240	Fuel Tank Assembly
2	9A017	Support Assembly, Lower
3	—	Insulator, Part of 9240 Tank Assembly
4	N801380-S100	Bolt

(Continued)

Item	Part Number	Description
5	9092	Strap, Upper
6	34976-S362	Nut
7	9K015	Stone Shield, RH
8	9C045	Stone Shield, LH
9	382873-S2	Washer
10	N620482-S2	Nut 37-50 (28-36 Ft-Lb)

REMOVAL AND INSTALLATION (Continued)

Plastic Aft-of-Axle Tank Installation, F-350, 136.8- and 160.8-Inch Wheelbase



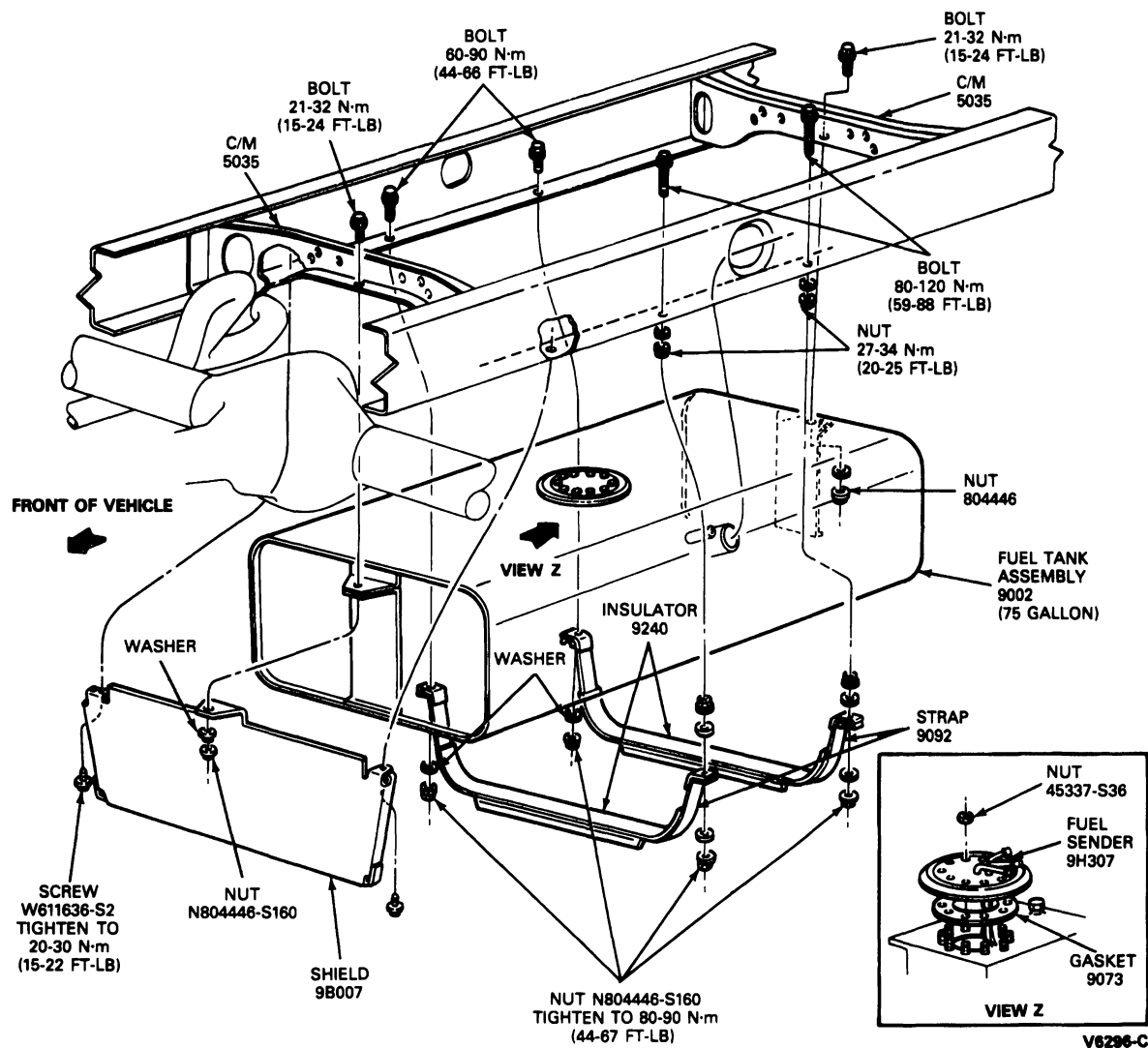
V3057-M

Aft-Of-Axle Fuel Tank, F-Super Duty Motorhome Chassis

Refer to the following illustration.

REMOVAL AND INSTALLATION (Continued)

F-Super Duty Motorhome Chassis, Aft-of-Axle 75-Gallon Tank

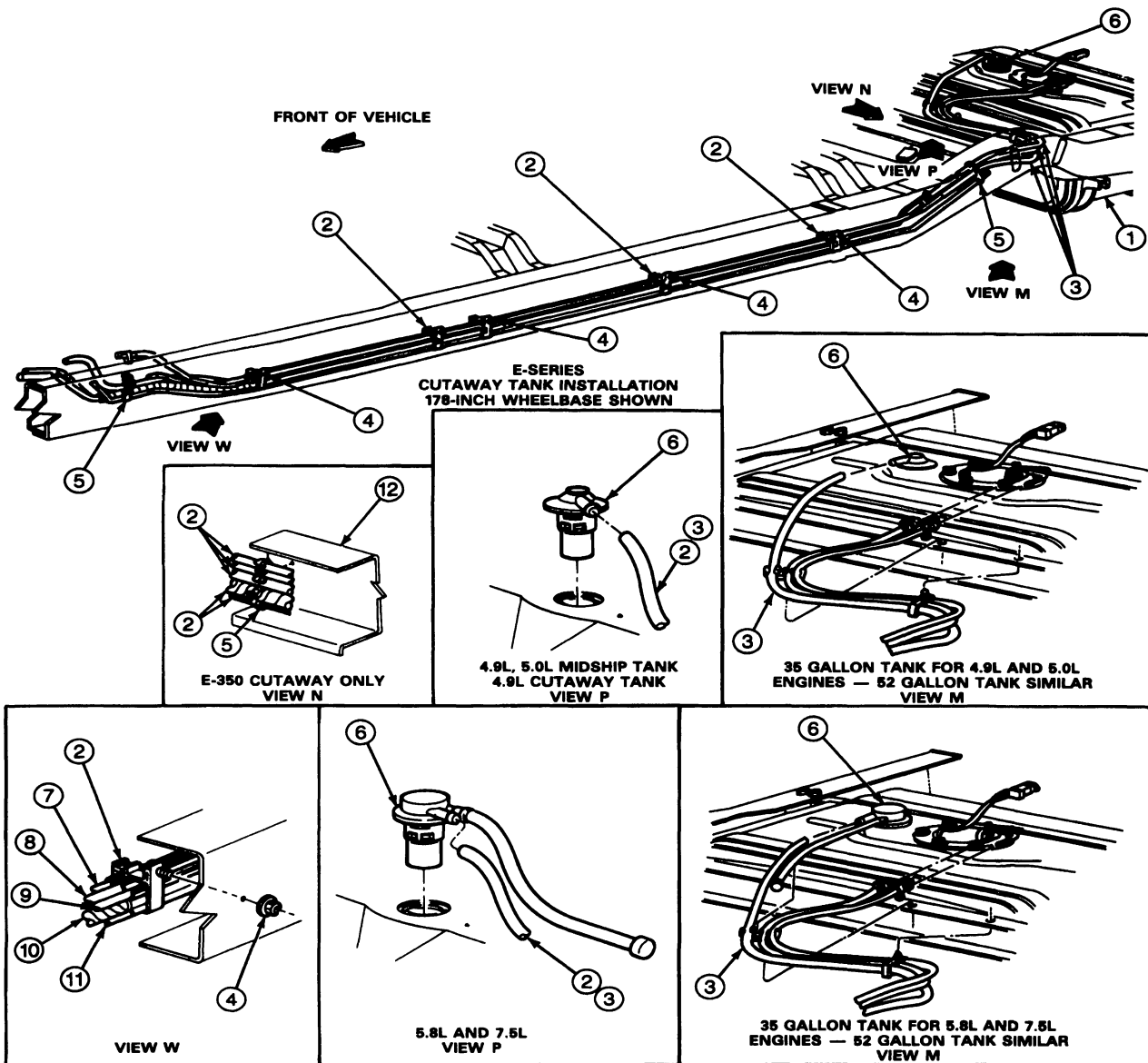


Fuel Line Illustrations, E-Series

Refer to the following illustrations for fuel supply, return, and vapor line routing and component location. Refer to fuel line component removal and installation procedures in this section.

REMOVAL AND INSTALLATION (Continued)

Fuel Lines, Aft-of-Axle Mounted Fuel Tanks, E-Series Cutaway



V9141-A

Item	Part Number	Description
1	9002	Tank Assembly, Fuel
2	9S293	Organizer Assembly, Fuel, Brake and Electrical
3	9S296	Tube Assembly, Fuel Tank
4	N620480-S2	Nut 8-10 N-m (6-7 Ft-Lb)
5	9N589	Clip
6	9B227	Valve and Hose Assembly, Fuel Vapor

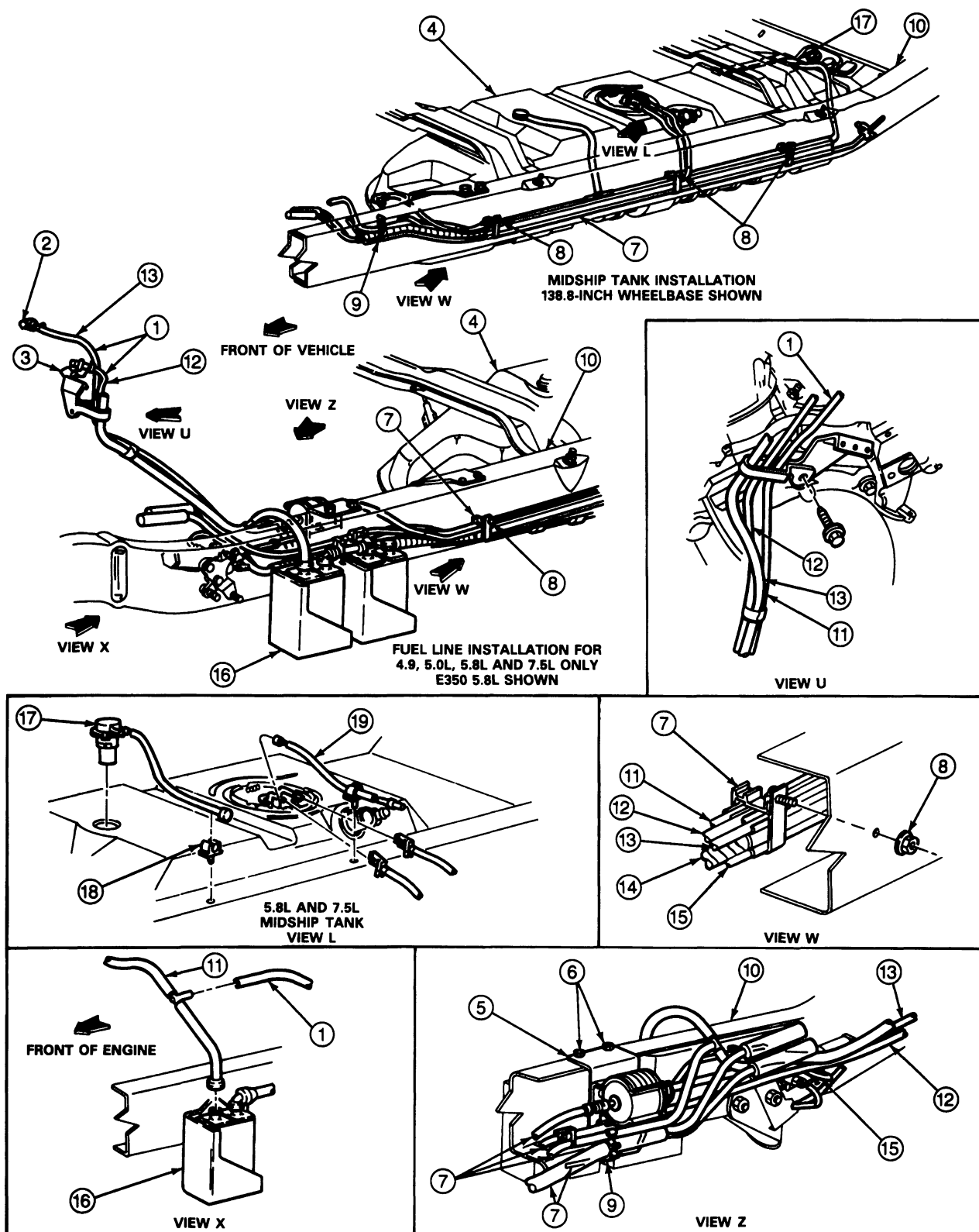
Item	Part Number	Description
6	9B593	Valve Assembly, Fuel Vapor
7	—	Fuel Vapor Line
8	—	Fuel Return Line
9	—	Fuel Supply Line
10	—	Electrical
11	—	Brake Line
12	5005	Frame Assembly

(Continued)

TV9141A

REMOVAL AND INSTALLATION (Continued)

Fuel Lines, Midship Mounted Fuel Tank, E-150-250-350



V9142-A

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9B325	Tube Assembly, Front Fuel Line
2	N805528-S190	Clip 1/2-inch (Black)
3	N805526-S190	Clip 3/8-inch (Silver)
4	9002	Tank Assembly, Fuel
5	9A335	Bracket Assembly, Fuel Filter — E-350
5	5361	Bracket Assembly, Fuel Filter — E-150-E-250
6	W611645-S2	Screw 20-25 N·m (15-18 Ft-Lb)
7	9S293	Organizer Assembly, Fuel, Brake and Electrical
8	N620480-S2	Nut 8-10 N·m (6-7 Ft-Lb)
9	9N589	Clip

(Continued)

Item	Part Number	Description
10	5005	Frame Assembly
11	—	Fuel Vapor Line
12	—	Fuel Return Line
13	—	Fuel Supply Line
14	—	Electrical
15	—	Brake Line
16	9D653	Vapor Canister
17	9B593	Valve Assembly, Fuel Vapor — Midship Tank
18	N806683-S190	Clip
19	9S303	Tube Assembly, Fuel Tank Auxiliary Drain — For Heavy Duty Service E-350 School Bus and RV Conversion Only

TV9142A

Fuel Tanks, E-Series

Aft-of-Axle Fuel Tank, E-Series Cutaway

Removal and Installation

1. Disconnect battery ground cable.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

2. Using Rotunda 034-00001 Fuel Storage Tanker or equivalent, drain fuel tank.
3. Raise vehicle on hoist.
4. Position suitable jack under tank.
5. Remove screws and nuts from fuel tank shield.
NOTE: On 55 gallon tank, shield does not have to be removed to lower tank.
6. Loosen clamps and disconnect filler tube and overflow hoses at filler tube end.

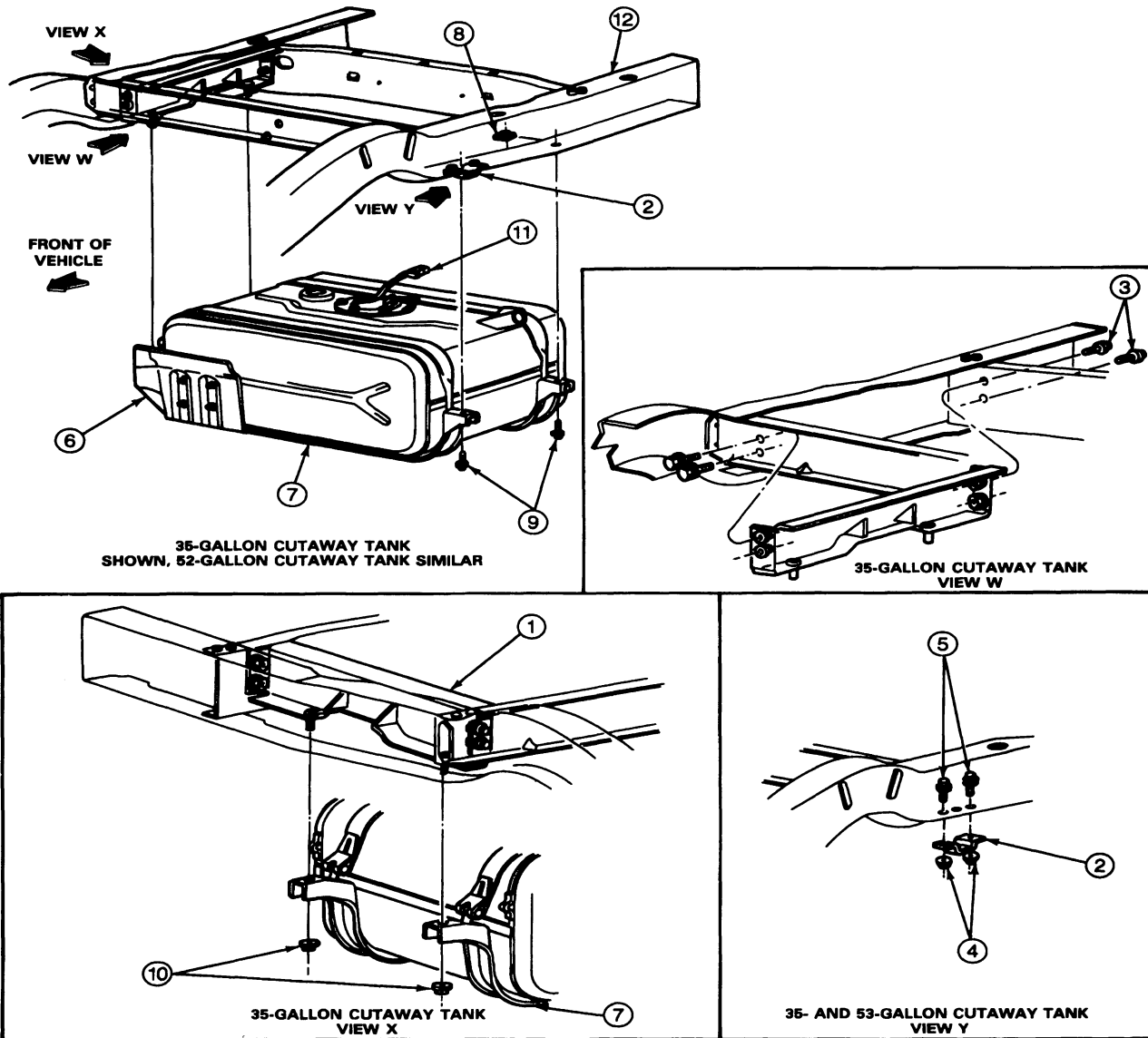
CAUTION: On 55 gallon tank, loosen strap nuts enough to relieve strap tension. (If tension is not relieved lower support arms will deform upward, making installation difficult.)

7. Lower tank.
8. Disconnect fuel pump and sending unit electrical connector.
9. Disconnect fuel vapor hose from fuel vapor valve. Remove short vapor vent hose (5.8L and 7.5L) from grommet in frame.
10. Disconnect fuel supply and return lines according to instructions for push connectors in this section.
11. Remove fuel tank from vehicle.

For installation, follow removal procedures in reverse order. Refer to the following illustration for tightening specifications.

REMOVAL AND INSTALLATION (Continued)

Aft-of-Axle Fuel Tank Installation, E-Series Cutaway



V9143-A

Item	Part Number	Description
1	9A017	Support Assembly, Fuel Tank
2	9071	Spacer, Fuel Tank Bracket
3	N802115-S2	Bolt 87-119 N-m (65-87 Ft-Lb)
4	N801206-S2	Nut 59-81 N-m (44-59 Ft-Lb)
5	N803942-S2	Bolt
6	9A032	Heat Shield, Fuel Tank

(Continued)

Item	Part Number	Description
7	9002	Fuel Tank Assembly
8	N807463-S2	Nut and Retainer
9	N802115-S2	Bolt 87-119 N-m (65-87 Ft-Lb)
10	N802073-S2	Nut
11	9H307	Sender and Pump Assembly, Fuel Tank
12	5005	Frame Assembly

TV9143A

REMOVAL AND INSTALLATION (Continued)**Midship Fuel Tank, E-150-250-350****Removal and Installation**

1. Disconnect battery ground cable.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

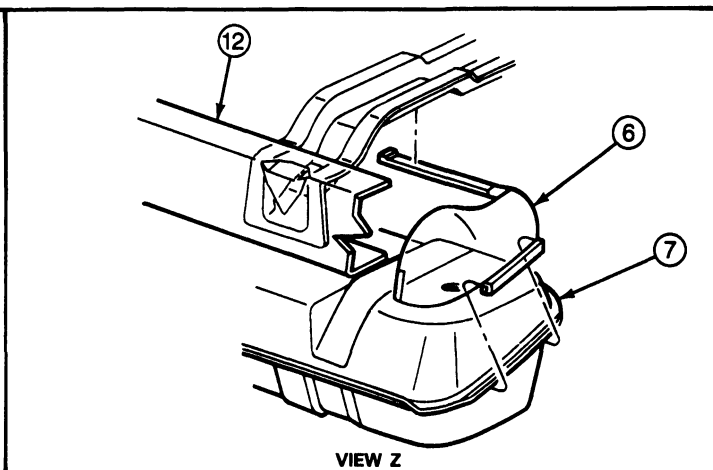
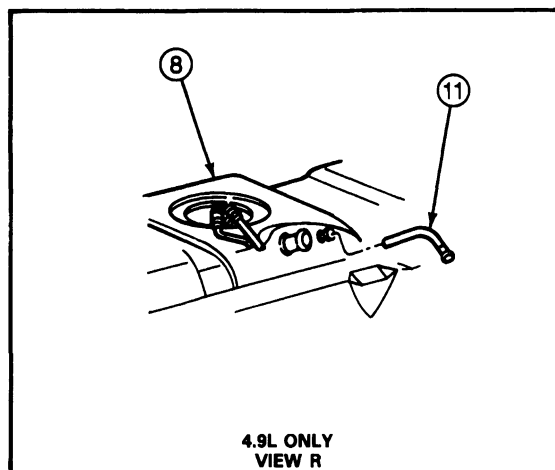
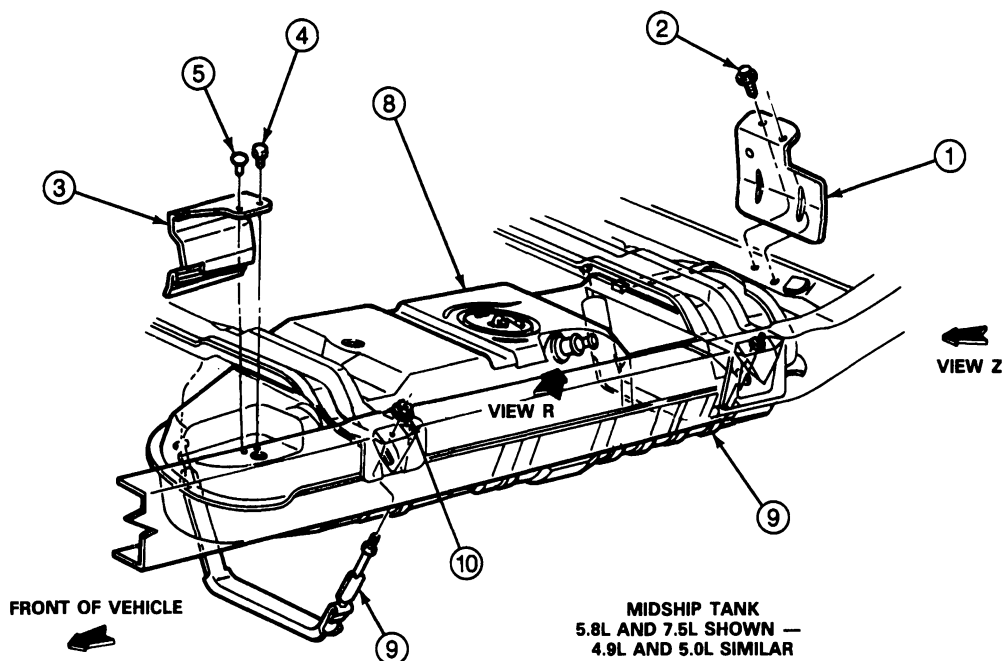
2. Raise vehicle on hoist.
3. Using Rotunda 034-00001 Fuel Storage Tanker or equivalent drain fuel tank by removing rear vapor valve.
NOTE: Push valve down and twist 90 degrees to remove.
4. Loosen clamps and disconnect fuel filler hose and overflow hose at filler assembly.
5. Disconnect fuel delivery module (FDM) electrical connector.

6. Position suitable jack under tank.
7. Remove two nuts and lower straps. If it is necessary to remove straps, turn T-bolts which are part of the straps 90 degrees and take out.
8. Lower tank enough to gain access to fuel connections.
9. Disconnect fuel vapor hose from port valve. Remove vent hose from clip on frame of 5.8L and 7.5L engine vehicles.
10. Disconnect fuel supply and return lines according to instructions for push connectors in this section.
11. Remove fuel tank from vehicle.
12. Loosen clamps and remove filler and overflow hoses from tank.

For installation, follow removal procedures in reverse order. Refer to the following illustration for tightening specifications. Install filler hose with stripes in line with dimples on tank.

REMOVAL AND INSTALLATION (Continued)

Midship Fuel Tank Installation, E-150-250-350



V8682-B

Item	Part Number	Description
1	9B212	Shield, Fuel Tank Rear
2	N611184-S2	Screw 10-14 N·m (8-10 Ft-Lb)
3	9K014	Shield Assembly, Fuel Tank
4	N800369-S2	Screw and Washer 6-7 N·m (53-61 In-Lb)
5	388930	Push Pin
6	9K014	Shield Assembly, Fuel Tank

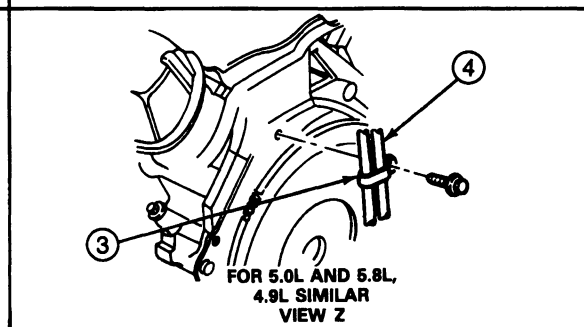
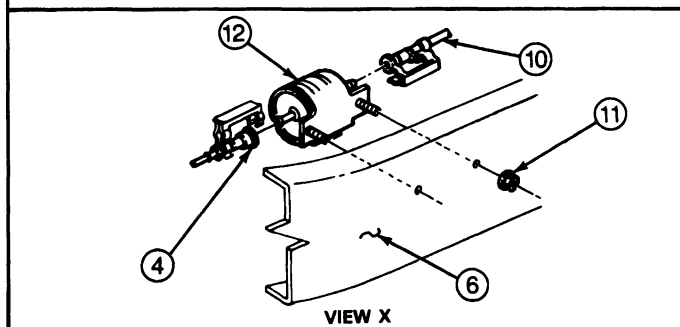
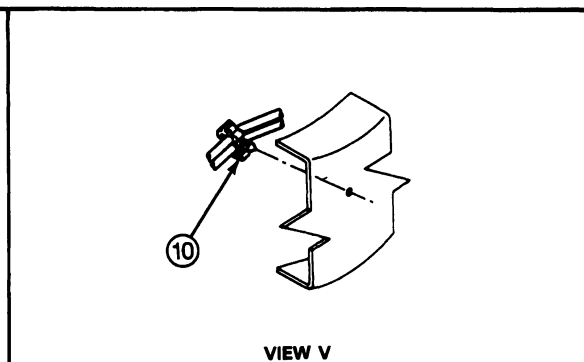
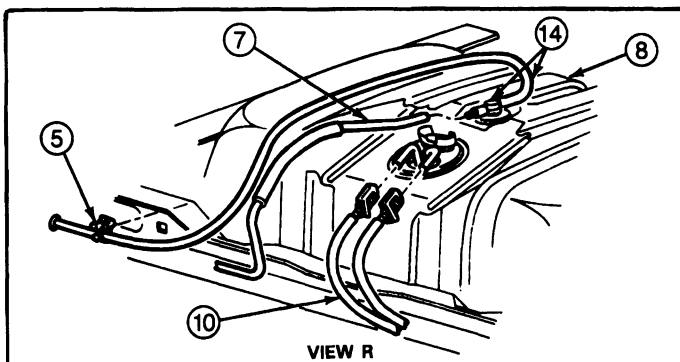
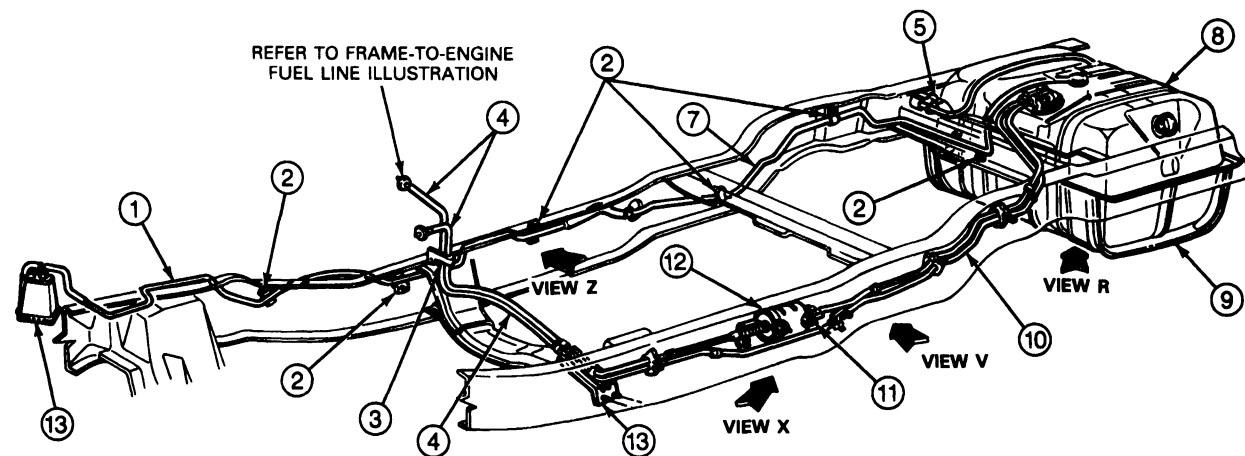
(Continued)

Item	Part Number	Description
7	9A017	Support Assembly, Fuel Tank
8	9002	Fuel Tank Assembly — Midship
9	9054	Strap Assembly, Fuel Tank
10	N820482-S2	Nut and Washer Assembly 17-23 N·m (13-16 Ft-Lb)
11	9B023	Insert, Fuel Tank Vent Tube
12	5005	Frame Assembly

TV8682A

REMOVAL AND INSTALLATION (Continued)**Fuel Line Illustrations, Bronco**

Refer to the following illustrations for fuel supply, return and vapor line routing and component location. Refer to fuel line component removal and installation procedures in this section.

Fuel Lines Installation, Bronco (Includes Fuel Vapor Lines)

V8684-B

Item	Part Number	Description
1	9C016	Tube & Hose Assembly, Fuel Tank Vapor
2	9F274	Clip
3	9D319	Front Support Bracket
4	9J338	Tube Assembly — Fuel Supply and Return
5	370443-S32	Clip
6	Ref.	Frame Rail

(Continued)

Item	Part Number	Description
7	9C015	Tube and Hose Assembly, Fuel Tank Vapor
8	9002	Fuel Tank
9	9A017	Support Assembly
10	9S278	Tube Assembly — Rear
11	N620480-S2	Nut 8-10 N-m (6-7 Ft-Lb)
12	9A335	Filter Assembly
13	9D653	Charcoal Canister

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
14	9C987	Hose and Valve Assembly, Fuel Vapor Return — 4.9L and 5.0L Engines

(Continued)

Item	Part Number	Description
14	9B227	Hose and Valve Assembly, Fuel Vapor Return — 5.8L Engine

TV8684A

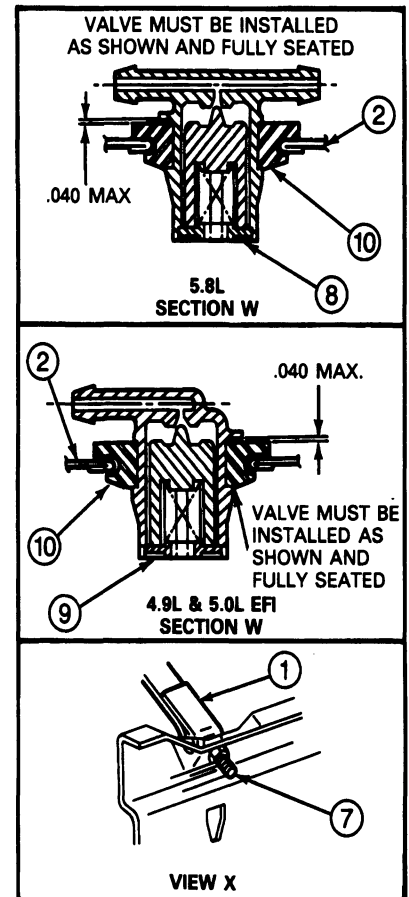
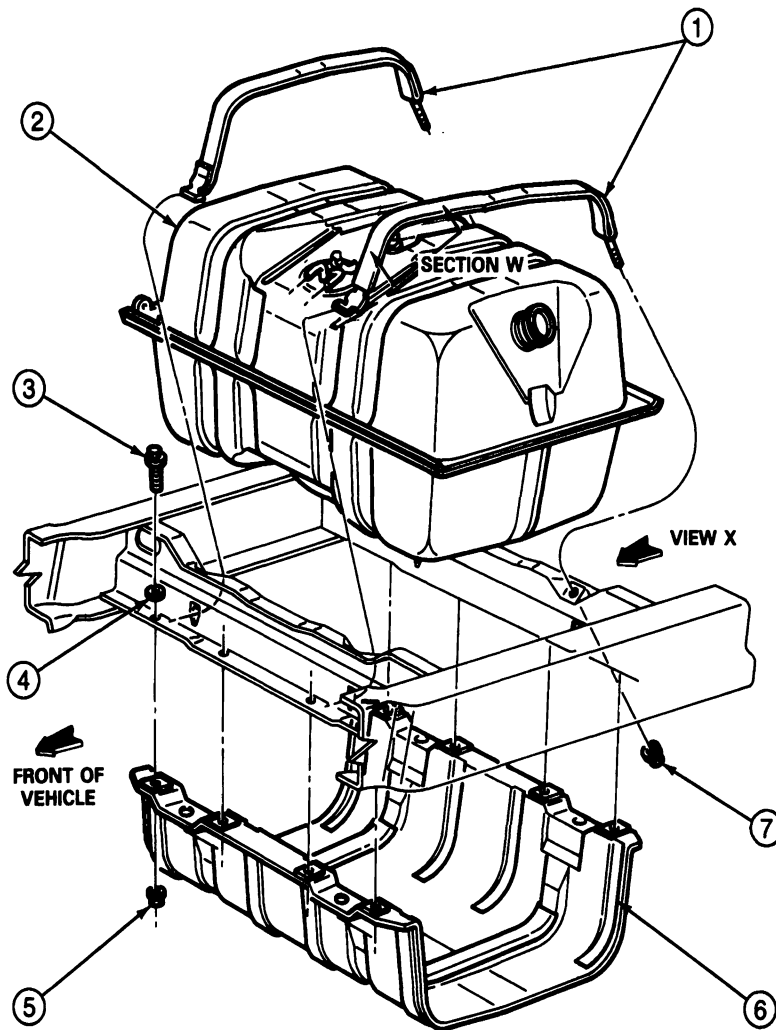
Fuel Tanks, Bronco**Removal and Installation**

1. To avoid electrical sparking at the tank, disconnect battery ground cable.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
2. Using Rotunda 034-00001 Fuel Storage Tanker or equivalent drain fuel tank.
3. Raise the rear of the vehicle.
4. Loosen the clamp on the fuel filler pipe hose at the filler pipe and disconnect the hose from the pipe by pulling along the internal fuel tube from the tank filler neck.

5. Disconnect fuel delivery module (FDM) connector.
 6. Disconnect fuel line push connectors and fuel vapor lines as outlined in this section.
 7. Support the tank and remove the lower support bracket bolts or skid plate bolts. Remove the support assembly or skid plate attaching nut at each tank mounting strap. Lower the support assemblies, and lower the tank enough to gain access to the tank vent hose.
 8. Remove the fuel tank from under the vehicle.
- For installation, follow removal procedures in reverse order. Refer to the following illustration for tightening specifications.

REMOVAL AND INSTALLATION (Continued)

Aft-of-Axle Fuel Tank Installation, Bronco (4x4)



V8234-C

Item	Part Number	Description
1	9057	Strap Assembly, Fuel Tank Rear
2	9002	Fuel Tank Assembly, 32 Gallon
3	N801380-S100	Bolt
4	382873-S2	Washer
5	N620482-S2	Nut 37-50 N·m (28-36 Ft·Lb)

(Continued)

Item	Part Number	Description
6	9A017	Support Assembly, Fuel Tank Nut
7	34976-S36	
8	9B227	Hose and Valve Assembly, Fuel Vapor Return
9	9C987	Hose and Valve Assembly, Fuel Vapor Return
10	9B076	Seal, Separator Fuel Vapor

TV8234A

REMOVAL AND INSTALLATION (Continued)**Filler Pipes****F-150-250-350, Bronco and E-Series Cutaway and Stripped Chassis**

Procedures are the same for the aft-of-axle and midship fuel filler pipe.

Removal

1. Drain fuel to a level (approximately 3 / 4 full) below the fuel tank filler connection by using the fuel hose at the fuel pump-to-fuel tube connection.
2. On Econoline, loosen clamp attaching filler pipe to tank fuel filler neck and vent hoses.
3. Detach fuel filler pipe from support bracket and disconnect fuel filler and vent hoses.
4. On F-Series, loosen clamp attaching filler pipe and disconnect hose from the pipe, pulling the internal fuel tube from tank filler neck.
5. Remove the three retainer screws that attach the filler pipe flange to the fuel filler housing.
6. Remove fuel filler pipe from vehicle.
7. Remove hose and clamps. Replace all damaged or worn parts.

Installation

1. Position fuel filler pipe in vehicle, being careful to position neck on vehicles with internal vent tube.
2. Position fuel filler vent hoses on filler pipe of vehicles with external vent hose.
3. Position clamps on filler pipe and vent hoses.
4. Secure fuel filler pipe to mounting brackets. For F-150-250-350 and Bronco, tighten screws to 2-3 N·m (15-25 in-lb).
5. Adjust hose to obtain snug filler pipe installation. Tighten hose clamps to 3-4 N·m (25-35 in-lb). Make certain clamps are forward of flange on filler pipe to ensure a leakproof connection.
6. Fill tank with fuel. Install filler cap; check for leaks.

E-150-250-350 Vans and Club Wagons**Removal**

1. Disconnect battery to prevent possible sparking.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

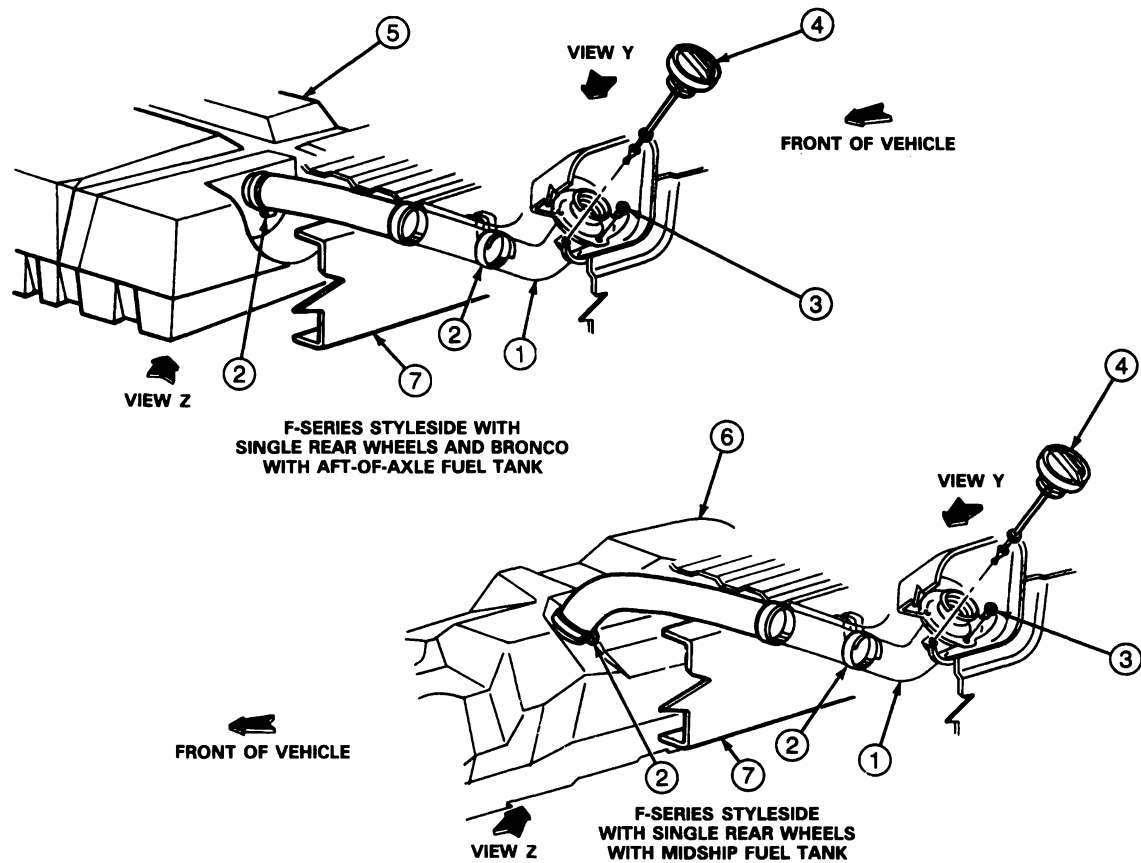
2. Drain the fuel into a suitable container by siphoning through the fuel hose at the supply line at the fuel reservoir connection.
3. Remove the three retainer screws that attach the filler pipe flange to the fuel filler pipe housing.
4. Loosen the clamps that attach the filler pipe to the fuel filler hose and the fuel vent hose. Disconnect the hoses.
5. Loosen the clamp that attaches the filler pipe to the support bracket at the underbody flange (aft / axle only).
6. Remove the fuel filler pipe assembly by rotating it through the opening in the underbody below the body housing assembly.

Installation

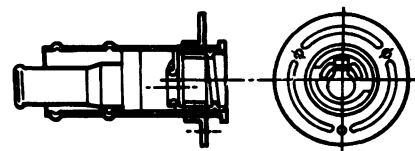
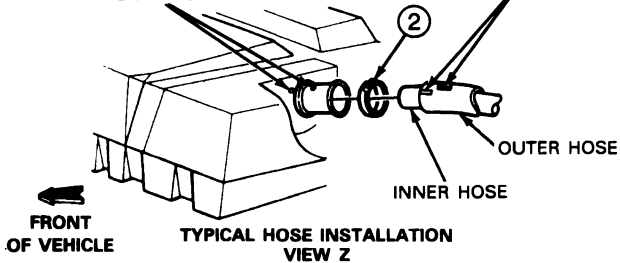
1. Install the fuel filler pipe assembly by inserting it through the underbody opening and rotating it to butt the pipe flange against the fuel filter pipe housing.
2. Attach the pipe flange to the fuel filter pipe housing with three retaining screws. Tighten screws to 3-4 N·m (25-35 in-lb).
3. Tighten the clamps that attach the filler pipe to the support bracket at the underbody flange to 3-4 N·m (25-35 in-lb) (aft / axle only).
4. Connect the fuel filler hose and the fuel vent hose to the fuel filler assembly. Tighten the attaching clamps to 3-4 N·m (25-35 in-lb).
5. Connect battery.
6. Fill the tank, install fuel filler cap and check all connections for leaks.

REMOVAL AND INSTALLATION (Continued)

Fuel Filler System Installation, Single Rear Wheel Styleside, F-150-250-350 and Bronco

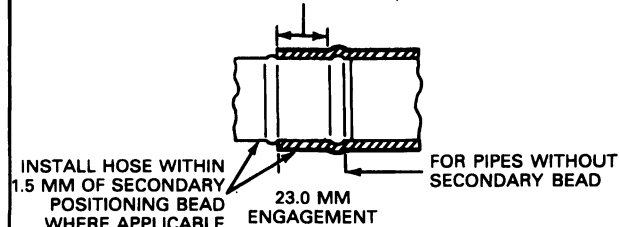


INSTALL HOSE WITH STRIPES IN LINE WITH TWO DIMPLES ON FUEL TANK



FOR UNLEADED FUEL PIPE ASSEMBLY VIEW Y

INSTALL CLAMP IN THIS AREA (BEYOND FIRST BEAD AND BEFORE HOSE END)



V5586-D

REMOVAL AND INSTALLATION (Continued)

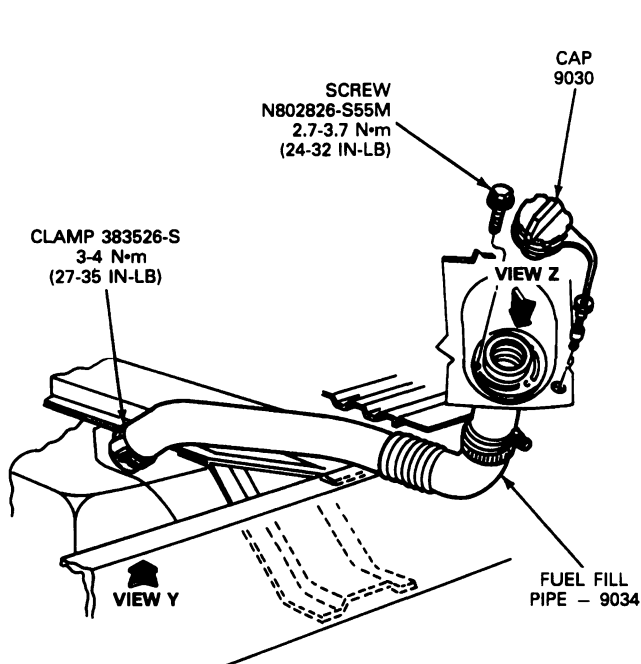
Item	Part Number	Description
1	9034	Pipe Assembly, Fuel Fill
2	383526-S	Clamp
3	N802826-S55M	Screw 3.0-3.5 N·m (27-30 IN·Lb)

(Continued)

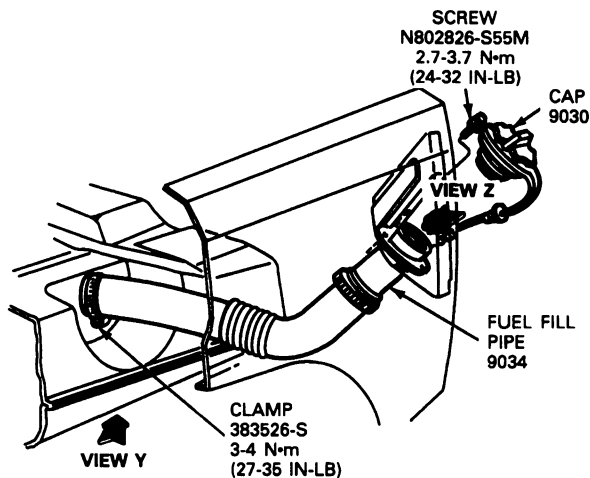
Item	Part Number	Description
4	9030	Cap
5	9104	Tank Assembly, Aft Axle
6	9002	Tank Assembly, Midship
7	5005	Frame Assembly

TV5586A

Fuel Filler System Installation, Single Rear Wheel Flareside, F-150



MIDSHIP FUEL TANK INSTALLATION

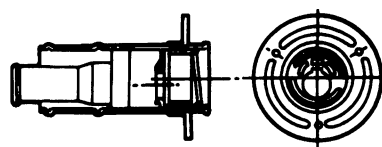
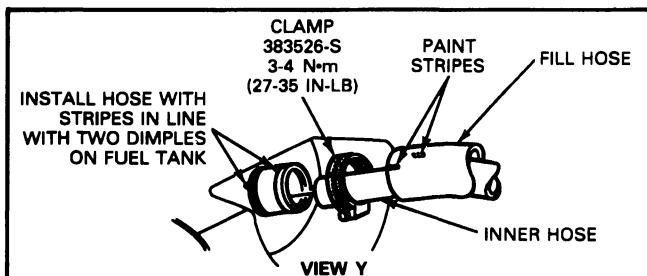
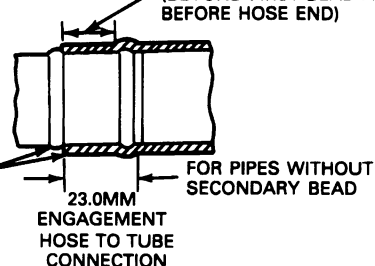


FRONT OF VEHICLE

AFT-OF-AXLE FUEL TANK INSTALLATION

INSTALL CLAMP IN THIS AREA
(BEYOND FIRST BEAD AND
BEFORE HOSE END)

INSTALL HOSE WITHIN 1.5 MM
OF SECONDARY POSITIONING
BEAD WHERE APPLICABLE

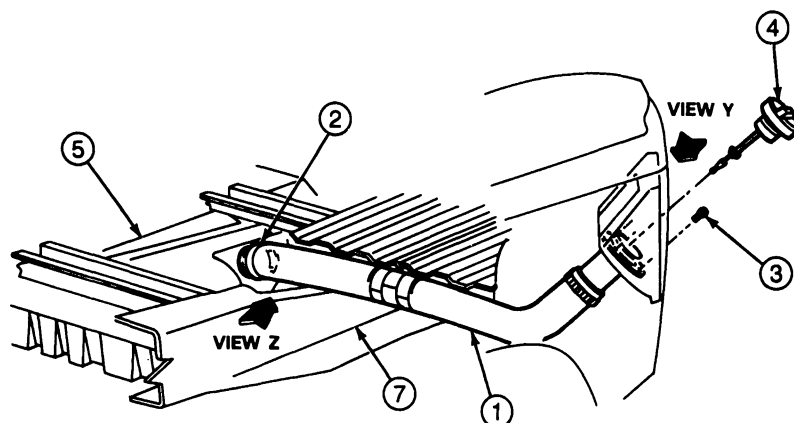


VIEW Z

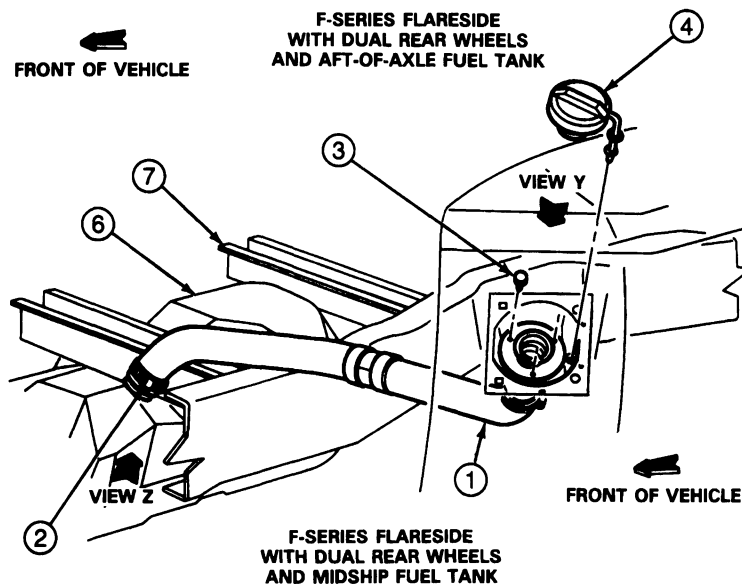
V9146-A

REMOVAL AND INSTALLATION (Continued)

Fuel Filler System Installation, Dual Rear Wheel Flareside, F-150-250-350 and F-Super Duty

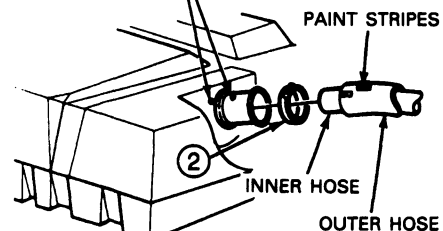


FRONT OF VEHICLE
F-SERIES FLARESIDE
WITH DUAL REAR WHEELS
AND AFT-OF-AXLE FUEL TANK

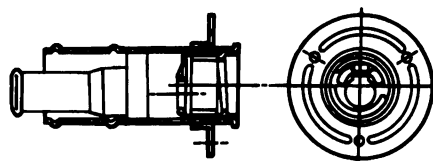


FRONT OF VEHICLE
F-SERIES FLARESIDE
WITH DUAL REAR WHEELS
AND MIDSHIP FUEL TANK

INSTALL HOSE WITH STRIPES IN LINE
WITH TWO DIMPLES ON FUEL TANK



FRONT OF VEHICLE
TYPICAL HOSE INSTALLATION SHOWN
VIEW Z



FOR UNLEADED FUEL PIPE ASSEMBLY
VIEW Y

V5587-C

Item	Part Number	Description
1	9034	Pipe Assembly, Fuel Fill
2	383526-S	Clamp
3	N802826-S55M	Screw 3.0-3.5 N·m (27-30 In-Lb)

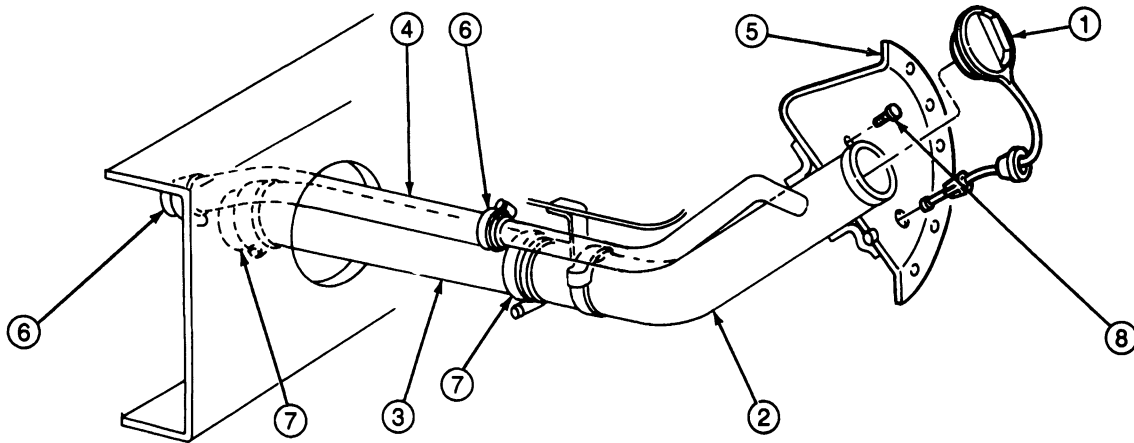
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Item	Part Number	Description
4	9030	Cap
5	9104	Tank Assembly, Aft Axle
6	9002	Tank Assembly, Midship
7	5005	Frame Assembly

TV5587A

REMOVAL AND INSTALLATION (Continued)

Fuel Filler System, Aft-of-Axle, F-Super Duty Commercial and Motorhome Chassis



V8726-B

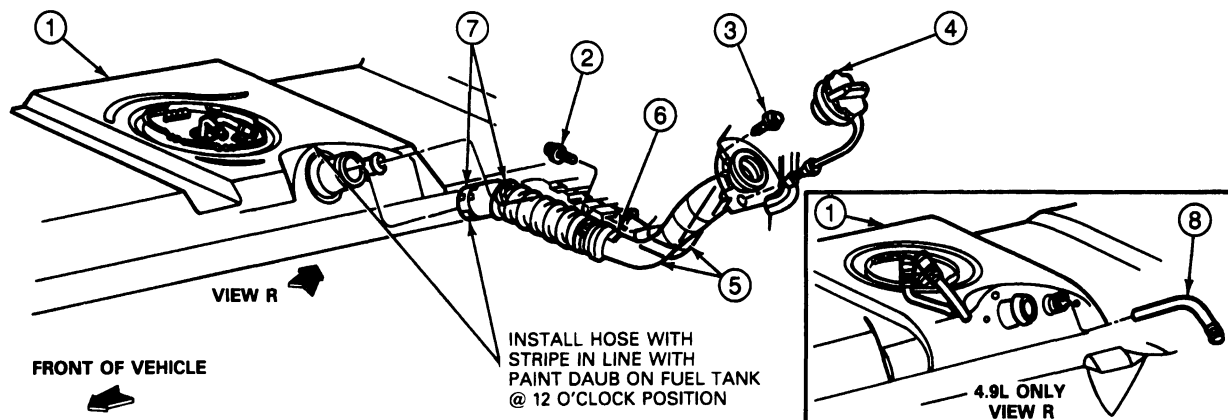
Item	Part Number	Description
1	9030	Cap Assembly, Fuel Tank Filler
2	9034	Pipe Assembly, Fuel Tank Filler
3	9047	Hose, Fuel Tank Filler
4	9170	Hose, Fuel Tank Vent Tube

(Continued)

Item	Part Number	Description
5	9B213	Support, Fuel Tank Filler Pipe
6	383522-S	Clamp
7	383526-S	Clamp
8	N802826-S55M	Screw and Washer 17-28 N·m (15-25 In-Lb)

TV8726A

Fuel Filler System, Midship Tank, E-150-250-350



V9144-A

Item	Part Number	Description
1	9002	Fuel Tank Assembly
2	N611037-S2	Screw 3.5-5.0 N·m (31-44 In-Lb)
3	N802826-S55M	Screw and Washer Assembly

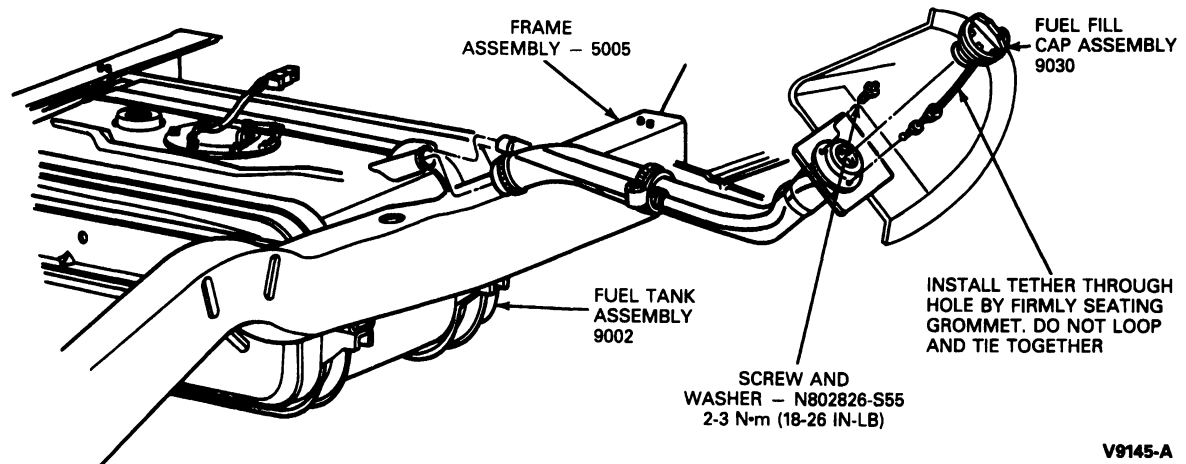
(Continued)

Item	Part Number	Description
4	9030	Cap Assembly, Fuel Fill
5	9034	Pipe Assembly, Fuel Fill
6	9040	Bracket
7	—	Clamp 3-4 N·m (27-35 In-Lb)
8	9B023	Insert, Fuel Tank Vent Tube

TV9144A

REMOVAL AND INSTALLATION (Continued)

Fuel Filler System, Aft-of-Axle Tank, E-150-250-350



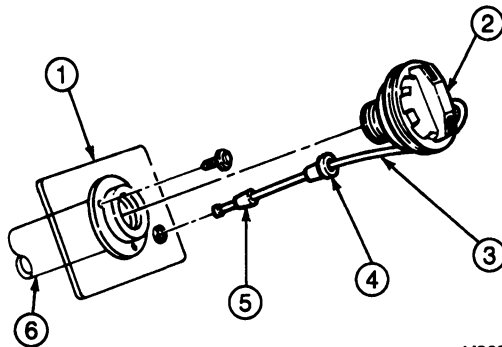
Fuel Filler Cap

Removal

1. Unscrew and remove cap from filler pipe.
2. Pry out grommet from body.
3. Pull out tether with assembled cap and grommet.

Installation

1. Put tether through hole in body.
2. Firmly seat grommet in body. Do not loop or tie tether.
3. Screw cap into filler pipe until it clicks.



Item	Part Number	Description
1	Ref.	Vehicle Body or Bed
2	9030	Fuel Filler Cap Assembly
3	—	Tether (Part of 9030)
4	—	Grommet (Part of 9030)
5	—	Stop (Part of 9030)
6	9034	Fuel Filler Pipe

TV8692A

MAJOR SERVICE OPERATIONS

Evaporative Emission System

WARNING: THE EVAPORATIVE EMISSION SYSTEM CONTAINS FUEL VAPOR AND CONDENSED FUEL VAPOR. ALTHOUGH NOT PRESENT IN LARGE QUANTITIES, IT STILL PRESENTS THE DANGER OF EXPLOSION OR FIRE. DISCONNECT THE BATTERY GROUND CABLE FROM THE BATTERY TO MINIMIZE THE POSSIBILITY OF AN ELECTRICAL SPARK OCCURRING, POSSIBLY CAUSING A FIRE OR EXPLOSION IF FUEL VAPOR OR LIQUID FUEL ARE PRESENT IN THE AREA.

Evaporative emission components have been designed and tested to exceed 193,121 km (120,000 miles) or 10 years of vehicle use. No maintenance or servicing should be required. However, if components have been damaged and are to be replaced, or if disconnection or removal is required for diagnosis, the following techniques should be used to aid servicing the system.

Typical evaporative emission systems are shown in Section 03-13.

Use Ford-approved fuel hoses for replacement of damaged hoses. Original equipment hoses are designed to resist most environmental conditions encountered in the evaporative emission system.

Refer to Section 03-13 for additional evaporative emission system service procedures.

MAJOR SERVICE OPERATIONS (Continued)**Fuel Tanks**

Fuel tanks do not require special service procedures and may be steam-cleaned and /or serviced using standard procedures. After steaming, allow time to thoroughly air dry. The vapor valve assembly and fuel sender assembly should be removed prior to steaming.

CAUTION: Leaks or damage to the polyethylene fuel tanks are not repairable. This applies to certain F-Series with plastic fuel tanks including all polyethylene portions of the tank body and fittings. Tank replacement is the only acceptable service. There are no reliable repair products that meet the same standards as a new tank. Methods which appear to work may not function for the long term or after being subjected to normal use or abuse.

Electric Fuel Pumps

An electric fuel pump is located in the fuel tank. The pump is attached to the fuel tank as part of the sender unit. The fuel tank must be removed or lowered to service the fuel pump. Care should be taken during installation due to the hose and wire routing on the tank. Be sure all hoses and wires are routed properly. Check the fuel line connections for leaks.

NOTE: Remove the fuel pump prior to steaming the fuel tank.

For electric fuel pump service, refer to Fuel Delivery Module (FDM) in the Diagnosis portion of this section.

WARNING: FUEL SUPPLY LINES ON VEHICLES EQUIPPED WITH FUEL INJECTED ENGINES WILL REMAIN PRESSURIZED FOR LONG PERIODS OF TIME AFTER ENGINE SHUT-DOWN. THE PRESSURE MUST BE RELIEVED BEFORE SERVICING THE FUEL SYSTEM.

Refer to Fuel System Pressure Relief in this section.

Replacing Damaged Steel Push Connect Tube Ends

1. Relieve fuel system pressure as outlined. Read the cautionary note prior to relieving the pressure in the fuel system.
2. Using a tube cutter, remove the damaged push connect tube end at a convenient distance from the end.

NOTE: Allow for adequate room to tighten a union with a wrench at this location.

3. Choose a proper replacement push connect tube end.

4. If required, form the new tube end to the same shape as the damaged tube end which was removed.
5. Select the proper size union and attach the new steel tube end to the original tube.
6. Clean off the steel tube end and replace the push connector onto the tube. (A new retainer clip is recommended.)
7. Check that the fuel tubes are properly secured.
8. Start engine and check for leaks.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Lb-Ft
Front Fuel Line Bracket Nuts, F-Series and Bronco	11-15	8-11
Filter Bracket Nuts, F-Series and Bronco	8-10	6-7
Filter Bracket Nuts, F-Super Duty Motorhome Chassis	9-13	7-10
Front and Rear Strap Nuts, F-Series Midship Fuel Tank	30-41	22-30
Skid Plate / Heat Shield Nuts and Bolts, F-Series Midship Fuel Tank	16-24	12-17
Heat Shield Bracket, F-Series Midship Fuel Tank	16-24	12-17
X-Member Nuts, F-Series Midship Fuel Tank	35-49	26-36
Support Assembly Nuts, F-Series and Bronco Aft-of-Axle Fuel Tank	37-50	28-36
Locking Ring, Plastic Fuel Tank Fuel Delivery Module (FDM Pump)	54-75	40-55
Filter Bracket Screws, E-Series	20-25	15-18
Shield, Rear, E-Series Midship Fuel Tank	10-14	8-10
Shield, Front, E-Series Midship Fuel Tank	6-7	(53-61)
Strap Nuts, Front and Rear, E-Series Midship Fuel Tank	17-23	13-16
Strap Bracket Nuts, Front, E-Series Midship Fuel Tank	22-28	17-20
Strap to Frame Bolts, E-Series Cutaway	87-119	65-87
Bracket Spacer Nuts, E-Series Cutaway	59-81	44-59
Fuel Delivery Module (FDM Pump), to Tank Nuts, E-Series Cutaway	9-11	7-8

SPECIFICATIONS (Continued)

Fuel Delivery Module (FDM) Specifications

Engine Condition	4.9L MFI	5.0L MFI	5.8L MFI	7.5L MFI
Engine Running	45-60 PSI 310-415 kPa	30-45 PSI 210-310 kPa	30-45 PSI 210-310 kPa	30-45 PSI 210-310 kPa
Key ON Engine OFF	50-60 PSI 345-415 kPa	35-45 PSI 210-310 kPa	35-45 PSI 210-310 kPa	35-45 PSI 210-310 kPa

STANDARD AND AUXILIARY FUEL TANKS — CAPACITY IN LITERS (GALLONS)

Model		Body Style	Location	Fuel Evap.	Advertised Tank Cap. Refill Liters (Gal.)
Series	W.B. mm (in)				
Vans and Club Wagons — 4.9L Engine	3505 (138)	All	Midship ^a	X X	87 (23)
350 Cutaway & Stripped Chassis ^b	3505 (138) 4018 (158) 4470 (176)	All	Aft / Axle	X	136 (36) ^c
Vans and Club Wagons — All Engines Except 4.9L	3505 (138)	All	Midship ^a	X	132.7 (35)
Bronco (4 x 4)	2660 (104.7)	All	Aft / Axle ^d	X	121 (32)
F-150 (4 x 2)	2967 (116.8)	Reg. Cab	Midship ^a Aft / Axle	X X	62 (16.3) 69 (18.2)
F-150 (4 x 2)	3378 (133.0)	Reg. Cab	Midship ^a Aft / Axle	X X	72 (19) 69 (18.2)
F-150 (4 x 4)	2967 (116.8)	Reg. Cab	Midship ^{aa} Aft / Axle ^a	X X	N/A 69 (18.2)
F-150 (4 x 4)	3378 (133.0)	Reg. Cab	Midship ^{aa} Aft / Axle ^a	X X	72 (19) 69 (18.2)
F-150 (4 x 2)	3526 (138.8)	Super Cab	Midship ^f Aft / Axle	X X	64 (16.5) 69 (18.2)
F-150 (4 x 2)	3937 (155.0)	Super Cab	Midship Aft / Axle ^f	X X	72 (19) 69 (18.2)
F-150 (4 x 4)	3937 (155.0)	Super Cab	Midship ^a Aft / Axle ^{af}	X X	72 (19) 69 (18.2)
F-250 (4 x 2)	3378 (133.0)	Reg. Cab	Midship Aft / Axle ^f	X X	72 (19) 69 (18.2)
F-250 (4 x 2)	3937 (155.0) 4278 (168.0)	Super Cab	Midship Aft / Axle ^f	X X	72 (19) 69 (18.2)
F-250 (4 x 4)	3378 (133.0)	Reg. Cab / W / E4OD	Midship ^a Midship ^{fa} Aft / Axle ^{af}	X X X	72 (19) 62 (16.5) 69 (18.2)
F-250 (4 x 4)	3937 (155.0)	Super Cab	Midship ^a Aft / Axle ^{af}	X X	72 (19) 69 (18.2)
F-350 (4 x 2) and (4 x 4)	3378 (133.0)	Chassis Cab W / E4OD Chassis Cab	Midship Midship ^{da} Aft / Axle ^{af}	X X X	69 (18.2) 62 (16.5) 72 (19)
F-350 (4 x 2) and (4 x 4)	3475 (136.8)	Chassis Cab	Midship Aft / Axle ^{dh}	X X	72 (19) 72 (19)
F-350 (4 x 2) and (4 x 4)	4084 (160.8)	Chassis Cab	Midship Aft / Axle ^{dh}	X X	72 (19) 72 (19)
F-350 (4 x 2) and (4 x 4)	3937 (155.0)	Super Cab	Midship Aft / Axle ^a	X X	72 (19) 69 (15.2)
F-Super Duty	3475 (136.8)	Chassis Cab	Midship Aft / Axle ^a	X X	72 (19) 72 (19)
F-Super Duty	4085 (160.8)	Chassis Cab	Aft / Axle ^a Midship	X X	72 (19) 72 (19)

(Continued)

SPECIFICATIONS (Continued)

STANDARD AND AUXILIARY FUEL TANKS — CAPACITY IN LITERS (GALLONS) (Cont'd)

Model		Body Style	Location	Fuel Evap.	Advertised Tank Cap. Refill Liters (Gal.)
Series	W.B. mm (In)				
F-Super Duty Motorhome Chassis	4521 (178)	Stripped Chassis	Aft / Axle ^b	X	284 (75)
F-Super Duty Motorhome Chassis	5283 (208)	Stripped Chassis	Aft / Axle ^b	X	284 (75)
F-Super Duty Motorhome Chassis	4826 (190)	Stripped Chassis	Aft / Axle ^b	X	284 (75)
	5791 (228)	Stripped Chassis	Aft / Axle ^b	X	284 (75)

a Steel Auxiliary Tank.

b 15 Liters (4 Gal.) Throwaway Standard on RV Chassis / RV Cutaway, Commercial Cutaway, and Commercial Chassis.

c Available on Cutaway and Stripped Chassis Only.

d Standard Skid Plate on 4 x 4 Models.

e Optional Skid Plate Available w / 4 x 4 Models.

f Standard Dual Tanks.


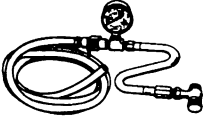


g Standard Plastic Tank (Diesel Only).

h Plastic Auxiliary Tank.

NOTE: All F-Series Aft-of-Axle Fuel Tanks are Standard. Midship (133-Inch [3378mm] and 116.8-Inch [2967mm] wheelbase only) is optional.

TV2386A

SPECIAL SERVICE TOOLS / EQUIPMENT

Tool Number / Description	Illustration
T63P-9171-A Keystone Clamp Pliers	 T63P-9171-A
T80L-9974-B Fuel Pressure Gauge	 T80L-9974-B
T74P-9275-A Fuel Tank Sender Wrench	 T74P-9275-A
T83P-19623-C Spring Lock Coupling Tools — 5/8 inch	 T83P-19623-C

Tool Number	Description
D85L-9974-B	Adapter
D87L-9280-A	Spring-Lock Coupling Tool — 3/8 inch
D87L-9280-B	Spring-Lock Coupling Tool — 1/2 inch

ROTUNDA EQUIPMENT

Tool Number	Description
034-00002	Fuel Storage Tanker

SECTION 10-01B Fuel Tank, Pump, Lines and Filters, Diesel Engines

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION AND OPERATION		REMOVAL AND INSTALLATION (Cont'd.)	
Fuel Selector Valve (Vehicles with Dual Tanks Only)	10-01B-2	Fuel Gauge Sending Unit, Secured with Plastic Locking Ring	10-01B-18
Fuel Supply Pump	10-01B-1	Fuel Line and Hose Components	10-01B-10
Fuel Tank Draining	10-01B-2	Fuel Line Service Procedures	10-01B-45
Fuel Tank Filling	10-01B-2	Fuel Lines	10-01B-46
Fuel Tanks and Lines	10-01B-2	Fuel Lines and Hoses	10-01B-45
Fuel/Water Separator	10-01B-3	Fuel Tubes, Plastic	10-01B-46
Push Connect Fittings	10-01B-2	Splicing Nylon to Nylon	10-01B-46
DIAGNOSIS AND TESTING		Fuel Supply Pump	10-01B-9
Fuel Supply Pump	10-01B-4	Fuel Tanks	10-01B-19
Fuel Valve System	10-01B-6	F-250-350 and F-Super Duty Chassis Cab	10-01B-25
REMOVAL AND INSTALLATION		Major Service Operations	10-01B-45
Connecting Spring Lock Coupling	10-01B-12	Selector Valve, Auxiliary Fuel Tank, F-250-350	10-01B-41
Disconnecting Spring Lock Coupling	10-01B-11	SPECIAL SERVICE TOOLS/EQUIPMENT	10-01B-49
Filler Pipes	10-01B-36	SPECIFICATIONS	
Fuel Filter	10-01B-41	Torque Specifications	10-01B-48
Fuel Gauge Sending Unit, Secured with Metal Locking Ring or Screws	10-01B-17	VEHICLE APPLICATION	10-01B-1

VEHICLE APPLICATION

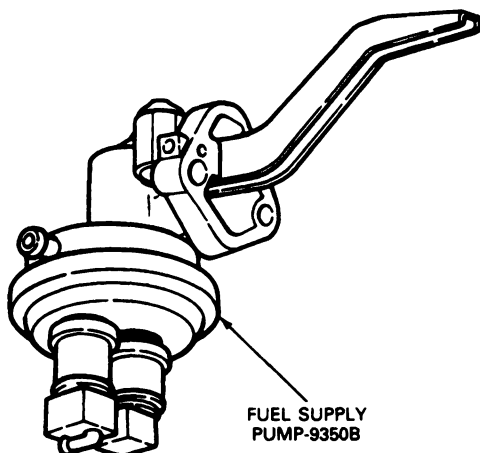
F-Series, Econoline, and F-Super Duty Series Vehicles
Equipped with Diesel Engines

DESCRIPTION AND OPERATION

Fuel Supply Pump

The fuel supply pump is bolted to the right front side of the cylinder block on the 7.3L V-8 diesel engine.

The pump is mechanically operated by an eccentric cam located on the camshaft. The pump rocker arm riding against the eccentric provides the diaphragm up-and-down pumping motion.

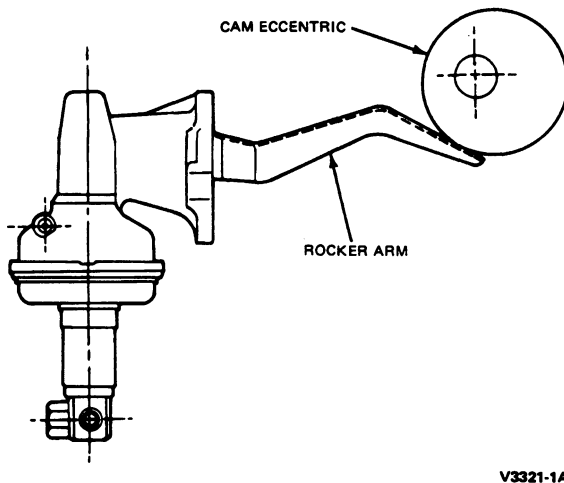


V5612-1A

DESCRIPTION AND OPERATION (Continued)

The fuel supply pump cannot be disassembled for repairs and must be replaced if testing indicates it is not within performance specifications. Refer to Diagnosis and Testing for testing procedures, and to the Specifications at the end of this section.

WARNING: NO SMOKING OR OPEN FLAME OF ANY TYPE SHOULD BE PRESENT WHEN WORKING NEAR FUEL OR FUEL VAPOR.

**Fuel Tanks and Lines**

Typical fuel tank and line installations are shown under Removal and Installation. Refer to these illustrations and remove damaged or worn parts as necessary.

Push Connect Fittings

Push connect fittings are used to make most fuel line connections in diesel fuel systems. These fittings must be serviced as outlined. Service is not possible if the fitting is damaged, except to replace a damaged retaining clip.

Fuel Tank Filling

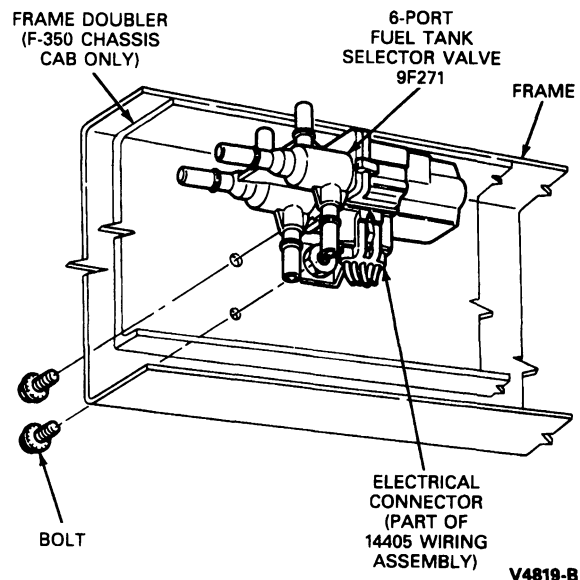
Expansion of fuel due to temperature increases, or overfilling ("topping off") could cause fuel overflow at the filler cap when the vehicle is standing or the cap is removed. To minimize this condition, it is recommended that the amount of fuel put in the tank when filling be limited to the automatic pump shutoff. If vehicle has two tanks, use fuel from both tanks after fill-up to reduce fuel levels.

Fuel Tank Draining

Use appropriate adapter to connect Rotunda Suction Pump 034-00006 or equivalent suction pump to the fuel hose (at the fuel sedimenter-to-fuel tube connection) and drain the fuel tank.

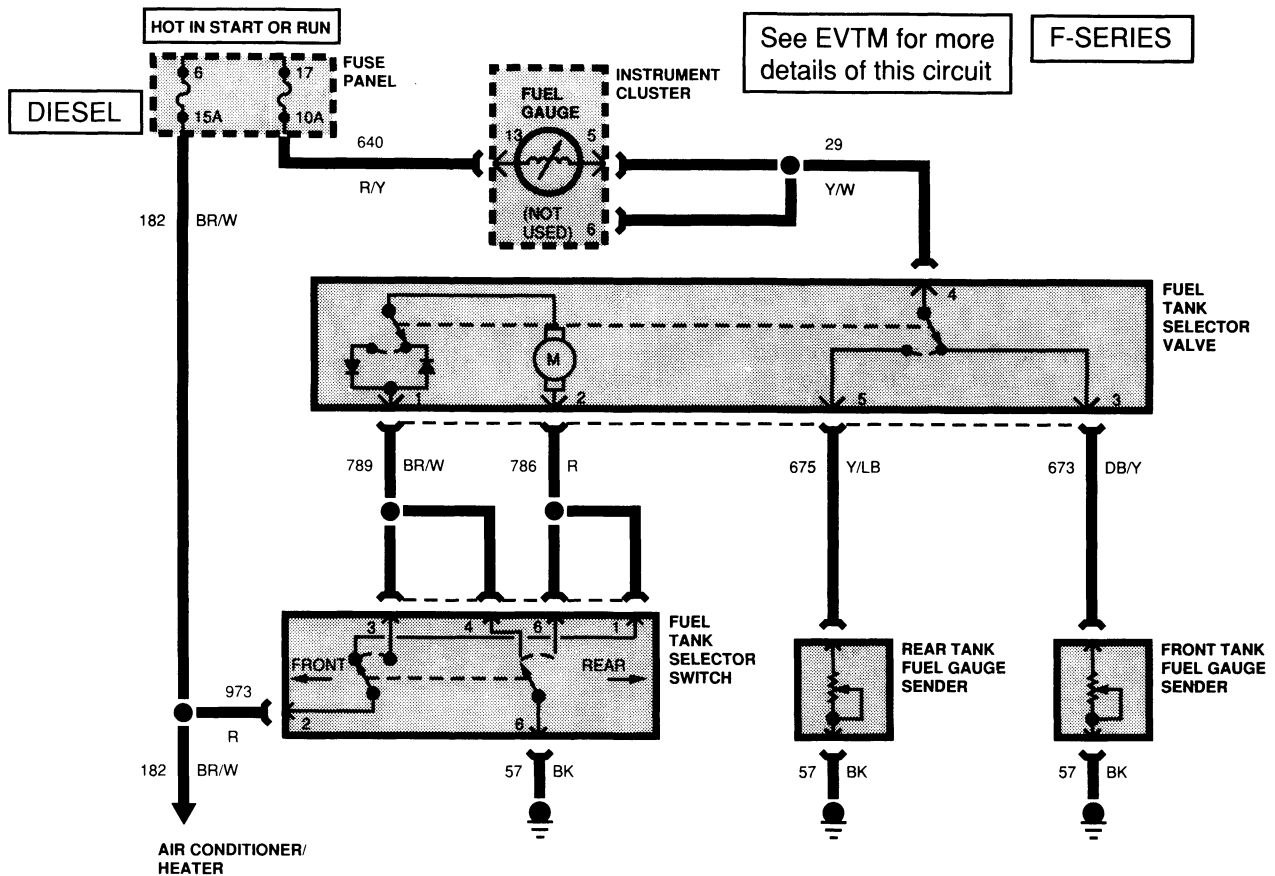
Fuel Selector Valve (Vehicles with Dual Tanks Only)

The 6-port diesel fuel valve is powered by a small electric motor which opens and closes the valve ports. The supply and return ports for either tank open and close simultaneously. The valve is shifted to the front mode (that is, the front supply and return ports open to the engine supply and engine return port respectively) by applying a positive 12 volts to terminal 2 and ground to terminal 1. When the valve reaches the front mode position, an internal switch opens the circuit and stops the motor. Returning the valve to the rear mode is accomplished by reversing power: positive 12 volts to terminal 1 and ground to terminal 2. Terminals 3 and 5 connect to the front and rear fuel tank senders respectively, and terminal 4 feeds the fuel gauge. In the front tank mode, an internal switch connects terminal 3 to terminal 4, thus supplying the front tank sender signal to the fuel gauge. Terminals 4 and 5 are connected in the rear tank mode. Therefore, a change in the fuel gauge reading (assuming at least 1/4 tank fuel level difference), means that the valve has shifted.

Fuel Tank Selector Valve, Typical

DESCRIPTION AND OPERATION (Continued)

Fuel Tank Selector Valve Wiring Diagram, F-250-350



V9066-A

Power is supplied to the fuel tank selector switch from the fuse panel when the ignition switch is in the ON position. This power goes through the fuel tank selector switch directly to the motorized fuel tank selector valve.

With the fuel tank selector switch in the front tank position, power is supplied from the selector switch to terminal 2 of the fuel selector valve. The ground path is completed through terminal 1 of the fuel tank selector valve and is grounded through the selector switch. This causes the fuel selector valve to rotate internally, opening the ports to the front tank position which allows fuel to flow through the fuel line to the engine.

With the fuel tank selector switch in the rear tank position, power is supplied from the selector switch to terminal 1 of the fuel tank selector valve. The ground path is completed through terminal 2 of the fuel tank selector valve and is grounded through the selector switch. This current path causes the motorized valve to rotate internally, opening the ports to the rear tank position which allows fuel to flow through the fuel line to the engine.

NOTE: When diagnosing the selector valve for failure to switch tanks and voltage is on terminals 1 and 2 of the valve, make sure the ground wire is attached below the instrument panel.

Fuel/Water Separator

Water should be drained from the engine mounted fuel/water separator whenever the warning lamp comes on or every 8047 km (5000 miles). More frequent drain intervals may be required depending on fuel quality and vehicle usage.

DESCRIPTION AND OPERATION (Continued)

The instrument panel warning lamp (WATER IN FUEL) will glow when approximately 0.1 liter (0.1 quart) of water has accumulated in the sediment. When the warning lamp glows, shut off the engine as soon as safely possible.

Drain Procedure

Refer to Section 03-01D.

DIAGNOSIS AND TESTING**Fuel Supply Pump**

When an engine has a lean (fuel starving) condition, the fuel supply pump is often suspected to be the problem. Similar symptoms will be present if the fuel filter is plugged or restricted, if the fuel / water separator is contaminated, or if fuel lines and hoses are leaking, kinked or restricted.

NOTE: Refer to Powertrain Control / Emissions Diagnosis Manual ¹ for further diagnosis.

If the fuel supply pump is suspected of being noisy, check for:

1. Loose fuel supply pump mounting bolts. Tighten to 26-37 N·m (19-27 ft-lb) if loose. Replace gasket if damaged or worn.
2. Check for loose or missing fuel line attaching clips. This condition will result in the noise being more audible when sitting inside the vehicle than standing outside of it. Tighten clips on fuel lines if necessary.

Before removing a suspect fuel supply pump:

1. Make sure there is fuel in the tank.
2. If the fuel filter has not been changed recently, install a new filter.
3. Inspect all rubber hoses from the fuel pump to fuel tank for kinks or cracks. With engine idling, inspect all fuel lines and rubber hoses and connections from fuel pump to fuel tank for fuel leaks. Tighten loose connections and replace kinked, cracked or leaking fuel lines or hoses as required.

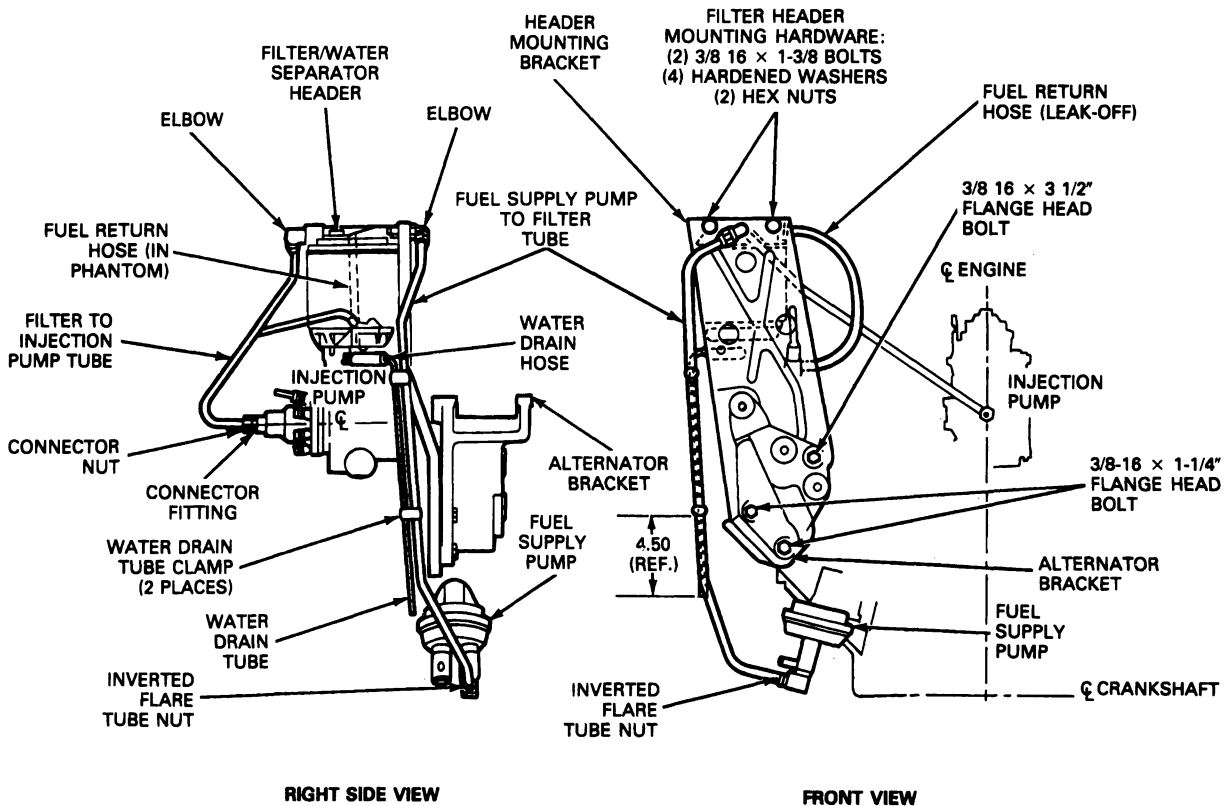
NOTE: Leaking fuel supply lines or hoses and kinked supply line hoses will severely affect fuel pump performance.

4. Inspect the fuel supply pump outlet connection for fuel leaks. Tighten to 20-24 N·m (15-18 ft-lb).
5. Inspect the fuel supply pump diaphragm crimp (the area where the stamped steel section is attached to the casting) and the breather hole(s) in the casting for evidence of fuel or oil leakage. Replace pump if leaking.

¹ Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Fuel Supply Pump



V5934-B

To determine if the fuel supply pump is performing properly, test the fuel supply pump for capacity (volume) and pressure, with the fuel supply pump installed on the engine. If the engine is excessively hot, let it cool for 20-30 minutes.

Capacity (Volume) Test

1. Slowly (fuel line is pressurized) disconnect the fuel line at the fuel filter.

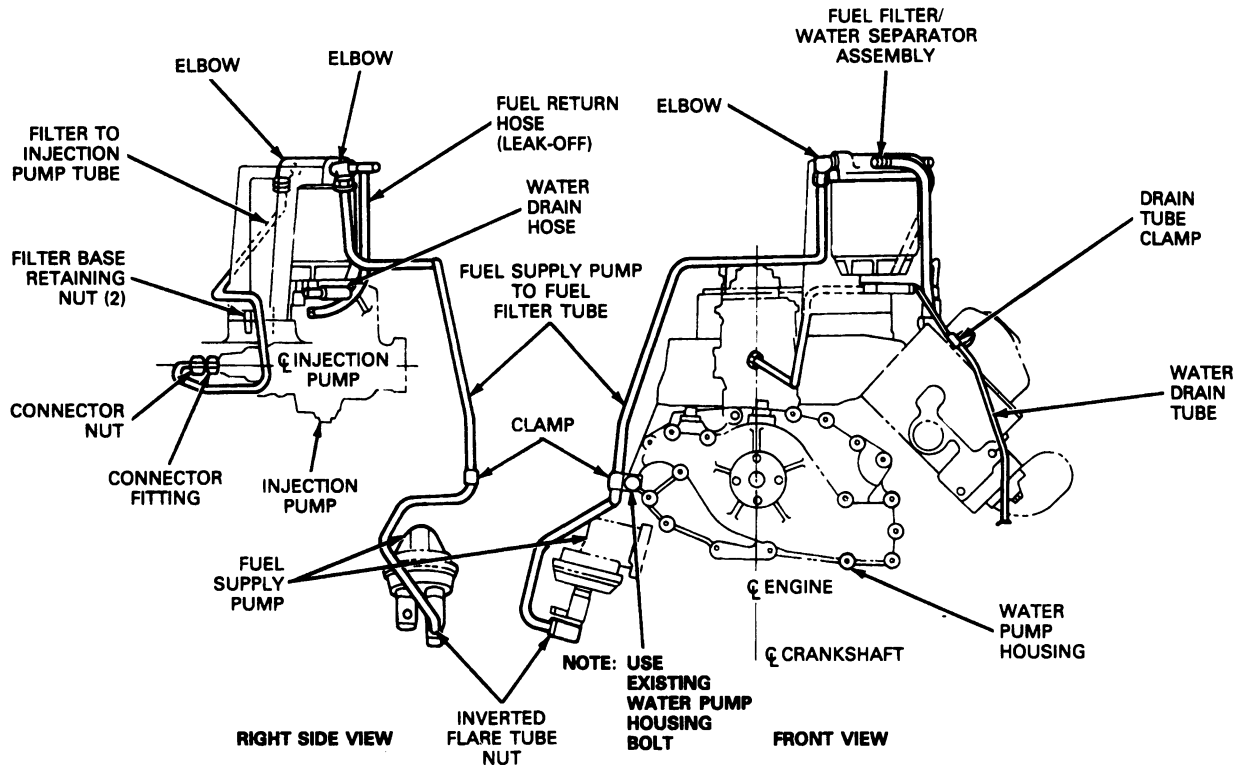
WARNING: USE CARE TO PREVENT COMBUSTION OF SPILLED FUEL.

2. Place a suitable non-breakable container (one-half liter or one pint minimum) Rotunda Safety Can 018-00003 or equivalent at the end of the disconnected fuel line (a piece of hose may be needed on the fuel line end). Crank engine ten seconds. The fuel supply pump should deliver one-third pint of fuel, or more.

3. If fuel flow is to specification, perform pressure test.
4. If fuel flow is low, repeat test using a remote non-breakable container of diesel fuel. Remove fuel hose from fuel pump inlet supply line. Connect a length of fuel hose from the fuel supply line to the non-breakable container and repeat Step 3. If fuel flow is to specification, the problem is either a plugged fuel / water separator or a kinked or leaking fuel hose. Service as necessary.
5. If fuel flow is below specification, replace fuel supply pump.

DIAGNOSIS AND TESTING (Continued)

Fuel Supply Pump



V5935-B

Pressure Tests

1. Connect Rotunda Vacuum and Pressure Tester 059-00008 or equivalent (0-103 kPa or 0-15 psi) to the injection pump end of the fuel line. (No T is required.)
2. Crank the engine for 10 seconds and read the pressure. Refer to the fuel system specification at the end of this section for the fuel pressure specification. If pump pressure is too low or too high, install a new fuel supply pump.
3. Connect fuel line.

Fuel Valve System

Refer to the following diagnosis charts for fuel valve system troubleshooting.

For diagnosis of fuel indicating system problems with fuel selector valve, refer to Sections 13-03. For the following diagnostic procedure, both tanks must contain some useable fuel.

FUEL SELECTOR VALVE DOES NOT CHANGE TANKS, 7.3L DIESEL WITH DUAL TANKS — TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	CHECK FOR VOLTAGE		
	<ul style="list-style-type: none"> Disconnect electrical connector from tank selector valve. Turn ignition to RUN position. Move selector switch to FRONT position and check for voltage between connector terminals No. 2 and No. 1. 	Voltage present No voltage present	GO to A2. GO to A5.

DIAGNOSIS AND TESTING (Continued)**FUEL SELECTOR VALVE DOES NOT CHANGE TANKS, 7.3L DIESEL WITH DUAL TANKS — TEST A (Continued)**

TEST STEP		RESULT	ACTION TO TAKE
A2	CHECK VOLTAGE		
	<ul style="list-style-type: none"> Check voltage between terminal No. 2 and ground. 	Voltage present No voltage present	GO to A3. GO to A5.
A3	CHECK FUEL VALVE MOTOR		
	<ul style="list-style-type: none"> Jumper motor terminal No. 2 to battery positive and motor terminal No. 1 to frame ground. Motor should run. Reverse jumper leads to motor. Motor should run in opposite direction. 	Motor runs in both directions Motor does not run in one or both directions	GO to A6. REPLACE motor.
A4	CHECK GROUND CIRCUIT		
	<ul style="list-style-type: none"> Check for open ground circuit from motor, through switch to ground. Is open ground circuit OK? 	Yes No	GO to A6. REPAIR ground circuit.
A5	CHECK FUSE		
	<ul style="list-style-type: none"> Check for voltage across fuse No. 15 (10 amp) in fuse panel. Is fuse OK? 	Yes No	GO to A6. REPAIR short(s) in selector valve circuits as necessary. REPLACE fuse. REPEAT Test Step A1.
A6	CHECK SELECTOR SWITCH CONTINUITY		
	<ul style="list-style-type: none"> Remove fuel tank selector switch mounting screws and disconnect switch from harness connector. With selector switch in FRONT (F) position, check for continuity between terminals No. 1 and No. 2 and between terminals No. 4 and No. 5. Move selector switch in REAR (R) position, and check continuity between terminals No. 2 and No. 3 and between terminals No. 5 and No. 6. Is selector switch continuity OK? 	Yes No	GO to A7. REPLACE fuel selector switch.
A7	CHECK CONTINUITY OF CIRCUITS 974 and 674		
	<ul style="list-style-type: none"> Check continuity of Circuits 786 (R) and 789 (BR-W) between selector switch and selector valve. Is circuit continuity OK? 	Yes No	GO to A8. REPAIR open circuit(s) as necessary.

DIAGNOSIS AND TESTING (Continued)**FUEL SELECTOR VALVE DOES NOT CHANGE TANKS, 7.3L DIESEL WITH DUAL TANKS — TEST A (Continued)**

TEST STEP		RESULT	ACTION TO TAKE
A12	BY-PASS FUEL SELECTOR VALVE		
	<ul style="list-style-type: none"> Disconnect the supply line to the engine at the selector valve. Disconnect the supply line from the rear tank at the selector valve. Connect the two lines together using a suitable length of fuel hose equipped with two male connectors and repeat Test Step A8. Is fuel selector valve OK? 	Yes No	REPLACE fuel selector valve. GO to A13.
A13	CHECK SYSTEM FOR RESTRICTIONS		
	<ul style="list-style-type: none"> Check rear fuel tank sender and fuel lines to selector valve for kinks and restrictions. Is system OK? 	Yes No	CHECK fuel tank for sufficient amount of fuel. REPEAT Test Step A11. CLEAN, REPAIR or REPLACE components as necessary. REPEAT Test Step A11.

TCV4262E

ENGINE RUNS ROUGH OR FLOODS OUT, ONE TANK POSITION ONLY, 7.3L DIESEL WITH DUAL TANKS — TEST B

TEST STEP		RESULT	ACTION TO TAKE
B1	CHECK FUEL RETURN TO SELECTOR VALVE		
	<ul style="list-style-type: none"> Disconnect fuel return line from engine at selector valve and insert line into suitable container. Turn ignition to RUN position and move tank selector switch to problem tank. Start engine and check for a solid, continuous flow of fuel. Is fuel return OK? 	Yes No	TURN engine OFF. CONNECT fuel return line to selector valve. GO to B2. CHECK return line for kinks or restrictions. REPAIR or REPLACE as necessary. REPEAT Test Step B1.
B2	CHECK FUEL RETURN TO TANK		
	<ul style="list-style-type: none"> Disconnect fuel return line from the problem tank from selector valve. Attach a length of 7.9mm (5/16 inch) diameter hose to selector valve return port and insert line into suitable container. Start engine and check for a solid, continuous flow of fuel. Is fuel flow OK? 	Yes No	CHECK fuel sender and fuel line to tank for kinks or restrictions. REPAIR or REPLACE as necessary. RUN engine and CHECK for smooth running. REPLACE fuel valve.

TCV4265D

REMOVAL AND INSTALLATION**Fuel Supply Pump****Removal**

- Loosen the threaded connection(s) with the proper size wrench (flare nut wrench preferred). Do not remove lines at this time. If rubber hose outlet connection is used, go to Step 2.

- Loosen pump mounting bolts approximately two turns. Apply force with hand to loosen fuel supply pump if gasket is stuck. Rotate the engine, by nudging the starter, until the fuel supply pump cam lobe is near its low position. The tension on the fuel supply pump will be greatly reduced at the low cam position.

NOTE: Outlet line is pressurized.

- Disconnect the fuel supply pump inlet, outlet and fuel vapor return line, if so equipped.

WARNING: USE CARE TO PREVENT COMBUSTION OF SPILLED FUEL.

REMOVAL AND INSTALLATION (Continued)

4. Remove the fuel supply pump attaching bolts and remove the pump and gasket. Discard the old gasket.

Installation

1. Remove all fuel supply pump gasket material from the engine and the fuel supply pump if installing the original pump.
2. Install the attaching bolts into the fuel supply pump and install a new gasket on the bolts. Position the fuel supply pump to the mounting pad. Turn the attaching bolts alternately and evenly and tighten them to 26-37 N·m (19-27 ft-lb).
3. Install fuel outlet line. If it is a threaded connection, start fitting by hand to avoid crossthreading. Tighten to 20-24 N·m (15-18 ft-lb).
4. Install inlet line. Install hose clamp(s).
NOTE: If rubber hoses are cracked, hardened or frayed, replace them with new "gasoline" rubber hose.
5. Start engine and observe all connections for fuel leaks for two minutes.
6. Stop engine and check all fuel supply pump fuel line connections for fuel leaks by running a finger under the connections. Check for oil leaks at the fuel supply pump mounting gasket.

Fuel Line and Hose Components

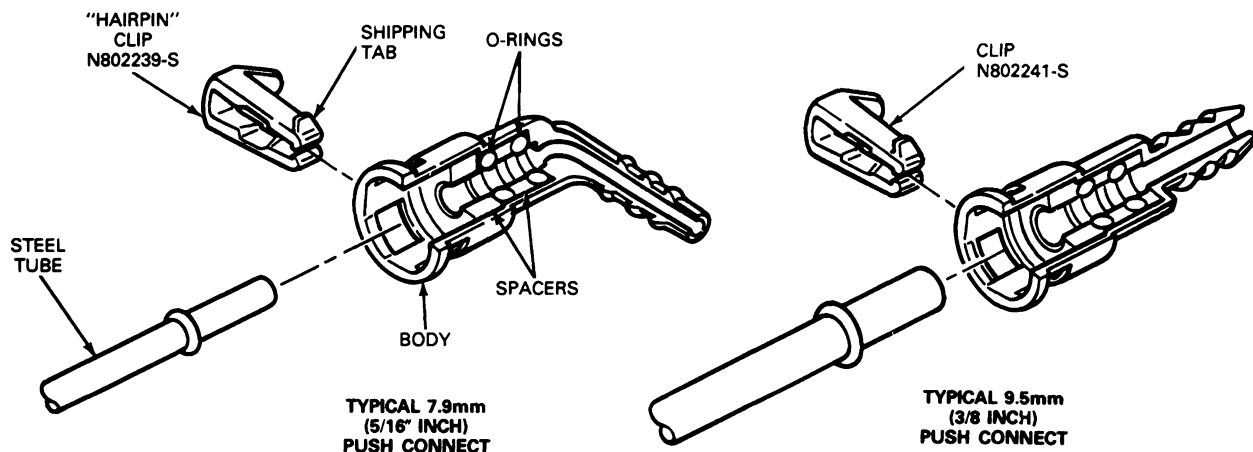
NOTE: General instructions are given for Push Connect Fittings, Metal Spring Lock Connectors, Plastic Fuel Tubes and Organizer Assemblies. Refer to these component instructions and to the reference illustrations of complete systems in this section to service fuel lines.

Push Connect Fittings

Push connect fittings for 7.3L diesel systems have two sizes for 9.5mm (3/8-inch) and 7.9mm (5/16-inch) tubing.

Disconnect all push connect fittings from components (sender, 6-way valve) prior to component removal. The push connect fittings that connect flexible fuel lines to the fuel tank sender often cannot be disconnected until the tank is partially lowered, just before removing the fuel tank completely.

Typical Push Connect Fittings, Diesel Engine Applications



V4780-2D

Removal

1. Inspect the visible internal portion of fitting for dirt accumulation. If more than a light coating of dust is present, clean the fitting before disassembly.
2. Some adhesion between the seals in the fitting and tubing will occur with time. To separate, twist the fitting on the tube, then push and pull the fitting until it moves freely on the tube.
3. Remove "hairpin" type clip from fitting by first bending the shipping tab downward so that it will clear the body. Next (**using hands only**), spread the two clip legs about 3.0mm (1/8 inch) each to disengage the body and push the legs into the fitting. Complete removal is accomplished by **lightly** pulling from the triangular end of the clip and working it clear of the tube and fitting.

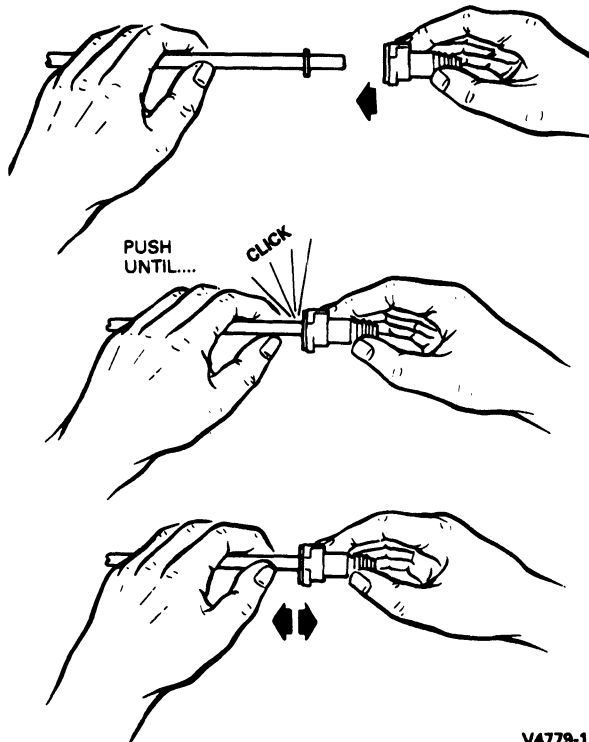
CAUTION: Do not use any tools.

REMOVAL AND INSTALLATION (Continued)

4. Grasp the fitting and hose assembly and pull in an axial direction to remove the fitting from the tube.
5. When fitting is removed from the tube end, inspect the fitting and tube for any internal parts that may have been dislodged from the fitting. Any loose internal parts should be immediately installed, using the mating tube to insert the parts.

Installation

1. It is recommended that the original retention clip **not** be reused in the fitting. To install the new clip, insert clip into any two adjacent openings with the triangular portion pointing away from the fitting opening. Install clip to fully engage the body (legs of "hairpin" clip locked on outside of body). Piloting with an index finger is necessary.
2. Before installing the fitting on the tube, wipe tube end with a clean cloth. Inspect the inside of the fitting to make sure it is free of dirt and / or obstructions.
3. To install the fitting onto the tube, align the fitting and tube axially and push the fitting onto the tube end. When the fitting is engaged, a definite click will be heard. Pull on fitting to make sure it is fully engaged.

Connecting "Push Connect" Fittings**Metal Spring-Lock Connectors**

The tools will not always fit over the shielded line. To accommodate the shielding, the hole in the tubing end of the tool must be enlarged. To do this, clamp the tool closed and drill out the existing hole with 5/8-inch bit. Be careful to drill only the tubing hole and not the working end of the hole.

Removal and Installation

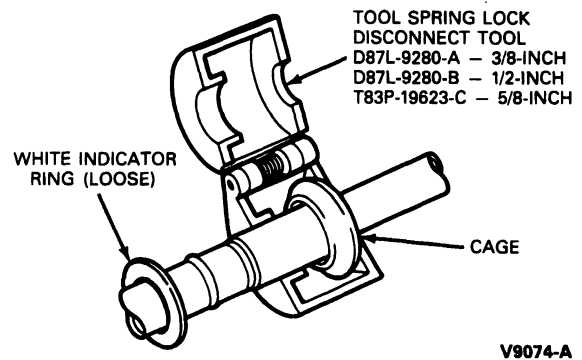
NOTE: Either plastic or metal safety clips are used on metal tubes with Metal Spring-Lock Connectors. Both types are illustrated.

Disconnecting Spring Lock Coupling

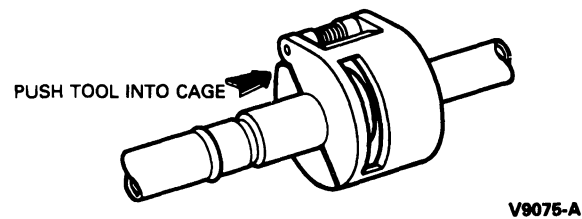
CAUTION: Discharge fuel system before disconnecting coupling.

NOTE: Before disassembly, locate white indicator ring which may have slipped down length of fuel line.

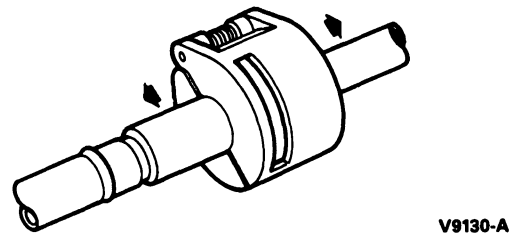
1. Fit tool to coupling so that tool can enter cage to release the garter spring.



2. Push the tool into the cage opening to release the female fitting from the garter spring.

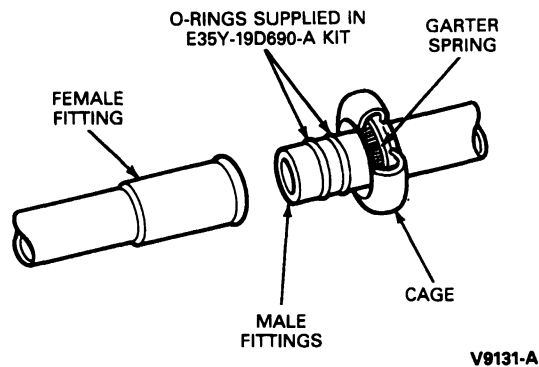


3. Pull the coupling male and female fittings apart.



REMOVAL AND INSTALLATION (Continued)

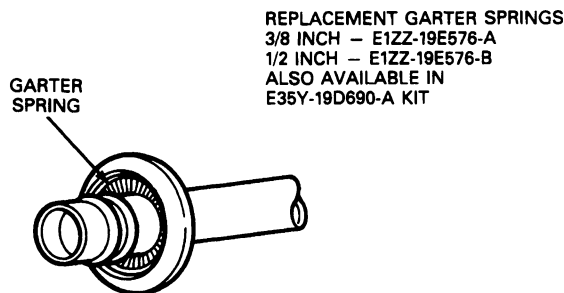
- Remove the tool from the disconnected spring lock coupling.



V9131-A

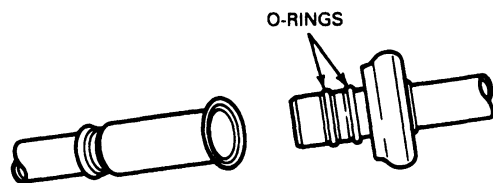
Connecting Spring Lock Coupling

- Check for missing or damaged garter spring. If spring is damaged or missing remove damaged spring with small hooked wire and install a new spring.



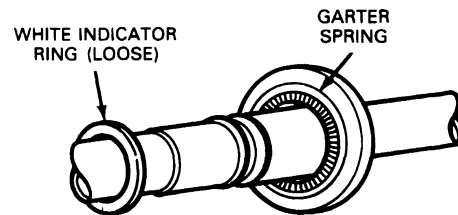
V9132-A

- Clean fittings and install new O-rings. Use only specified O-rings supplied in E35Y-19D690-A kit. Lubricate with clean refrigerant oil. Insert white indicator ring into cage on male fitting. Assemble fitting together by pushing with a slight twisting motion.



V9133-A

- White indicator ring will pop free of cage on male fitting when joint is full made. This indicates that garter spring inside cage of male fitting is properly seated over lip of female connector.



V9134-A

Fuel Lines, Steel

The 7.3L diesel engine uses a combination of flexible and steel tubing fuel supply and return lines. The fuel tube assemblies are secured to the body rails with clips.

Fuel supply tubes and the various fuel lines need not be serviced as assemblies. They may be cut, squared and formed out of rolls of fuel system service tubing and hose material available at dealerships, or a service part may be purchased.

A damaged section of tubing longer than 305mm (12 inches) can be cut out of the existing line and replaced by a comparable service tubing section, spliced into the line by means of connecting hoses and retaining clamps. A damaged section of tubing shorter than 305mm (12 inches) can be cut out of the line and replaced by a length of service hose and two retaining clamps.

All replacement hoses must be cut to a length and inside diameter that will ensure proper clamp retention.

Removal

- Disconnect the damaged line at both ends.
- Remove the line from the holding clips along the frame.
- Remove all damaged hose and tube sections.

Installation

- Cut a new section of steel tubing to approximately the same length and inside diameter as the section to be replaced. Allow extra length for flaring the ends of the tubing where required. Square the ends of the cut tubing with a file.
- Ream the inside edges of the cut tubing with the reamer blade on the tube cutter. Be sure metal chips are removed from inside the tube(s). Double flare the ends of the cut tubing, as required.
- Bend the tube section to conform to the contour of the original tube. Cut an ample length of hose to form a coupling between the ends of the fuel lines. Connect the hose couplings to the tubing and install the retaining clamps.
- Position the lines in the clips. Connect the lines and check for leaks.

REMOVAL AND INSTALLATION (Continued)**Fuel Tubes, Plastic**

CAUTION: Ford approved nylon fuel tubing is made from material which has been tested and proven to be acceptable for use with commercially available fuels. It is also resistant to most environmental conditions. Avoid using alternate tubing materials. Use of non-approved tubing could pose a hazard in service.

CAUTION: Plastic fuel tube must not be repaired using hose and hose clamps. Push connect fittings cannot be repaired except to replace the retaining clips. Should the plastic tubes, push connect fittings or mating tube ends become damaged and leak, approved service parts must be used to service the fuel lines.

CAUTION: The fuel lines can be damaged by torches, welding sparks, grinding and other operations which involve heat and high temperatures. If any repair or service operation will be used which involves heat and high temperatures, locate all fuel system components, especially the plastic fuel lines to be certain they will not be damaged. It is recommended that the plastic fuel tubes be removed from the vehicle if a torch or high heat producing equipment is to be used for service in the following areas:

1. Exhaust or suspension components in proximity to fuel tubes.
2. Underbody frames, rails and crossmembers (left side).
3. Dash panel, under vehicle or inside the passenger compartment (lower left side).

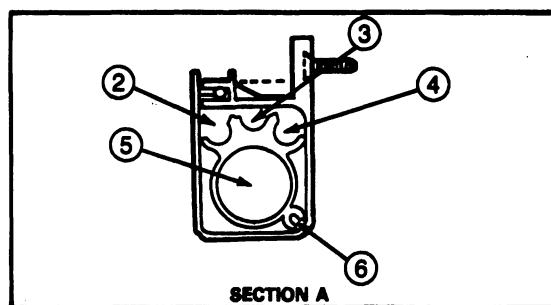
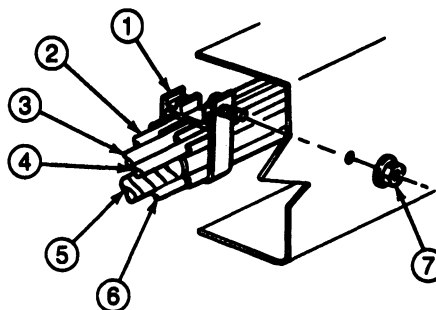
Organizer Assemblies, E-150-250-350**Removal and Installation**

Either single lines and hoses may be removed from organizer assemblies or the entire assembly may be removed.

To remove a single line or hose, snap open organizer-to-frame clips. Disconnect line or hose ends. Snap line or hose out of organizer plastic core and remove. It may be necessary to remove some other lines to get one out.

To remove the entire assembly: Disconnect battery ground cable. Disconnect all lines, hoses, and electrical connections going through organizer. Remove nuts retaining organizer assembly to frame. Remove assembly.

To install assembly, position organizer assembly on frame. Install organizer clip nuts and tighten to 8-10 N-m (6-7 ft-lb). Connect all hoses, lines, and wires.

Typical Organizer Assembly, E-150-250-350

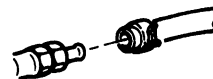
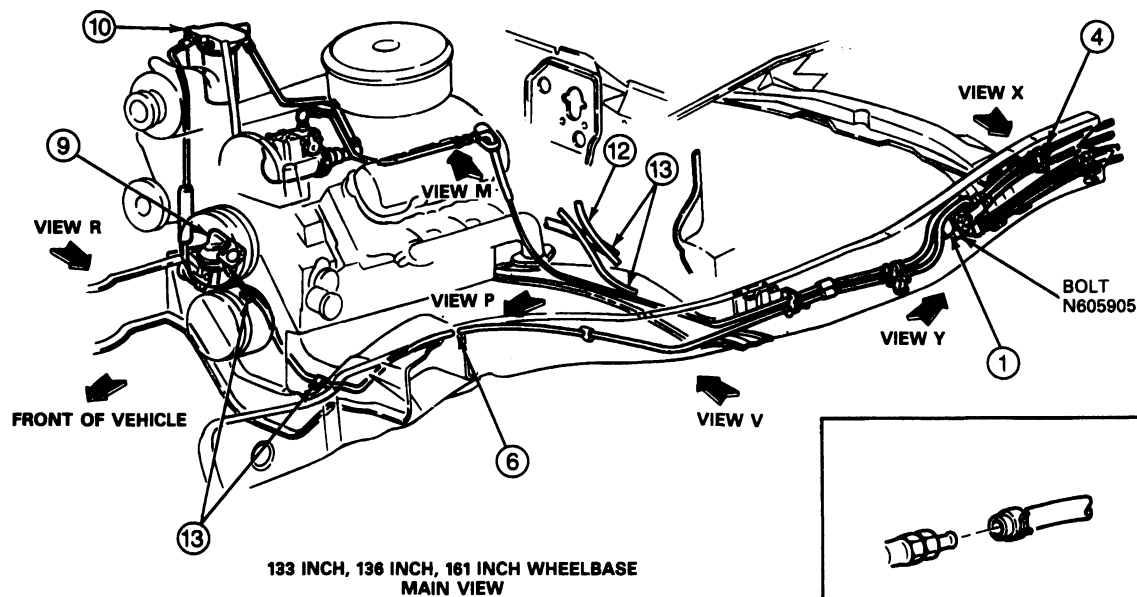
A16218-B

Item	Part Number	Description
1	9S293	Organizer Assembly, Fuel, Brake and Electrical
2	—	Fuel Vapor Line
3	—	Fuel Return Line
4	—	Fuel Supply Line
5	—	Electrical
6	—	Brake Line
7	N620480-S2	Nut 8-10 N-m (6-7 Ft-Lb)

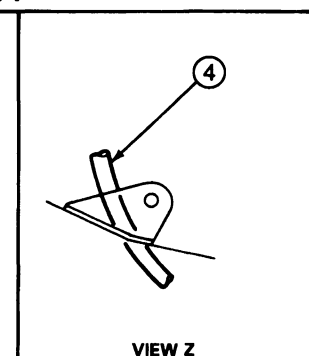
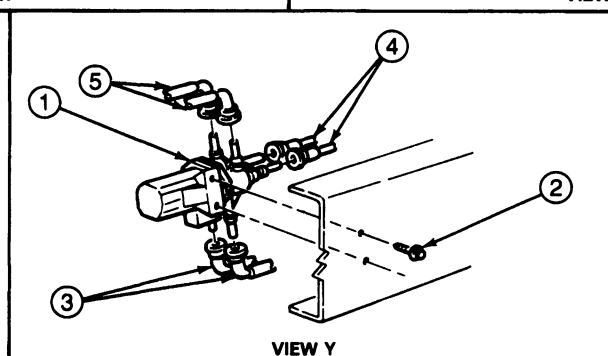
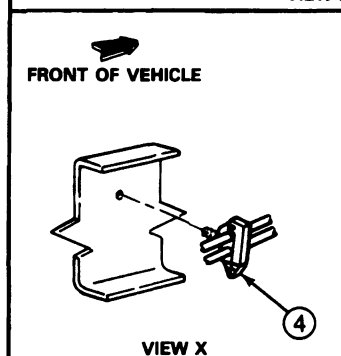
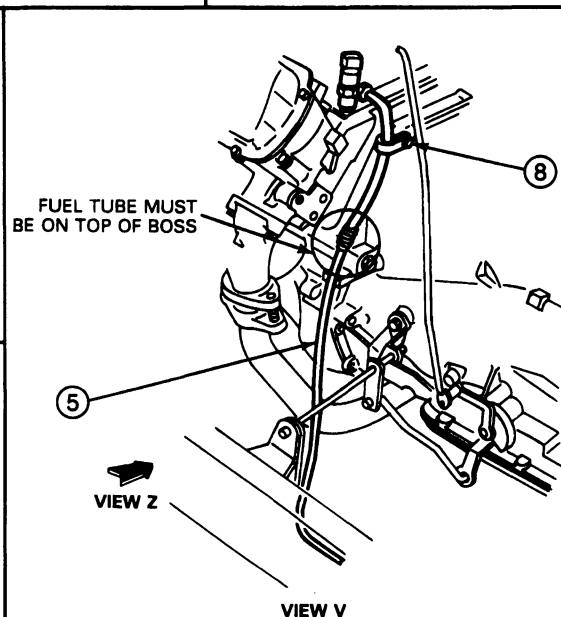
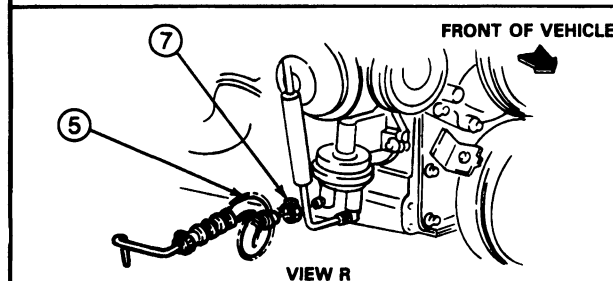
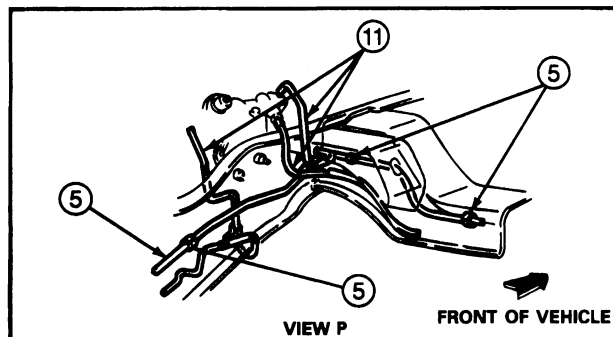
TA16218A

REMOVAL AND INSTALLATION (Continued)

Front Fuel Line Installation, F-250-350 and F-Super Duty Chassis Cab, 133-, 136.8-, 155- and 160.8-Inch Wheelbase



VIEW M



V5330-F

REMOVAL AND INSTALLATION (Continued)

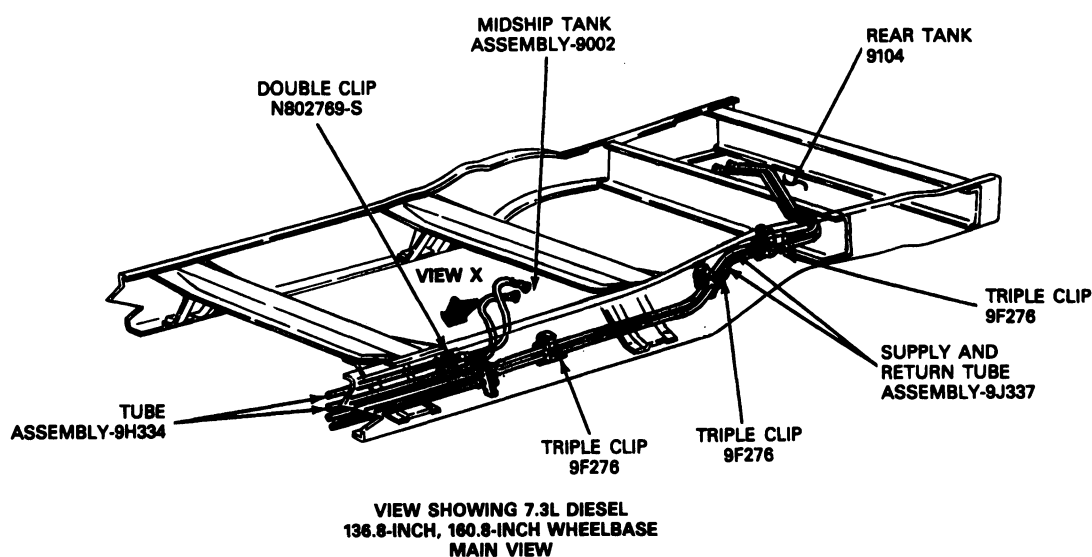
Item	Part Number	Description
1	9F271	Valve, Six-Port
2	N805905	Bolt 12-16 N-m (9-11 Ft-Lb)
3	9J337	Tube Assembly, Rear Tank
4	9H334	Tube Assembly, Midship Tank
5	9J338	Tube Assembly, Front
6	N802768-S	Clips
7	383521-S2	Clamp

Item	Part Number	Description
8	390962-S100	Clip
9	Ref.	Fuel Supply Pump
10	Ref.	Water Separator
11	Ref.	Brake Tubes
12	Ref.	Hydraulic Clutch Hose
13	Ref.	Wire Harness, Speedometer Cable

TV5330A

(Continued)

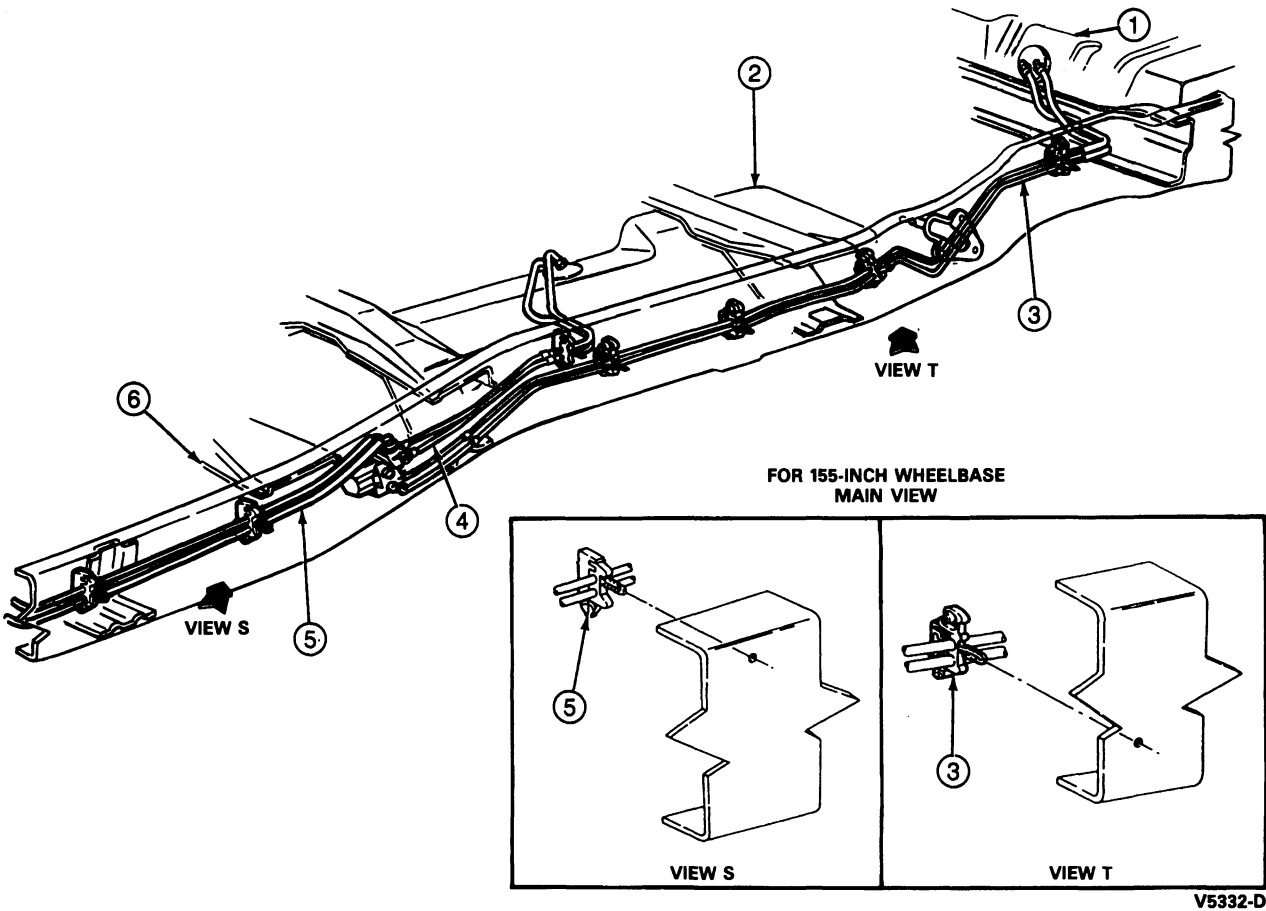
Rear Fuel Line Installation, F-250 — F-350 and F-Super Duty Chassis Cab, 137- and 161-Inch Wheelbase



V5331-D

REMOVAL AND INSTALLATION (Continued)

Rear Fuel Line Installation, F-250-350 and F-Super Duty Chassis Cab, 155- and 133-Inch Wheelbase



Item	Part Number	Description
1	9104	Tank Fuel, Rear
2	9002	Tank Fuel, Midship
3	9J337	Tube Assembly, Rear Tank

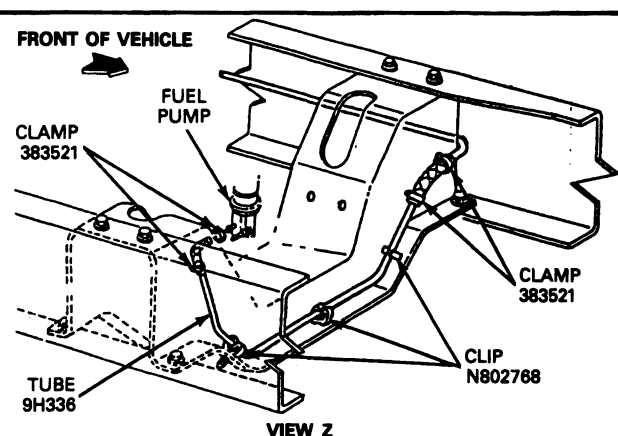
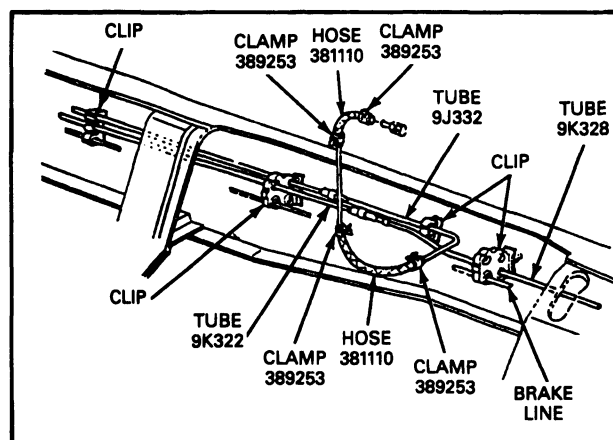
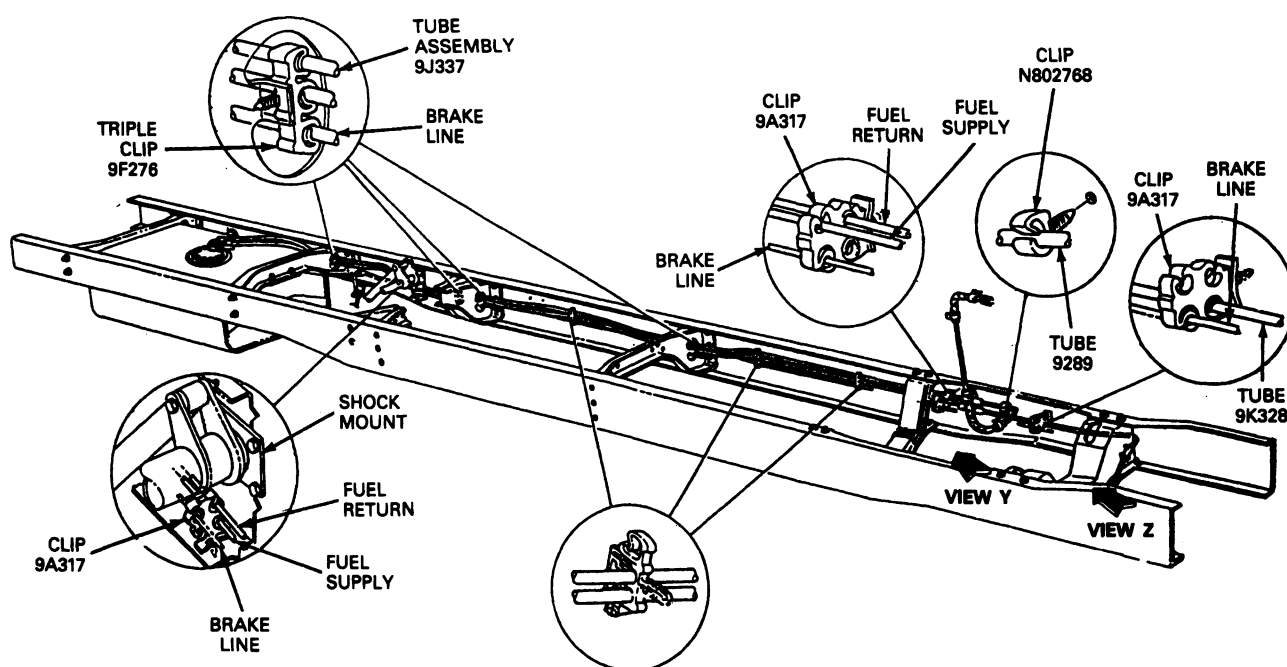
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Item	Part Number	Description
4	9H334	Tube Assembly, Midship Tank
5	9J338	Tube Assembly, Front
6	Ref.	Crossmember, For SuperCab Only

TV5332A

REMOVAL AND INSTALLATION (Continued)

Fuel Line Installation, Aft Fuel Tank, F-Super Duty Commercial Chassis Vehicles



V7778-C

Fuel Gauge Sending Unit, Secured with Metal Locking Ring or Screws

Removal

1. Remove the fuel tank as described in this section.
2. Position fuel tank on a workbench and remove any dirt that has accumulated around the sender so that it will not enter the fuel tank.
3. Turn the fuel sending unit locking ring counterclockwise with Fuel Tank Lock Ring Wrench T74P-9275-A and remove locking ring.

NOTE: On some aft-of-axle tanks, the fuel gauge sending unit is held in place by screws.

4. Remove the fuel gauge sending unit from the fuel tank.
5. Remove seal gasket and discard.

Installation

1. Clean the fuel gauge sending unit mounting flange and the fuel tank mounting surface and seal ring groove.
2. Put a light coating of Premium Long-Life Grease XG-1-C or -K (ESA-M1C75-B) or equivalent grease on a new seal ring to hold it in place during assembly and install it in the fuel ring groove.

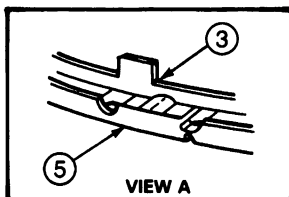
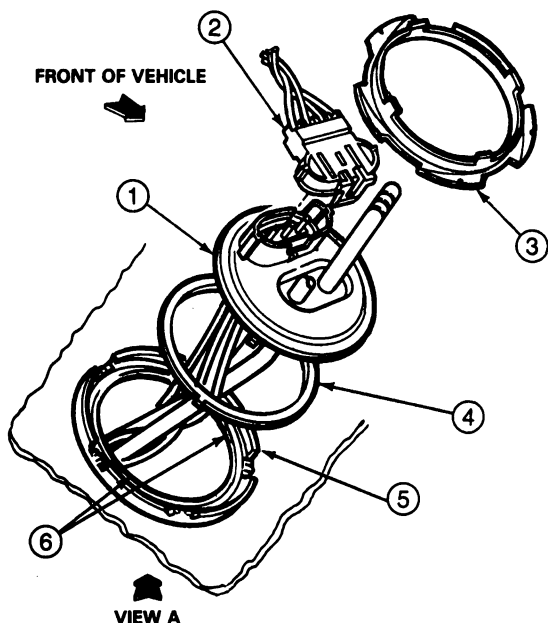
REMOVAL AND INSTALLATION (Continued)

3. Install fuel gauge sending unit assembly carefully to make sure that the filter is not damaged. Be sure that the tabs of the sender are positioned into slots of the fuel tank. Make sure ring remains in place.
4. Hold the fuel gauge sending unit and sealing gasket in place, install and rotate the locking ring clockwise until the stop is against the retainer ring tab.

NOTE: On aft-of-axle tanks where the fuel gauge sending unit is held in place by bolts, tighten the sending unit retaining screws to 9-11 N·m (7-8 ft-lb).

5. Install fuel tank as described in this section.

Fuel Gauge Sending Unit, Secured with Metal Locking Ring



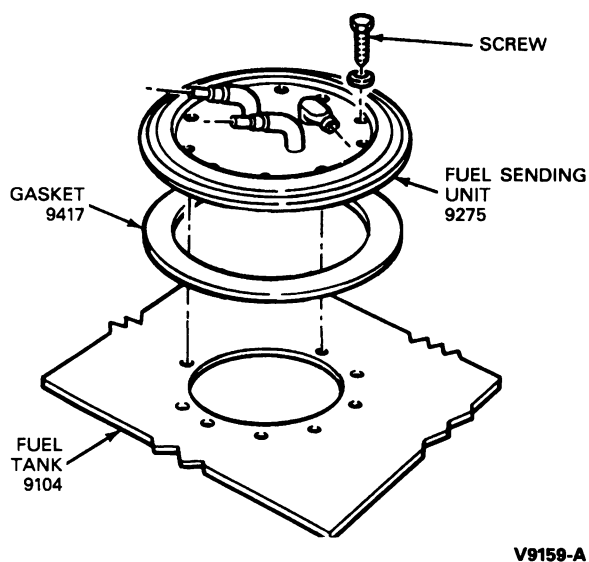
V4838-F

Item	Part Number	Description
1	9275	Sending Unit (Color Coded for Identification. See Parts Catalogue)
2	14405 or 14406	Wiring Assembly

(Continued)

Item	Part Number	Description
3	90383	Locking Ring (Using D84P-9275-A or Equivalent, Turn Until Tabs are Positioned Between Detent and Stop on Tank)
4	9417	Gasket
5	9002	Fuel Tank
6	—	Locking Slots — Part of Fuel Tank (Make Sure FDM Tabs are Seated in Slot)

Fuel Gauge Sending Unit, Secured with Screws

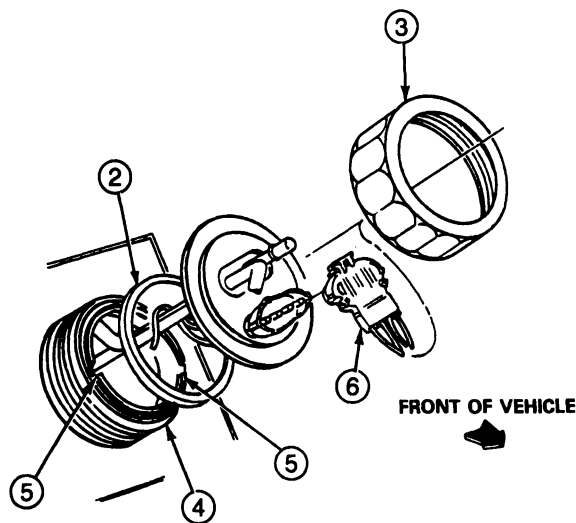


V9159-A

Fuel Gauge Sending Unit, Secured with Plastic Locking Ring

The fuel pump removal and installation procedure for units equipped with plastic locking rings is the same for units equipped with metal locking rings. The plastic locking ring on these units can be removed with a band-type oil filter wrench or equivalent by turning counterclockwise. When installing the plastic locking ring, tighten ring to 55-68 N·m (41-50 ft-lb).

Refer to Fuel Gauge Sending Unit, Secured with Metal Locking Ring or Screws removal and installation procedures in this section.

REMOVAL AND INSTALLATION (Continued)**Fuel Delivery Module, Units Secured with Plastic Locking Rings, F-350 Chassis Cab**

K17093-A

Item	Part Number	Description
1	9H307	Fuel Pump and Sending Unit (Gasoline Engines)
1	9275	Fuel Pump and Sending Unit (Diesel Engine)
2	9417	Gasket
3	9A307	Locking Ring
4	9002	Fuel Tank
5	—	Locating Tabs (Part of 9H307 or 9275 Fuel Pump and Sending Unit)
6	14405 or 14406	Wiring Assembly

TK17093A

Fuel Tanks**F-250-350, F-Super Duty Chassis Cab and Commercial Chassis****Aft-of-Axle Fuel Tank**

Fuel tank installations are shown in the following illustrations.

Removal

1. Raise the rear of the vehicle.
2. To avoid electrical sparking at the tank, disconnect the ground cables on both batteries. Then disconnect the fuel gauge sending unit wire at the fuel tank.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

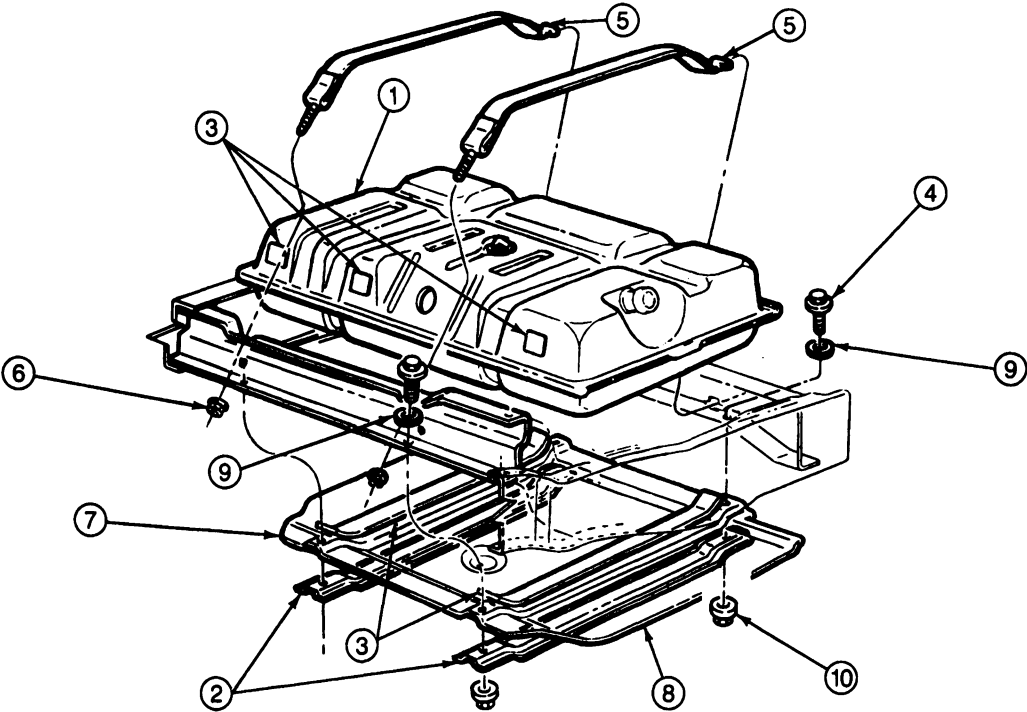
3. Disconnect the ground wire after both tanks have been drained.
4. Using Rotunda 034-00001 Fuel Storage Tanker or equivalent, drain fuel tank.
5. Loosen the clamp on the fuel filler pipe at the tank and disconnect the filler pipe hose, pulling along the rubber inner tube from filler neck.
6. If removing the metal type tank, support the tank and remove the bolts attaching the tank supports to the frame. Carefully lower the tank. Finish removing the filler pipe and filler pipe vent hose if not possible in Step 5. Remove the tank under the vehicle.
7. If removing the plastic type tank, support the tank and remove the bolts attaching the combination skid plate and tank support to the frame. Carefully lower the tank. Complete removing the filler pipe if not possible in Step 5. Remove the skid plate and tank from under the vehicle. Disassemble the skid plate from the tank.

Installation

1. Install new support strap insulation as required.
2. If installing the plastic type tank, preassemble the skid plate and support straps to the tank.
3. Raise the tank skid plate and support assembly and start the tank neck into the hose.
4. Connect the fuel gauge sending unit wire to the sending unit.
5. Connect the fuel line at the fuel gauge sending unit and tighten the fuel filler hose clamps securely. Install the drain plug, if so equipped.
6. Position the tank assembly against the top straps or the frame and install the attaching bolts and nuts. Tighten the attaching bolts and nuts to 37-50 N·m (28-36 ft·lb).
7. Insert rubber inner tube inside filler neck and connect filler pipe hose. Tighten clamp to 3-4 N·m (27-35 in·lb).
8. Connect both vehicle battery ground cables.
9. Fill the tank and check all connections for leaks.
10. Lower the vehicle.

REMOVAL AND INSTALLATION (Continued)

Steel Aft-of-Axle Fuel Tank Installation, F-250-350 and F-Super Duty Chassis Cab, Except F-350 with 136.8- and 160.8-Inch Wheelbase



V3201-L

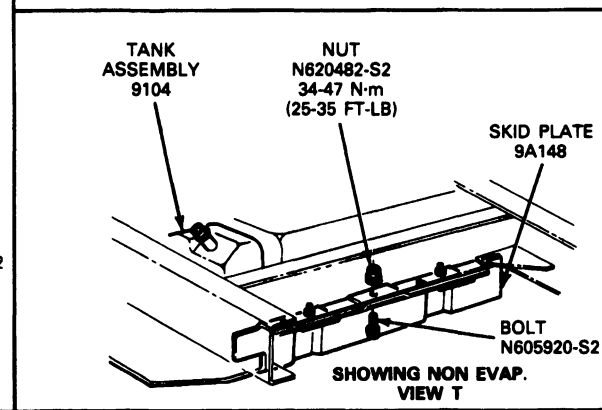
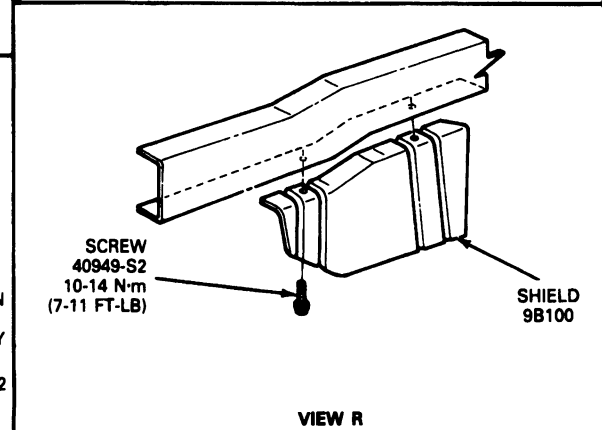
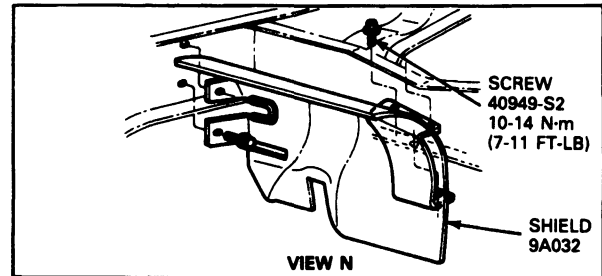
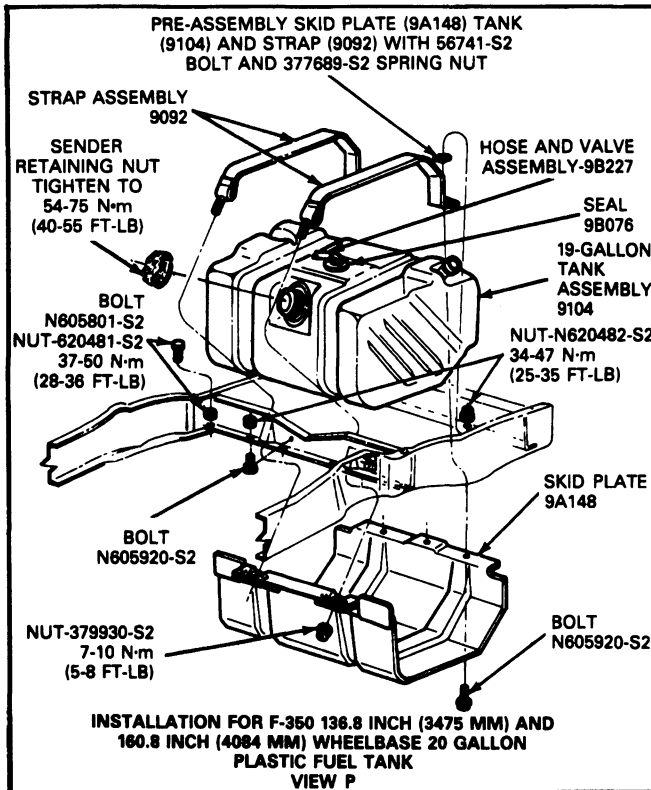
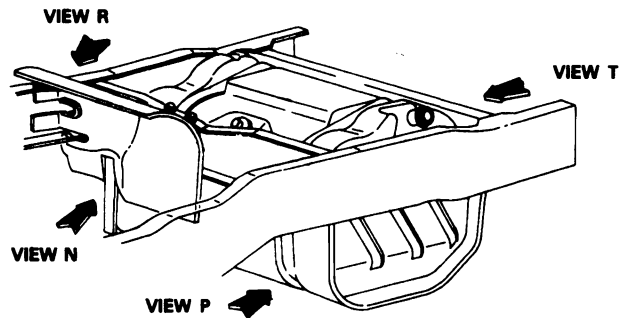
Item	Part Number	Description
1	9240	Fuel Tank Assembly
2	9A017	Support Assembly, Lower
3	—	Insulator, Part of 9240 Tank Assembly
4	N801380-S100	Bolt

(Continued)

Item	Part Number	Description
5	9092	Strap, Upper
6	34976-S362	Nut
7	9K015	Stone Shield, RH
8	9C045	Stone Shield, LH
9	382873-S2	Washer
10	N620482-S2	Nut 37-50 N-m (28-36 Ft-Lb)

REMOVAL AND INSTALLATION (Continued)

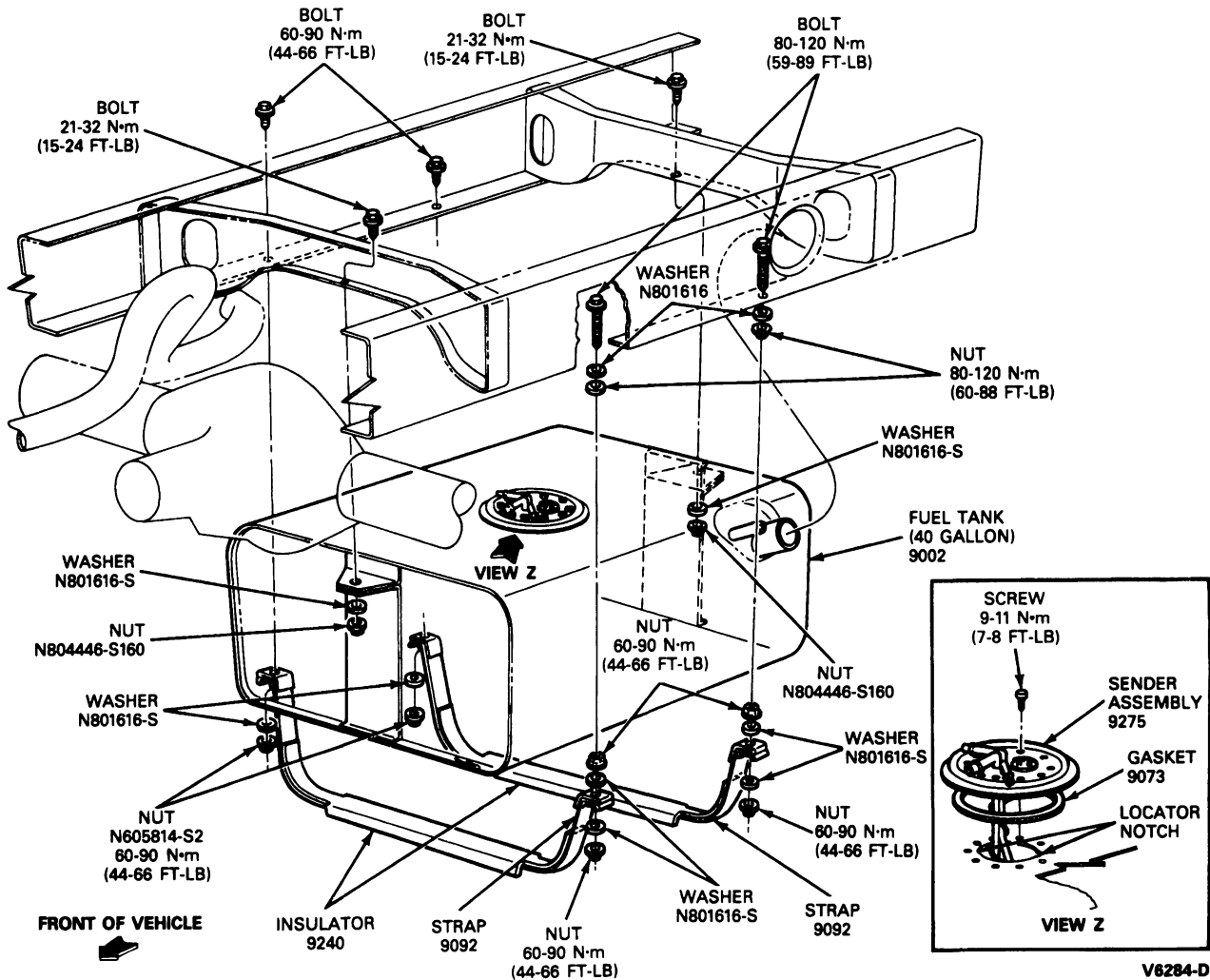
Plastic Aft-of-Axle Fuel Tank Installation, F-350, 136.8- and 160.8-Inch Wheelbase



V3057-M

REMOVAL AND INSTALLATION (Continued)

Steel Aft-of-Axle Fuel Tank Installation, F-Super Duty Commercial Chassis



Midship Fuel Tank, Plastic

Removal

1. To avoid electrical sparking at the tank, disconnect the ground cables on both batteries.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
2. Using Rotunda Fuel Storage Tanker 034-00001 or equivalent, drain fuel tank.
3. Remove skid plate and heat shields.
4. Loosen fuel filler hose clamp at the tank and disconnect the fuel filler hose.
5. Position suitable jack under tank. Remove nuts from straps and lower tank enough to gain access to hoses.

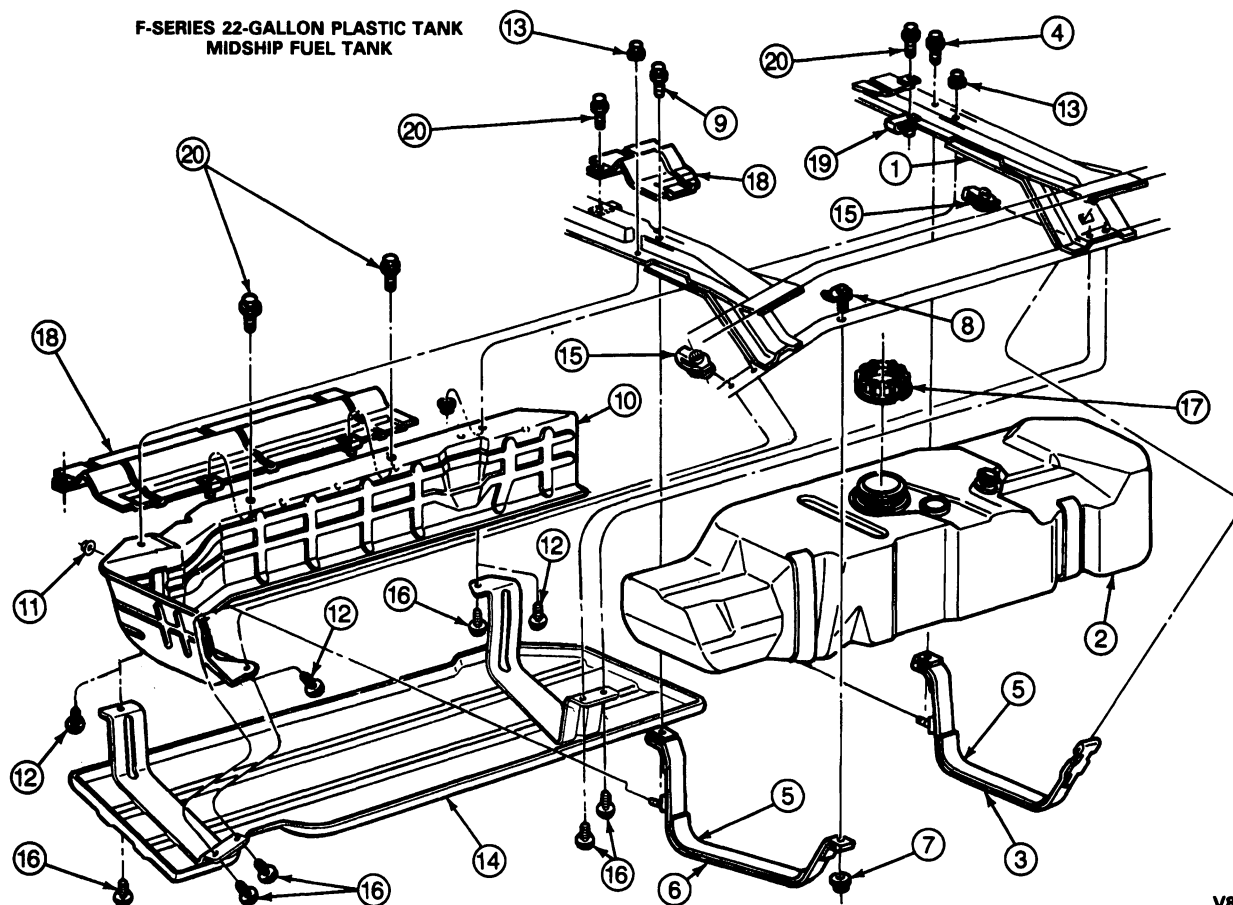
6. Disconnect the fuel gauge sending unit wire at the fuel tank.
7. Disconnect the fuel tube push-connect fittings at fuel gauge sending unit.
8. Disconnect fuel vapor hose from fuel vapor valve.
9. Remove fuel tank from vehicle.

Installation

1. Install jack under tank and raise tank enough to start the tank neck into the filler hose.
2. Connect fuel vapor hose to fuel vapor valve.
3. Connect the fuel tube push connect fittings at the fuel gauge sending unit.
4. Position and secure fuel filler hose on fuel tank filler neck. Make sure the inner hose is not twisted or kinked inside tank neck and filler pipe. Tighten hose clamp to 3-4 N·m (27-35 in-lb).
5. Connect the fuel gauge sending unit wire.

REMOVAL AND INSTALLATION (Continued)

6. Position tank to vehicle and install front and rear straps. Tighten rear strap bolt to 30-41 N·m (23-30 ft-lb). Tighten front strap nut to 37-50 N·m (28-36 ft-lb).
7. Position heat shield on fuel tank retaining strap studs and tighten attaching nuts to 16-24 N·m (12-17 ft-lb).
8. Position skid plate in vehicle and secure the skid plate and heat shield to frame with attaching bolts and nuts. Tighten to 16-24 N·m (12-17 ft-lb).
9. Position heat shield in vehicle and secure it to the frame and the heat shield with attaching bolts. Tighten to 11-15 N·m (9-11 ft-lb).
10. Connect battery ground cables at both batteries.
11. Fill the tank and check all connections for leaks.

Plastic Midship Fuel Tank Installation, F-Series 4x4 with E4OD, 133- and 155-Inch Wheelbase

V8325-C

Item	Part Number	Description
1	9240	Insulator, Upper
2	9002	Tank Assembly, Fuel
3	9057	Strap Assembly, Rear
4	N802253-S2	Bolt 30-41 N·m (23-30 Ft-Lb)
5	9240	Insulator
6	9054	Strap Assembly, Front
7	N620482-S2	Nut 37-50 N·m (28-36 Ft-Lb)
8	N805934-S2	Bolt
9	N802253-S2	Bolt
10	9A032	Shield
11	N620480-S36	Nut 16-24 N·m (12-17 Ft-Lb)

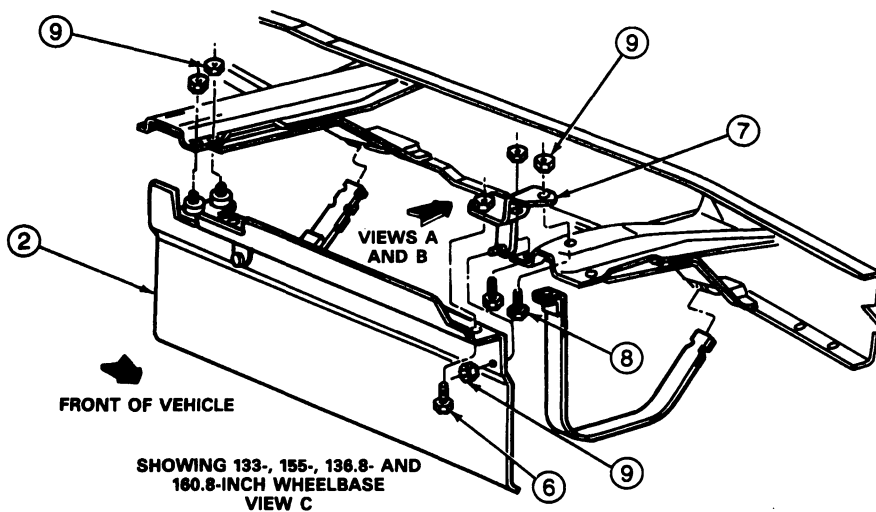
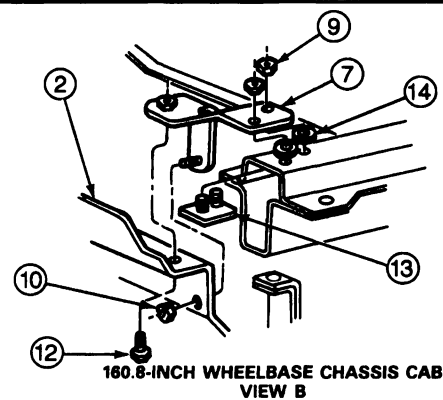
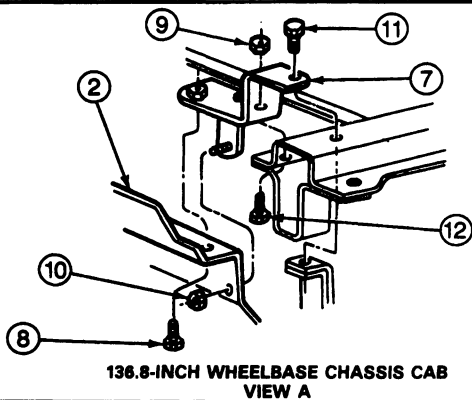
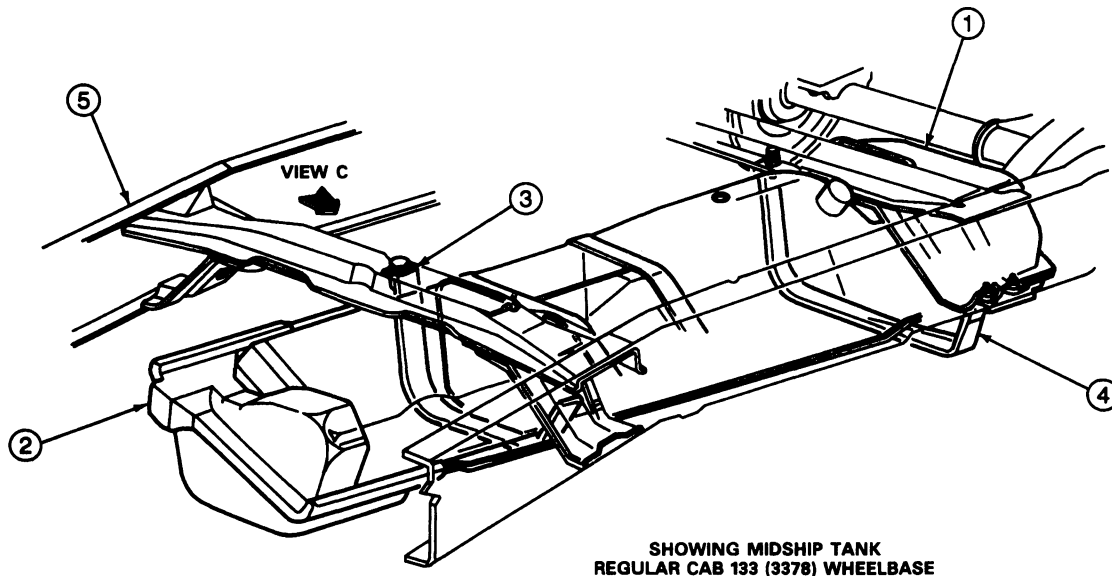
(Continued)

Item	Part Number	Description
12	N605906-S2	Bolt
13	N620481-S2	Nut 16-24 N·m (12-17 Ft-Lb)
14	9A148	Skid Plate
15	N804340-S2	U-Nut
16	N605906-S2	Bolt 16-24 N·m (12-17 Ft-Lb)
17	9A307	Locking Ring, Fuel Tank Pump 55-68 N·m (41-50 Ft-Lb)
18	9B100	Shield
19	N801595-S53	U-Nut
20	N605892-S2	Bolt 11-15 N·m (9-11 Ft-Lb)

TV8325A

REMOVAL AND INSTALLATION (Continued)

Steel Midship Fuel Tank Installation, F-250-350 and F-Super Duty Chassis Cab, 133-, 136.8-, 155- and 160.8-Inch Wheelbase



V9160-A

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9002	Tank Assembly, Fuel
2	9K014	Shield
3	9054	Strap, Front
4	9057	Strap, Rear
5	5005	Frame Assembly
6	N605906-S2	Bolt 16-24 N·m (12-17 Ft-Lb)
7	9K037	Bracket Assembly

(Continued)

Item	Part Number	Description
8	N605906-S36	Bolt
9	N620481-S2	Nut 16-24 N·m (12-17 Ft-Lb)
10	N803826-S56	Nut and Washer 16-24 N·m (12-17 Ft-Lb)
11	N802253-S2	Bolt 30-41 N·m (23-30 Ft-Lb)
12	N606689-S2	Screw and Washer
13	5R132	Bolt Assembly
14	W623464-S2	Nut, Push On

TV9160A

Midship Fuel Tank, Steel**F-250-350 and F-Super Duty Chassis Cab**

NOTE: As there are different midship tank installations which are removed and installed essentially the same way, follow steps and refer to appropriate illustration for details.

Removal and Installation

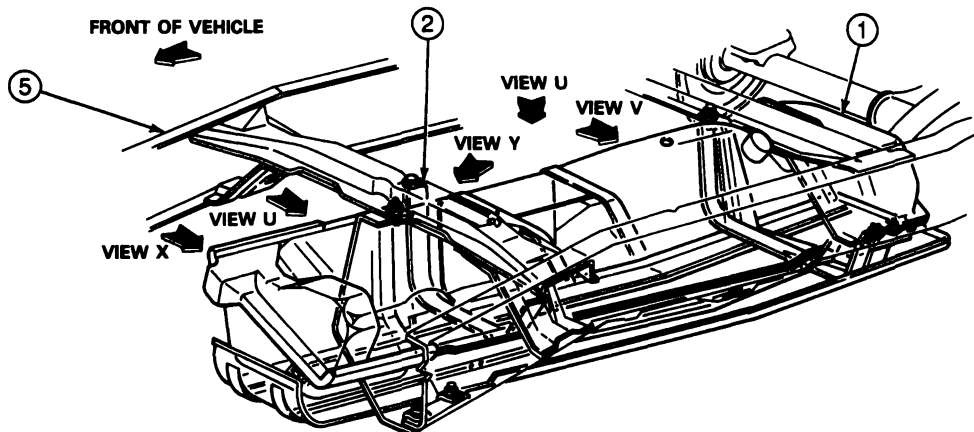
1. Disconnect battery ground cable.
NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.
2. Using Rotunda 034-00001 Fuel Storage Tanker or equivalent, drain fuel tank. Drain both tanks on dual-tank vehicles.
3. If equipped with skid plate, remove fasteners and remove skid plate assembly.
4. Disconnect fuel gauge sending unit electrical connector.

5. Loosen clamps and disconnect fuel filler hose and overflow hose at tank.
6. Position suitable jack under tank.
7. Remove nuts and bolts and lower straps. If necessary, turn strap approximately 30 degrees and remove.
8. Lower tank enough to gain access to fuel connections.
9. Disconnect fuel vapor hose from vapor valve.
10. Disconnect fuel supply and return lines according to instructions for push connectors in this section.
11. Remove fuel tank from vehicle.

For installation procedures, follow removal procedures in reverse order. Tighten the fuel tank strap bolts and nuts to 30-41 N·m (23-30 ft-lb). Tighten fuel tank bracket to frame nut to 22-28 N·m (17-20 ft-lb). Tighten fuel tank skid plate bolts and nuts to 16-24 N·m (12-17 ft-lb).

REMOVAL AND INSTALLATION (Continued)

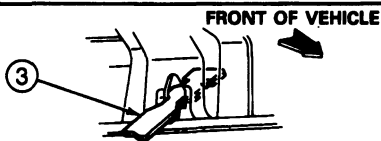
Steel Midship Fuel Tank Installation, F-250-350 4x4, 133-, 136.8-, 155- and 160.8-Inch Wheelbase



VIEW SHOWING MIDSHIP TANK



FOR 133-INCH (3378 MM) AND
155-INCH (3937 MM) WHEELBASE
REGULAR CAB AND SUPERCAB
VIEW K

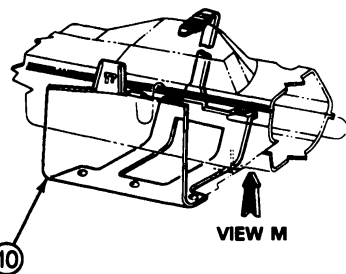


FOR 136.8-INCH (3475 MM) AND
160.8-INCH (4084 MM)
WHEELBASE CHASSIS CAB
VIEW K

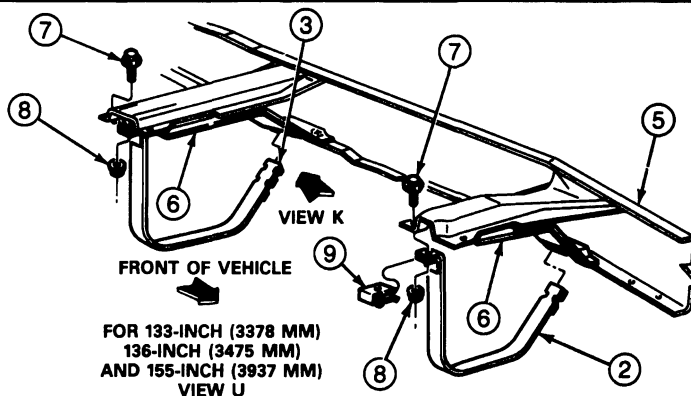
EDGE OF SHIELD MUST LINE UP WITH
RADIS ON TANK AS SHOWN. DO NOT
USE HAMMER OR Mallet WHEN
INSTALLING SHIELD.



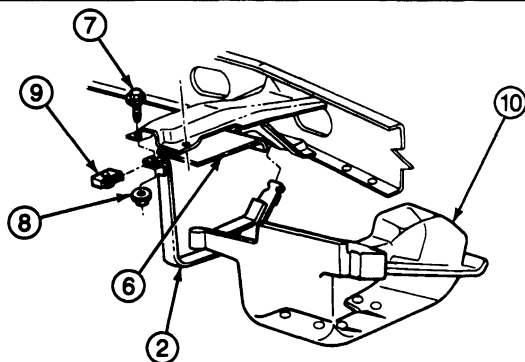
VIEW M



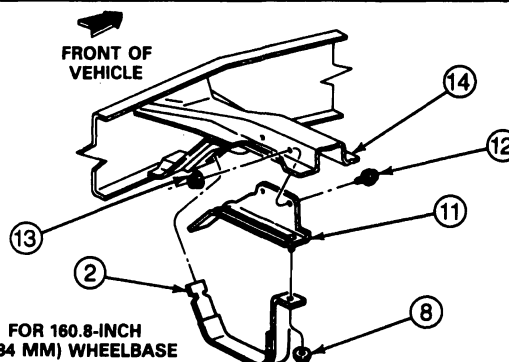
VIEW U



FOR 133-INCH (3378 MM)
136-INCH (3475 MM)
AND 155-INCH (3937 MM)
VIEW U



VIEW X



FOR 160.8-INCH
(4084 MM) WHEELBASE
F-350 FRONT STRAP ATTACHMENT
VIEW Y

V3563-F

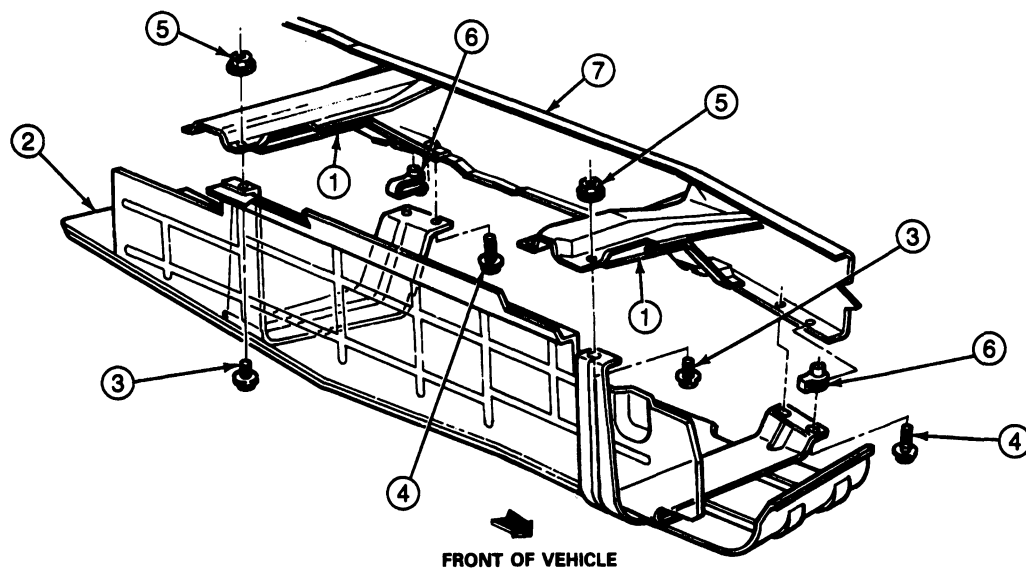
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9002	Tank Assembly
2	9054	Strap, Front
3	9057	Strap, Rear
4	9A148	Skid Plate
5	5005	Frame Assembly
6	9240	Insulator, Upper
7	N802253-S2	Bolt 30-41 N-m (23-30 Ft-Lb)

(Continued)

Item	Part Number	Description
8	N620482-S2	Nut 30-41 N-m (23-30 Ft-Lb)
9	N801107-S10	U-Nut
10	9K014	Shield Assembly
11	9065	Bracket
12	N605906-S2	Bolt
13	N620481-S2	Nut 22-28 N-m (17-20 Ft-Lb)
14	Ref.	Crossmember, No. 3A

TV3563A

Steel Midship Fuel Tank Skid Plate Installation, F-250-350 4x4, 133-, 136.8-, 155- and 160.8-Inch Wheelbase

V9161-A

Item	Part Number	Description
1	9240	Insulator, Upper
2	9A148	Skid Plate
3	N605906-S2	Bolt
4	N605906-S2	Bolt 16-24 N-m (12-17 Ft-Lb)

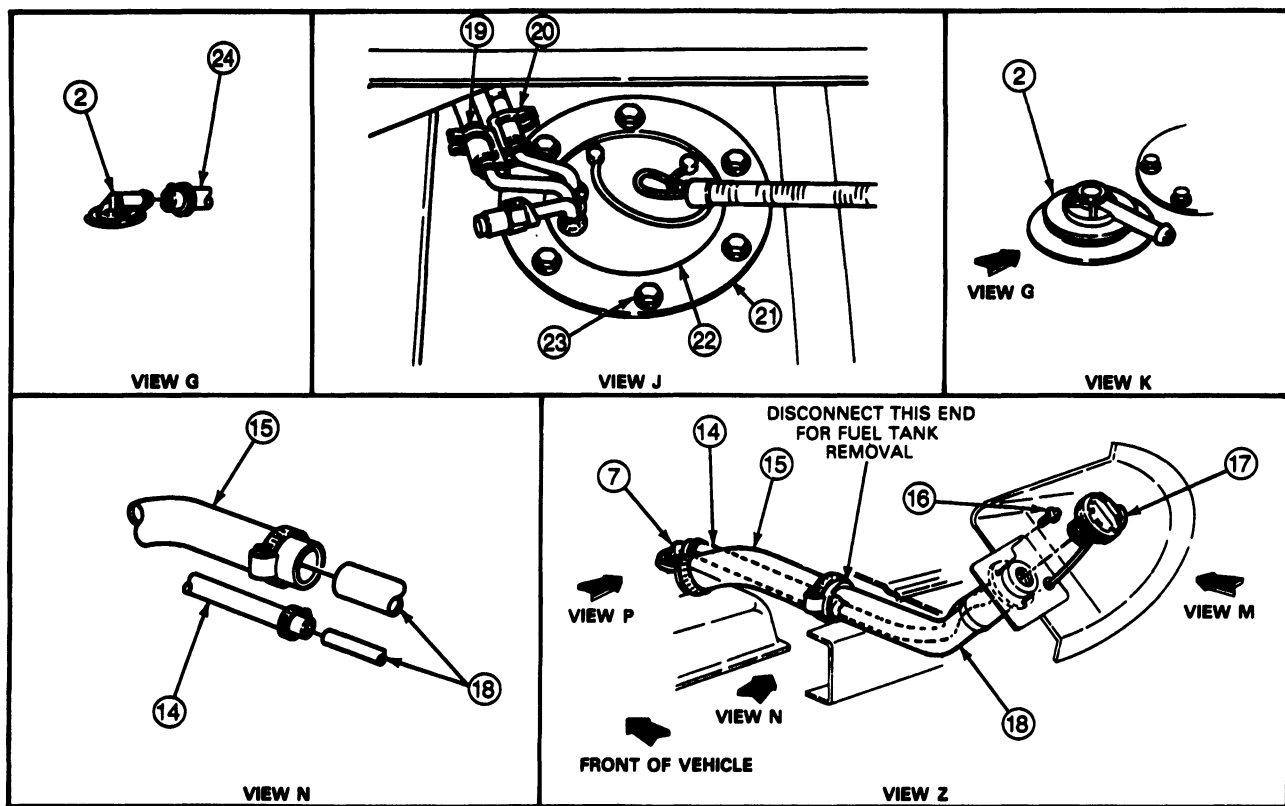
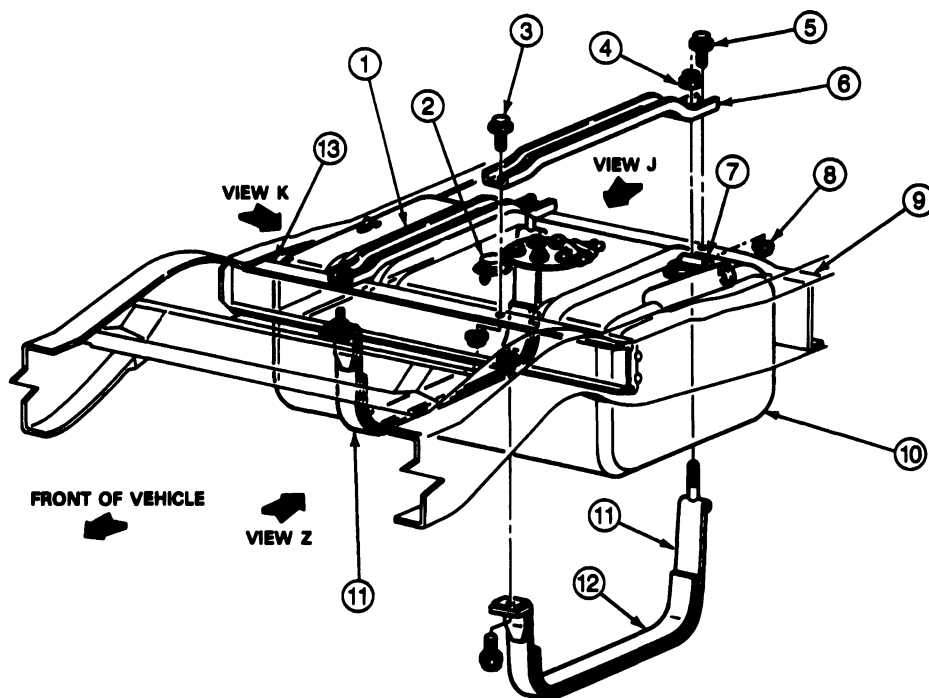
(Continued)

Item	Part Number	Description
5	N620481-S2	Nut 16-24 N-m (12-17 Ft-Lb)
6	N804340-S2	U-Nut
7	5005	Frame Assembly

TV9161A

REMOVAL AND INSTALLATION (Continued)

Aft-of-Axle Fuel Tank Installation, E-250-350, 7.3L Diesel



A16202-A

REMOVAL AND INSTALLATION (Continued)

AFT-OF-AXLE FUEL TANK INSTALLATION, E-250-350 7.3L DIESEL (LEGEND)

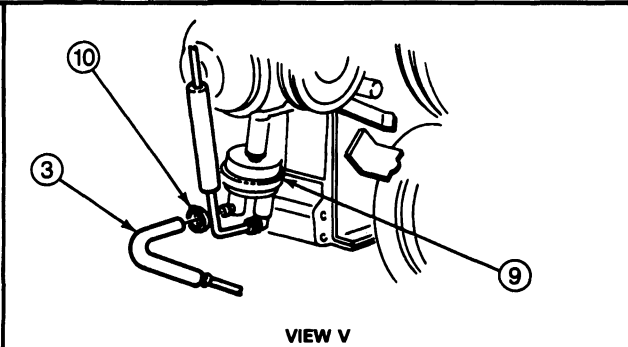
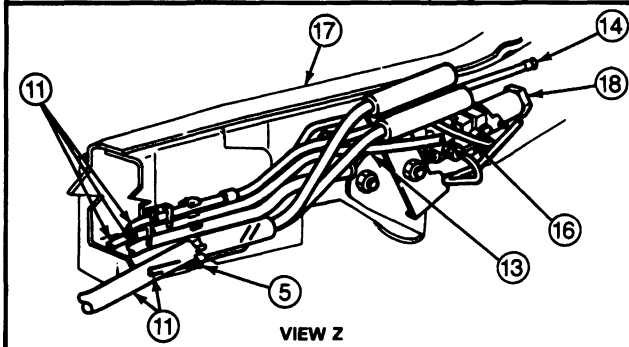
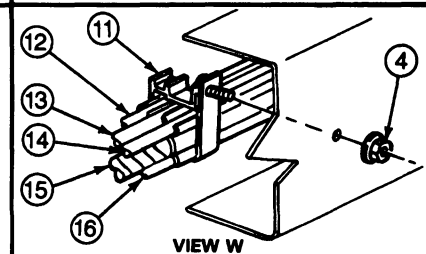
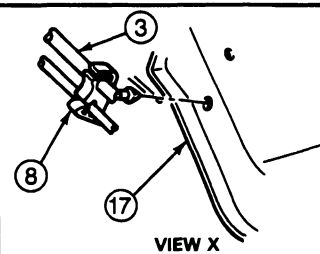
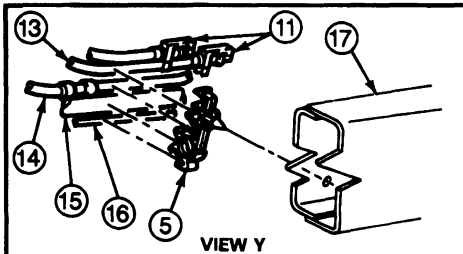
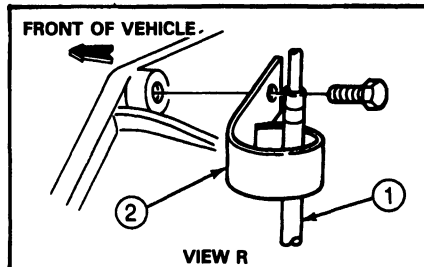
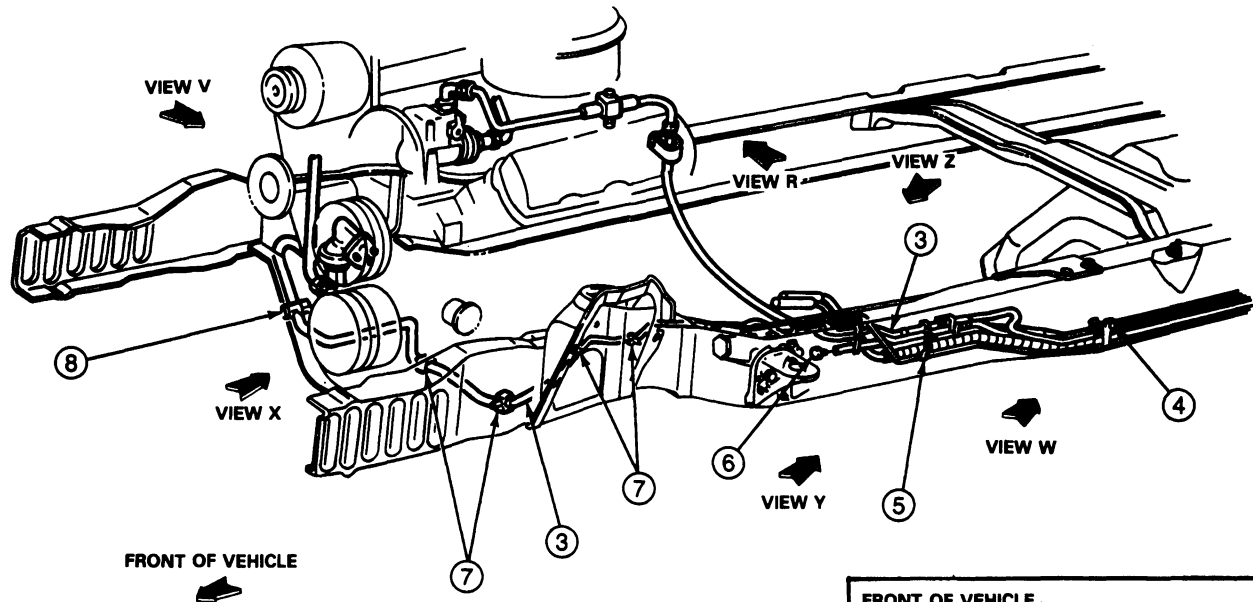
Item No.	Part Number	Description
1	9061	Upper Support
2	98593	Fuel Vapor Valve Assembly
3	390103-S36	Bolt 3/8-16 x 1.25 In. 42-57 N·m (31-42 Ft-Lb)
4	33773-S2	Nut 1/2-13 27-34 N·m (20-25 Ft-Lb)
5	390103-S36	Bolt 3/8-16 x 1.25 In. 42-57 N·m (31-42 Ft-Lb)
6	9061	Upper Support
7		Fuel Vapor (Rollover) Valve (Part of Tank Assembly 9002)
8	382802-S2	Nut 3/8-16 42-57 N·m (31-42 Ft-Lb)
9	5036	Fuel Tank Support
10	9002	Fuel Tank
11	9092	Strap Assembly
12	ESB-M3G56-A	Insulator .031 x 3.00 x 26.00

Item No.	Part Number	Description
13	9061	Upper Support
14	9170	Overflow Hose
15	9047	Fuel Filler Hose
16	N802826-S55M	Screw and Washer Assembly 1.70-2.83 N·m (15-25 In-Lb)
17	9030	Fuel Tank Cap Assembly
18	9034	Fuel Filler Pipe Assembly
19	—	Fuel Supply Line (Part of 9S296 Rear Tube Assembly)
20	—	Fuel Return Line (Part of 9S296 Rear Tube Assembly)
21	—	Fuel Gauge Sending Unit Retainer Ring
22	9275	Fuel Gauge Sending Unit
23	—	Nut 9-11 N·m (85-95 In-Lb)
24	—	Hose — Fuel Vapor

CA16203-A

REMOVAL AND INSTALLATION (Continued)

Front Fuel Line Installation, E-250-350 and E-350 Cutaway, 138-, 158- and 176-Inch Wheelbase



A16204-B

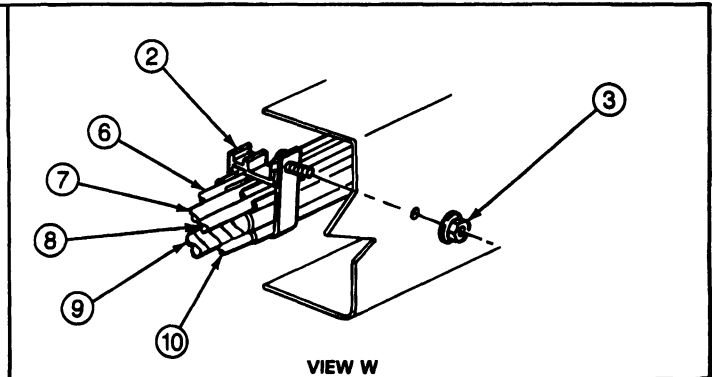
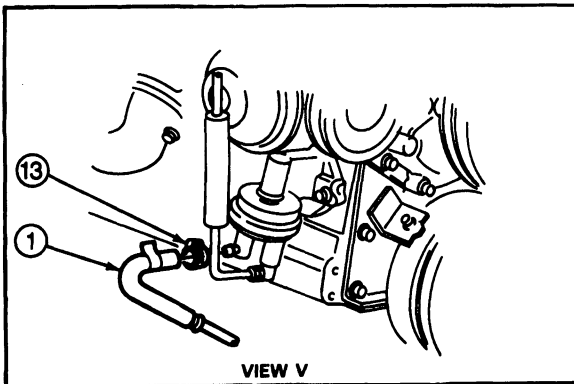
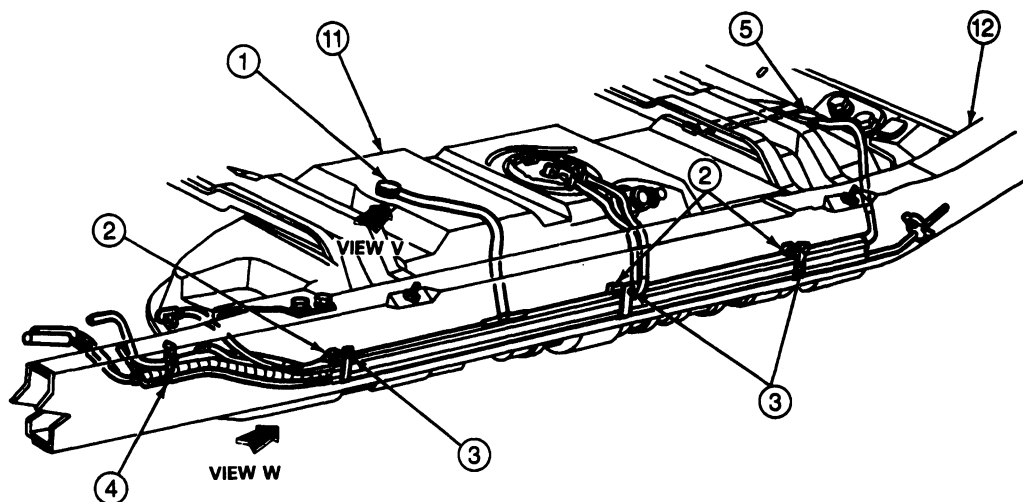
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9J296	Fuel Return Tube Assembly
2	390962-S100	Clip
3	9308	Supply Tube Assembly
4	N620480-S2	Nut
5	9N589	Clip
6	9A089	Plug
7	N802768-S	Single Clip
8	N802769-S	Double Clip
9	—	Fuel Pump

(Continued)

Item	Part Number	Description
10	—	Clamp
11	9S293	Organizer Assembly, Fuel, Brake and Electrical
12	—	Fuel Vapor Line
13	—	Fuel Return Line
14	—	Fuel Supply Line
15	—	Electrical
16	—	Brake Line
17	5005	Frame Assembly
18	9B373	Anti-Lock Brake Valve

Rear Fuel Line Installation, Midship Fuel Tanks, E-250-350



V9162-A

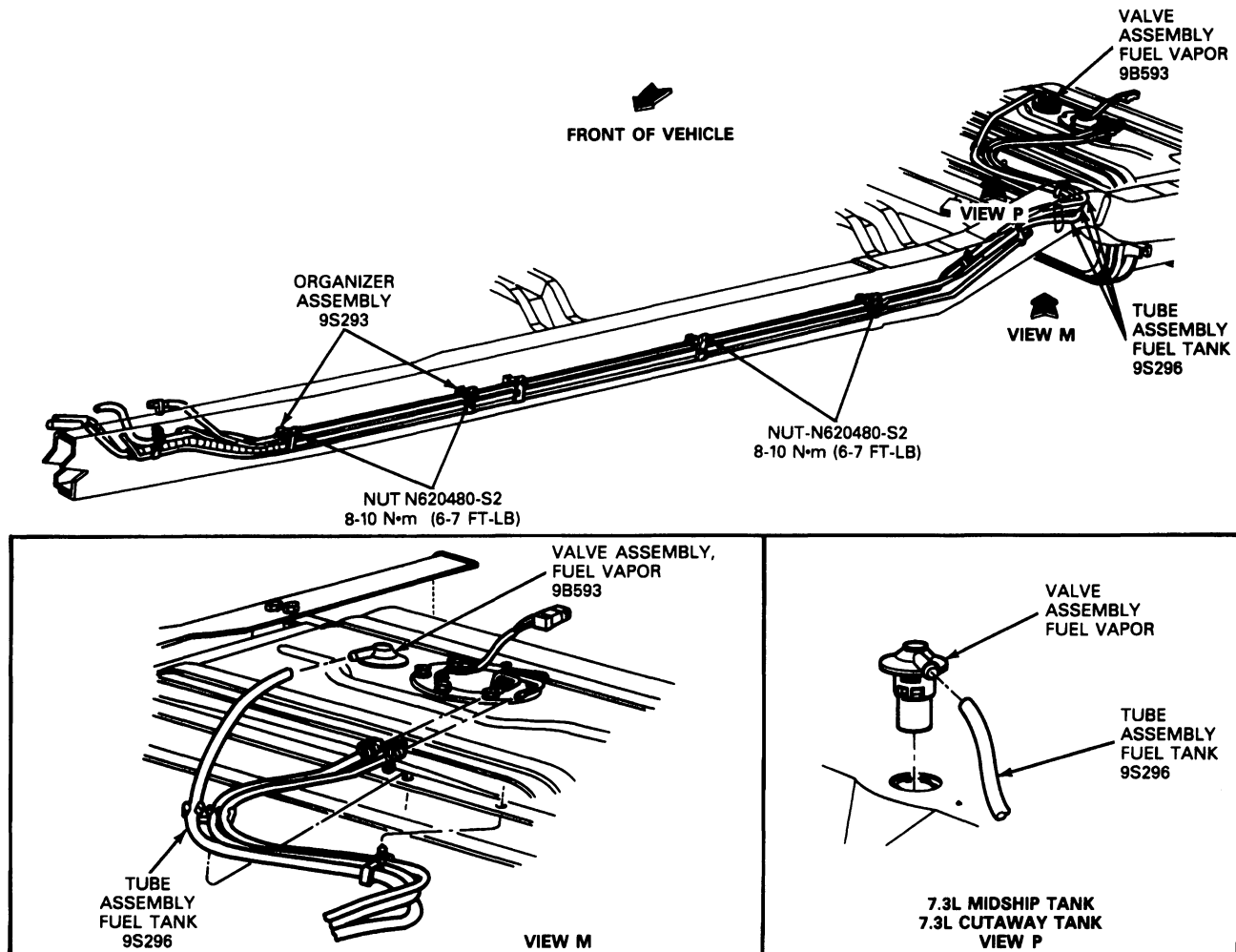
Item	Part Number	Description
1	9B227	Valve Assy., Fuel Vapor
2	9S293	Organizer Assembly, Fuel, Brake and Electrical
3	N620480-S2	Nut 8-10 N·m (6-7 Ft-Lb)
4	9N589	Clip
5	9B227	Valve Assembly, Fuel Vapor
6	—	Fuel Vapor Line

(Continued)

Item	Part Number	Description
7	—	Fuel Return Line
8	—	Fuel Supply Line
9	—	Electrical
10	—	Brake Line
11	9002	Fuel Tank Assembly
12	5005	Frame Assembly
13	383521-S	Clamp 1.6-2.2 N·m (15-19 In-Lb)

REMOVAL AND INSTALLATION (Continued)

Rear Fuel Line Installation, Aft-of-Axle Fuel Tanks, E-350 Cutaway



V9163-A

Midship Fuel Tank, E-250-350

Removal and Installation

1. Disconnect battery ground cable.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

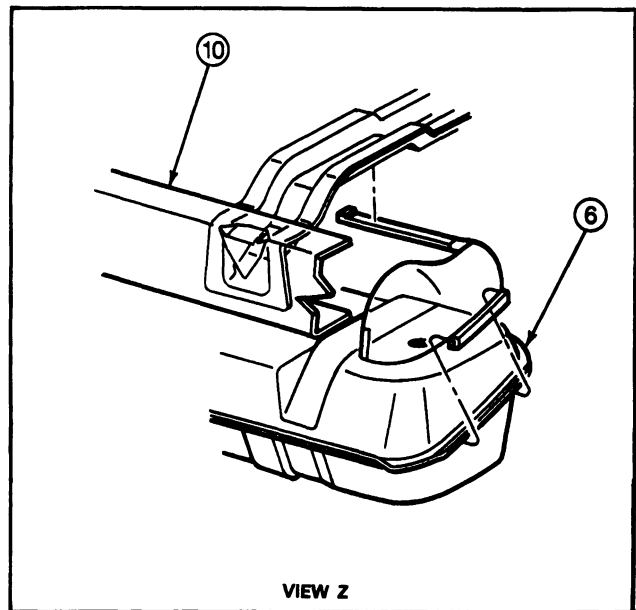
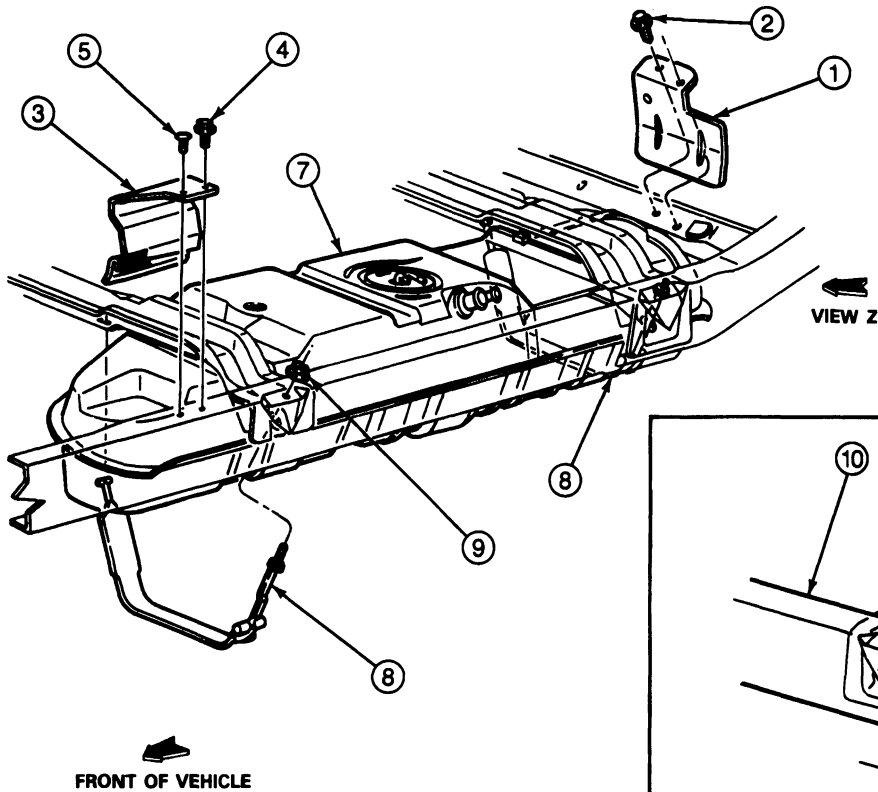
2. Raise vehicle on hoist.
3. Using Rotunda 034-00001 Fuel Storage Tanker or equivalent, drain fuel tank by first removing rear vapor valve.
- NOTE: Push valve down and rotate 90 degrees.
4. Loosen clamps and disconnect fuel filler hose and overflow hose at filler assembly.
5. Disconnect fuel gauge sending unit connector.

6. Position suitable jack under tank.
7. Remove two nuts and lower straps. If it is necessary to remove straps, turn T-bolts which are part of the straps 90° and take out.
8. Lower tank enough to gain access to fuel connections.
9. Disconnect fuel vapor hose from port valve.
10. Disconnect fuel supply and return lines according to instructions for push connectors in this section.
11. Take out fuel tank.
12. Loosen clamps and remove filler and overflow hoses from tank.

For installation, follow removal procedures in reverse order. Tighten rear shield screw to 10-14 N·m (8-10 ft-lb). Tighten front shield screw to 6-7 N·m (5-6 ft-lb). Tighten strap nuts to 17-23 N·m (13-16 ft-lb).

REMOVAL AND INSTALLATION (Continued)

Midship Fuel Tank Installation, E-250-350



V8164-A

Item	Part Number	Description
1	9B212	Shield, Fuel Tank Rear
2	N611194-S2	Screw 10-14 N·m (8-10 Ft-Lb)
3	9K014	Shield Assembly, Fuel Tank
4	N800369-S2	Screw and Washer 6-7 N·m (5-6 Ft-Lb)
5	388930-S	Push Pin

(Continued)

Item	Part Number	Description
6	9A017	Support Assembly, Fuel Tank
7	9002	Fuel Tank Assembly
8	9054	Strap Assembly, Fuel Tank
9	N820482-S2	Nut and Washer Assembly 17-23 N·m (13-16 Ft-Lb)
10	5005	Frame Assembly

TV8164A

E-250-350

The E-250-350 fuel tank installations are shown in the following illustrations.

REMOVAL AND INSTALLATION (Continued)**Aft-of-Axle Fuel Tank, E-350 Cutaway****Removal and Installation**

1. Disconnect battery ground cable.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

2. Using Rotunda 034-00001 Fuel Storage Tanker or equivalent, drain fuel tank.
3. Raise vehicle on hoist.
4. Position a suitable jack under the tank.
5. Remove four screws and fuel tank shield.

NOTE: On 55-gallon tank, shield does not have to be removed to lower tank.

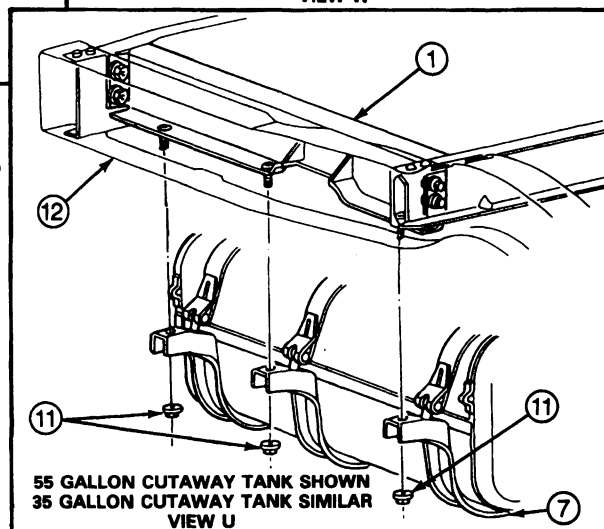
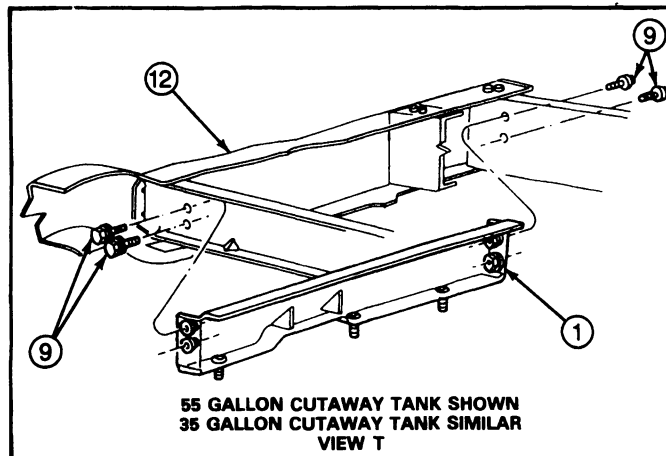
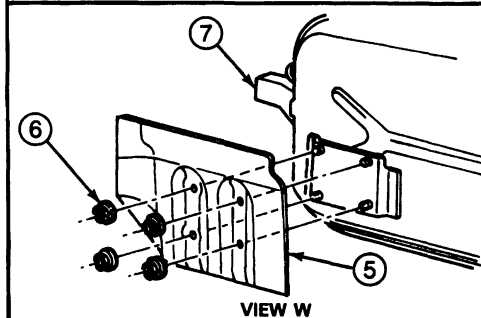
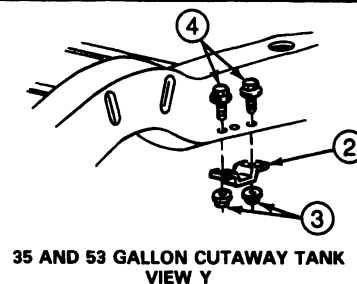
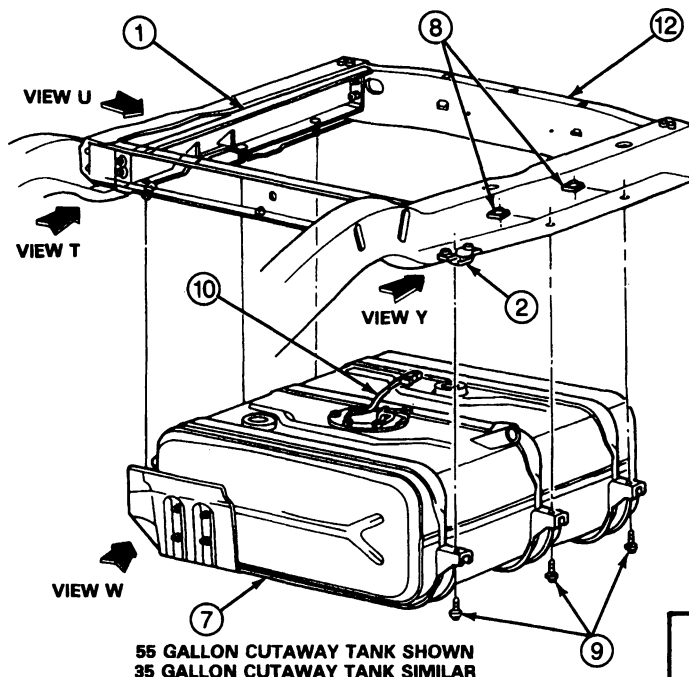
6. Loosen clamps and disconnect filler tube and overflow hoses filler tube end.
7. On 55-gallon tank, loosen strap nuts enough to relieve strap tension.

8. Lower tank.
9. Disconnect fuel pump and sending unit electrical connector.
10. Disconnect fuel vapor hose from fuel vapor valve.
11. Disconnect fuel supply and return lines according to instructions for push connectors in this section.
12. Remove fuel tank from vehicle.
13. Loosen clamps and remove filler and overflow hoses from tank.
14. If necessary, remove six nuts, fuel gauge sending unit and gasket.

For installation procedures, follow removal procedures in reverse order. Tighten shield to fuel tank nuts to 10-14 N·m (8-10 ft-lb). If removed, tighten fuel tank bracket spacer nuts to 59-81 N·m (44-59 ft-lb). Tighten strap to frame bolts to 87-119 N·m (65-87 ft-lb).

REMOVAL AND INSTALLATION (Continued)

Fuel Tank Installation, E-350 Cutaway



V9165-A

Item	Part Number	Description
1	9A017	Support Assembly, Fuel Tank
2	9071	Spacer, Fuel Tank Bracket
3	N801206-S2	Nut 59-81 N-m (44-59 Ft-Lb)
4	N803942-S2	Bolt
5	9A032	Heat Shield, Fuel Tank
6	N621939-S2	Nut 10-14 N-m (8-10 Ft-Lb)

(Continued)

Item	Part Number	Description
7	9002	Fuel Tank Assembly
8	N807463-S2	Nut and Retainer
9	N802115-S2	Bolt 87-119 N-m (65-87 Ft-Lb)
10	9H307	Sender Assembly
11	N802073-S2	Nut
12	5005	Frame Assembly

TV9165A

REMOVAL AND INSTALLATION (Continued)**Filler Pipes****F-250-350 and F-Super Duty Chassis Cab**

Procedures are the same for aft axle and midship fuel filler pipes.

Removal

1. Disconnect battery ground cable and drain fuel to a level (approximately 3/4 full) below fuel tank filler connection by using Rotunda 034-00001 Fuel Storage Tanker or equivalent.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

2. Loosen clamp attaching filler pipe hose to fuel tank filler neck. Disconnect filler pipe hose, pulling along rubber inner tube from filler neck.
3. Remove three retainer screws that attach filler pipe neck to body / box fuel filler housing.

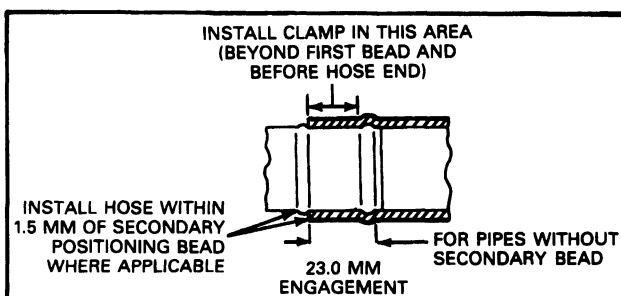
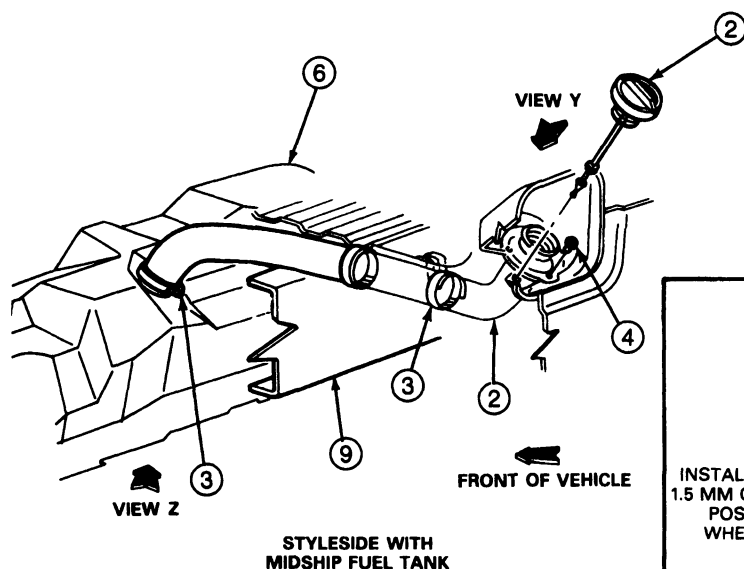
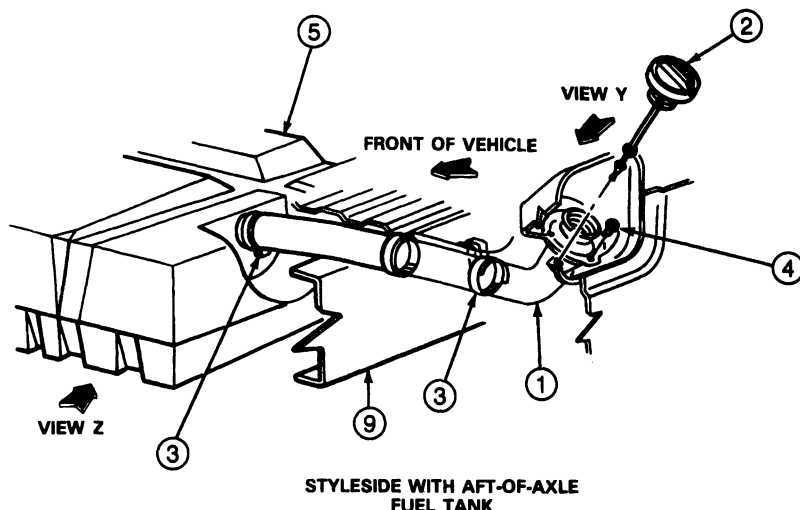
4. Remove fuel filler pipe from vehicle.
5. Remove hose and clamps. Replace cracked or leaking hoses or other damaged parts.

Installation

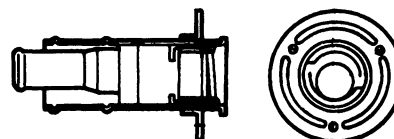
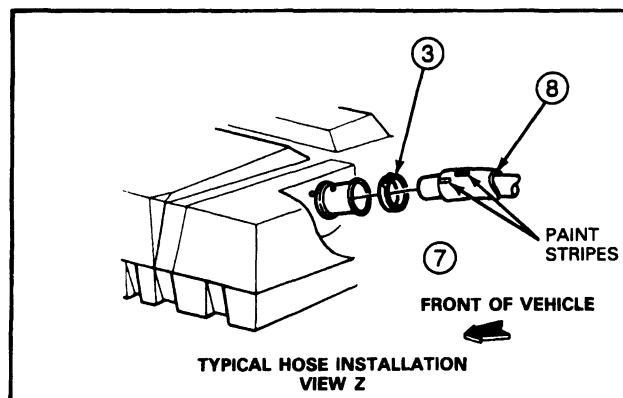
1. Position fuel filler pipe in vehicle.
2. Position clamp on filler pipe hose-to-filler pipe neck connection and insert rubber inner tube in filler neck. Make sure that the inner tube is not kinked or twisted in the neck and in the outer filler hose.
3. Install three retainer screws attaching filler pipe neck to body / box fuel filler housing. Tighten to 3-4 N·m (27-35 in-lb).
4. Adjust hose to obtain snug filler pipe installation. Tighten hose clamps to 3-4 N·m (27-35 in-lb). Make certain clamps are forward of flange on filler pipe to ensure a leakproof connection.
5. Fill tank with fuel. Install filler cap and check for leaks.

REMOVAL AND INSTALLATION (Continued)

Fuel Filler System Installation, Single Rear Wheel, F-250-350



HOSE TO TUBE CONNECTION

FOR DIESEL FUEL PIPE ASSEMBLY
VIEW Y

V5584-F

REMOVAL AND INSTALLATION (Continued)

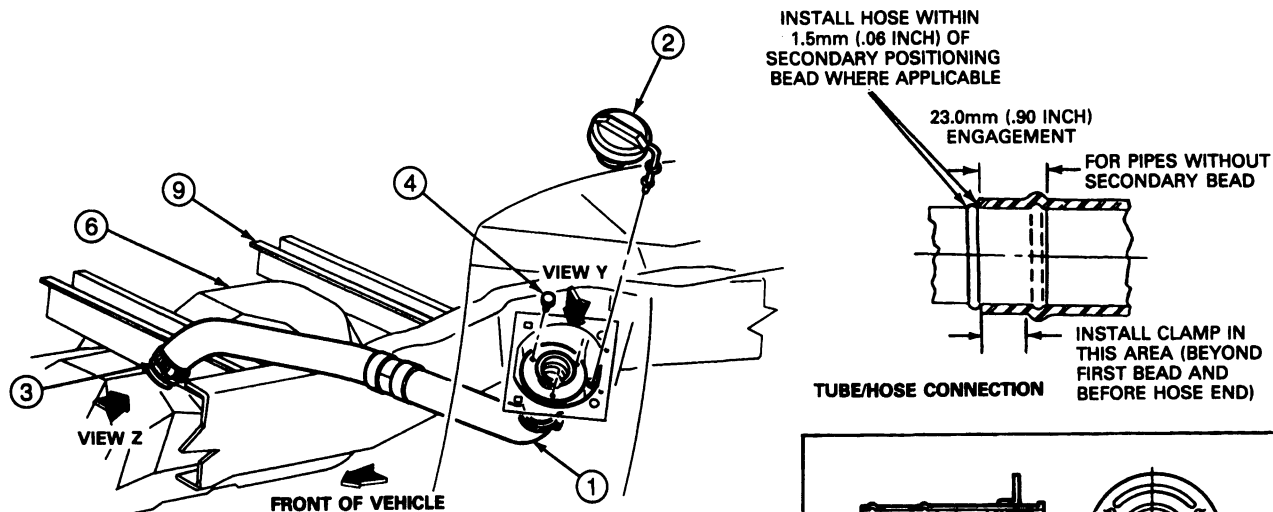
Item	Part Number	Description
1	9034	Pipe Assembly, Fuel Fill
2	9030	Cap
3	383526-S	Clamp 3-4 N-m (27-35 In-Lb)
4	N802826-S55M	Screw 3-4 N-m (27-35 In-Lb)
5	9104	Tank Assembly, Aft Axle Tank

(Continued)

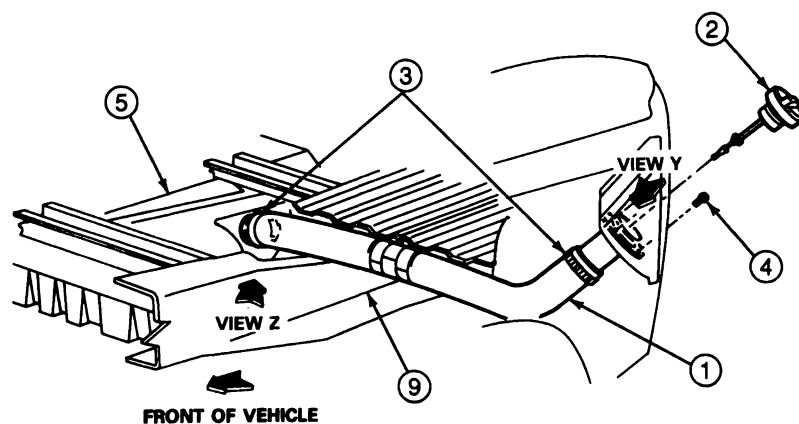
Item	Part Number	Description
6	9002	Tank Assembly
7	—	Inner Hose
8	—	Outer Hose
9	5005	Frame Assembly

TV5584A

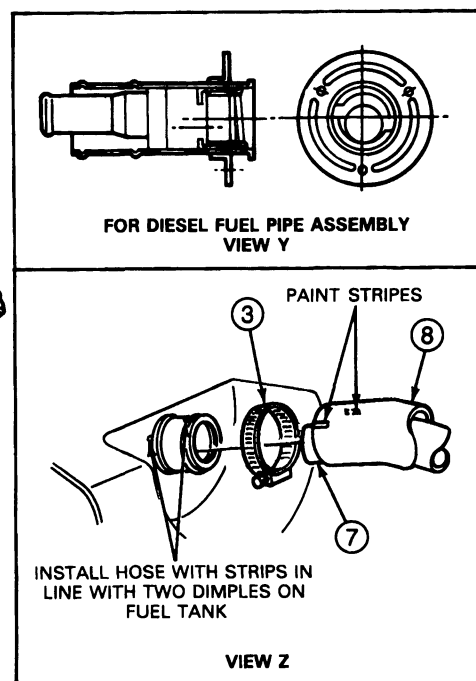
Fuel Filler System Installation, Dual Rear Wheel Flareside, F-250-350



FLARESIDE WITH DUAL REAR WHEELS AND MIDSHIP FUEL TANK



FLARESIDE WITH DUAL REAR WHEELS AND AFT-OF-AXLE FUEL TANK



V4259-K

Item	Part Number	Description
1	9034	Pipe Assembly, Fuel Fill
2	9030	Cap

(Continued)

Item	Part Number	Description
3	383526-S	Clamp 3-4 N-m (27-35 In-Lb)
4	N802826-S55M	Screw 3-4 N-m (27-35 In-Lb)

(Continued)

REMOVAL AND INSTALLATION (Continued)

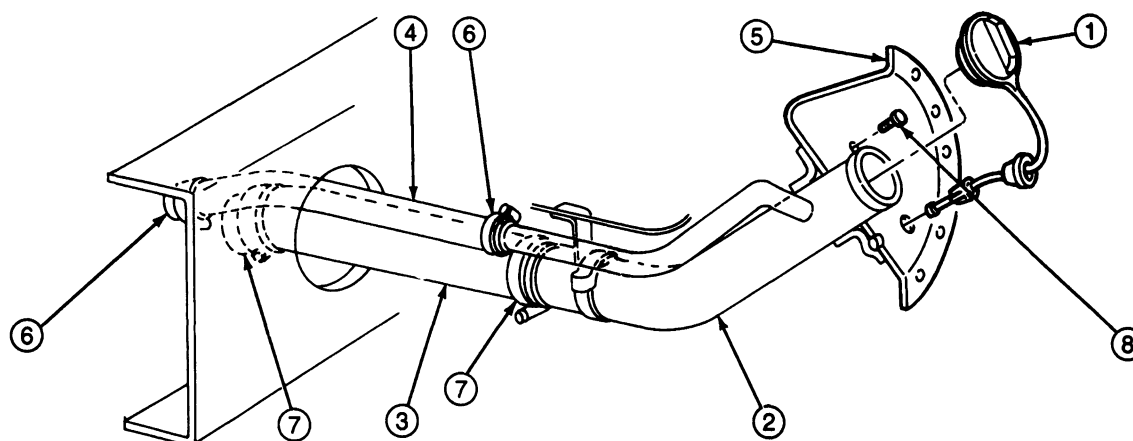
Item	Part Number	Description
5	9104	Tank Assembly, Aft Axle Tank
6	9002	Tank Assembly

(Continued)

Item	Part Number	Description
7	—	Inner Hose
8	—	Outer Hose
9	5005	Frame Assembly

TV4259A

Fuel Filler System, Aft-of-Axle, F-Super Duty Commercial and Motorhome Chassis



V8726-B

Item	Part Number	Description
1	9030	Cap Assembly, Fuel Tank Filler
2	9034	Pipe Assembly, Fuel Tank Filler
3	9047	Hose, Fuel Tank Filler
4	9170	Hose, Fuel Tank Vent Tube

(Continued)

Item	Part Number	Description
5	9B213	Support, Fuel Tank Filler Pipe
6	383522-S	Clamp
7	383526-S	Clamp
8	N802826-S55M	Screw and Washer 17-28 N·m (15-25 in·lb) (3 Req'd)

E-250-350

The procedures are the same for both aft-of-axle and midship filler pipe assemblies.

Removal

1. Disconnect battery ground cables and siphon the fuel from the tank using Rotunda Fuel Storage Tanker 034-00001 or equivalent.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

2. Remove the three retainer screws that attach the filler pipe flange to the body fuel filler pipe housing.
3. Loosen the clamps that attach the filler pipe to the fuel filler hose and the fuel vent hose. Disconnect the hoses.

4. Loosen the clamp that attaches the filler pipe to the support bracket at the underbody flange (if present).
5. Remove the fuel filler pipe assembly by rotating it through the opening in the underbody below the body housing assembly.

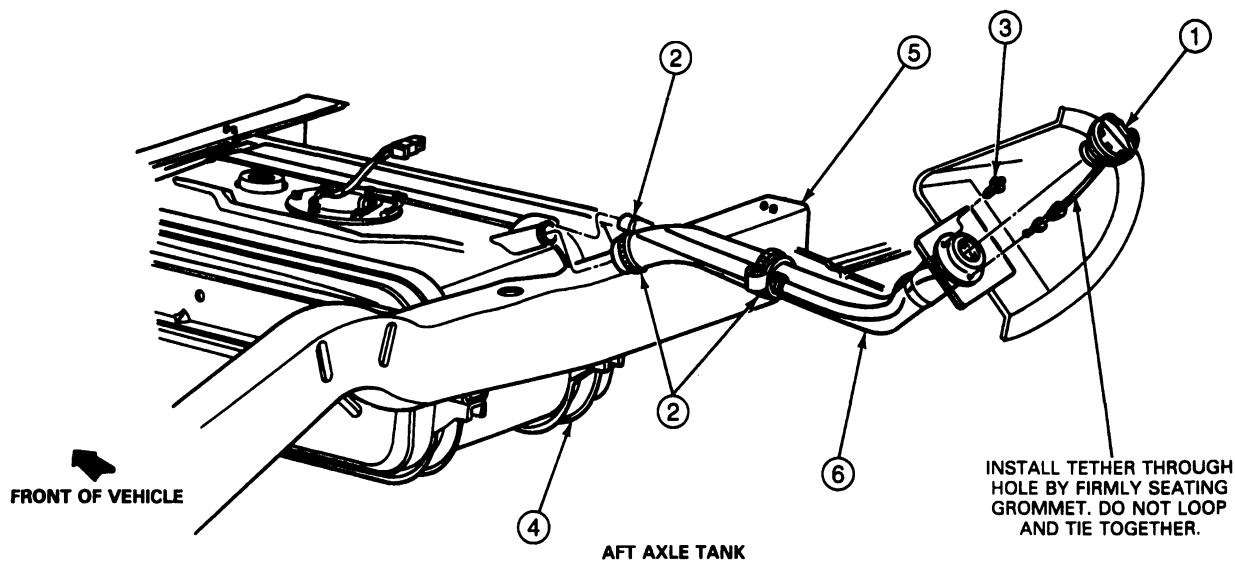
Installation

1. Install the fuel filler pipe assembly by inserting it through the underbody opening and rotating it to butt the pipe flange against the body side panel bracket.
2. Attach the pipe flange to the body side panel bracket with three retaining screws. Tighten screws to 1.8-2.8 N·m (16-24 in·lb).
3. Tighten the clamps that attach the filler pipe to the support bracket at the underbody flange to 3-4 N·m (27-35 in·lb.) (if present).
4. Connect the fuel filler hose and the fuel vent hose to the fuel filler assembly. Tighten the attaching clamps to 3-4 N·m (27-35 in·lb).

REMOVAL AND INSTALLATION (Continued)

5. Fill the tank, install fuel filler cap and check all connections for leaks.

Fuel Filler System, Aft-of-Axle Tank, E-250-350



A16212-B

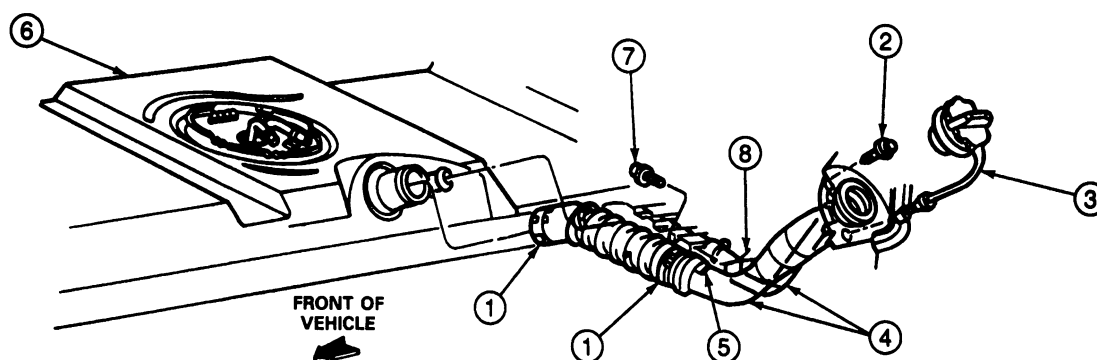
Item	Part Number	Description
1	9030	Cap
2	—	Clamp 3-4 N·m (27-35 In·Lb)
3	N802826-S55M	Screw and Washer Assembly 1.8-2.8 N·m (16-24 In·Lb)

(Continued)

Item	Part Number	Description
4	9002	Fuel Tank Assembly
5	5005	Frame Assembly
6	9B149	Kit, Fuel System

TA16212A

Fuel Filler System, Midship Tank, E-250-350



A16214-B

Item	Part Number	Description
1	—	Clamp
2	N802826-S55M	Screw and Washer Assembly 1.8-2.8 N·m (16-24 In·Lb)

(Continued)

Item	Part Number	Description
3	9030	Fuel Tank Cap Assembly (Install Tether Through Hole by Firmly Seating Grommet. Do Not Loop and Tie Together)
4	9034	Fuel Filler Pipe Assembly

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
5	9040	Bracket
6	9002	Fuel Tank

(Continued)

Item	Part Number	Description
7	N611037-S2	Screw 4.2x13 3-4 N-m (27-35 In-Lb)
8	1511218	Rear Floor

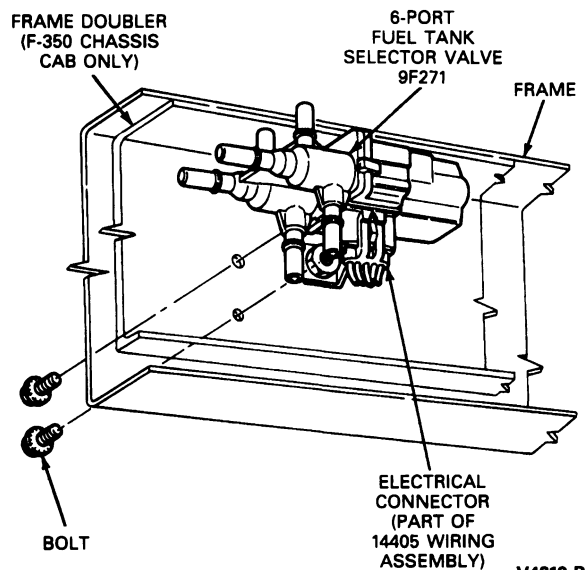
Selector Valve, Auxiliary Fuel Tank, F-250-350**Removal and Installation**

1. Disconnect battery ground cables and remove the fuel lines from the valve as outlined.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

2. Remove electrical connector.
3. Remove the two bolts mounting the selector valve.

For installation follow removal procedures in reverse order. Tighten selector valve mounting bolts to 12-16 N-m (9-11 ft-lb).

Fuel Tank Selector Valve, Typical**Fuel Filter****Removal**

1. Disconnect battery ground cables from both batteries.

NOTE: On vehicles equipped with EEC, when the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

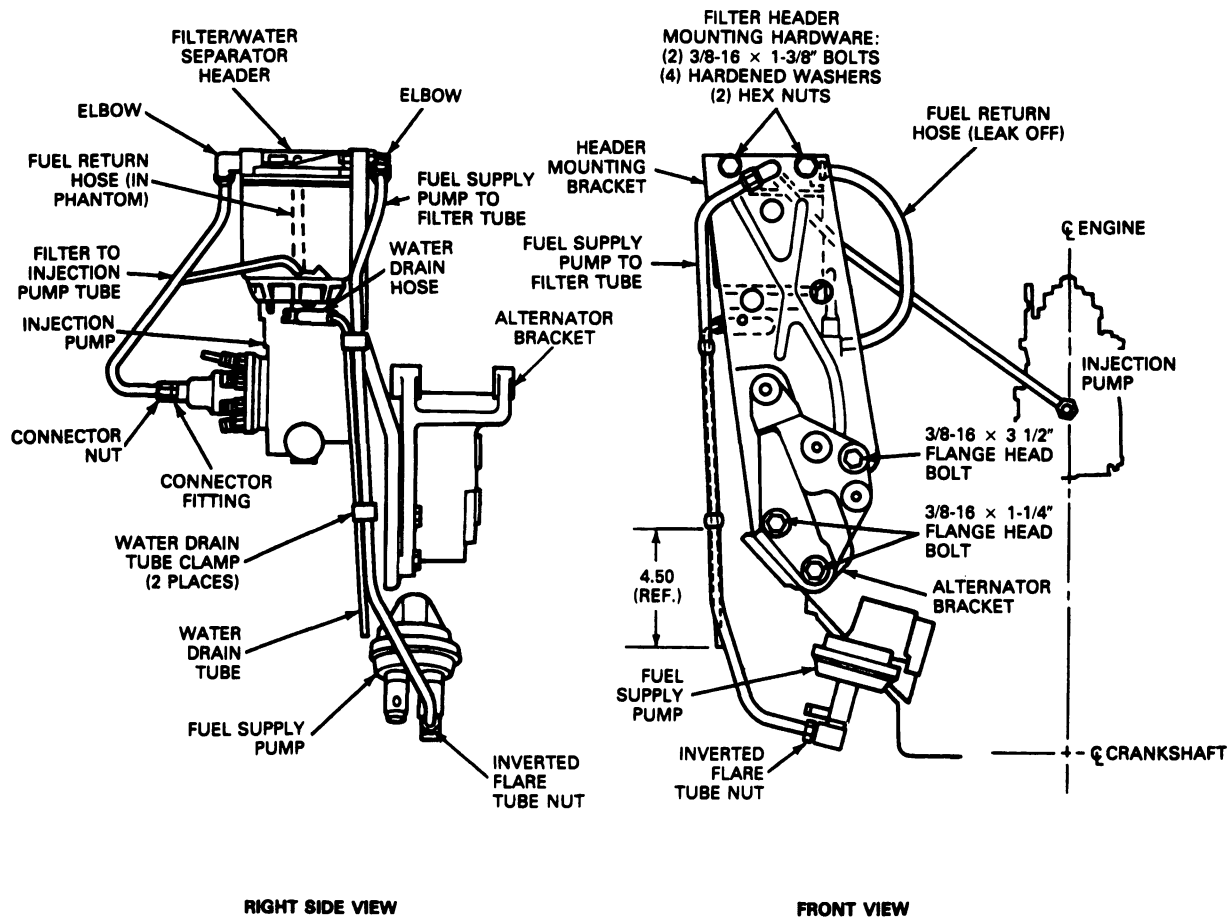
2. Place a container under vehicle and drain fuel from fuel filter.
3. Remove water drain tube from bottom of filter assembly.
4. Unscrew water separator drain bowl and remove.
5. Unscrew fuel filter element and discard.

Installation

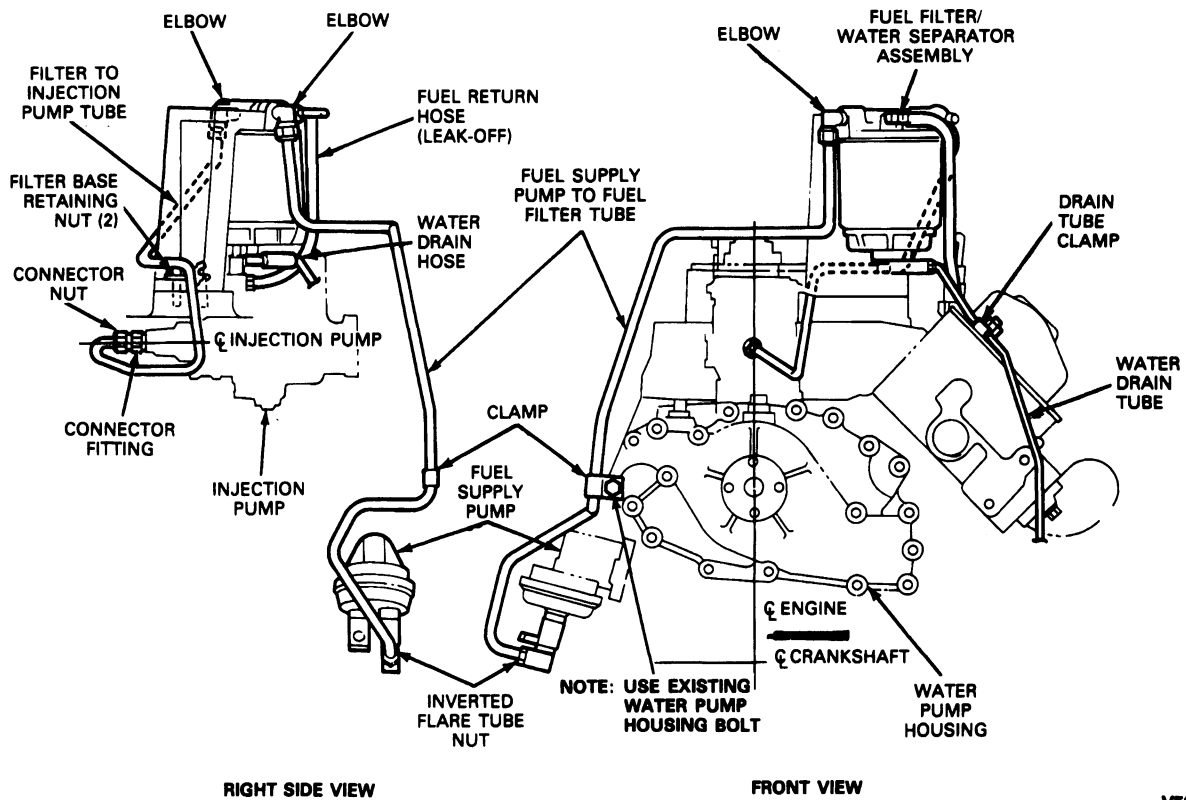
1. Clean gasket surfaces of the fuel filter adapter to prevent contamination.
2. Lightly coat filter sealing gaskets with clean diesel fuel.
NOTE: To avoid fuel contamination, do not add fuel directly to new filter. Allow engine to draw fuel through filter.
3. Screw new filter element onto filter base until seal contacts flange.
4. Tighten filter another 180 to 300 degrees of a turn.
5. Screw on water separator drain bowl. Tighten another 180 to 300 degrees of a turn.
6. Install water drain tube.
7. Clean up any spilled fuel from top of engine.
8. Connect battery ground cables to both batteries.
9. Run engine and check for fuel leaks.

REMOVAL AND INSTALLATION (Continued)

Fuel Filter Removal and Installation, 7.3L Engine, F-Series



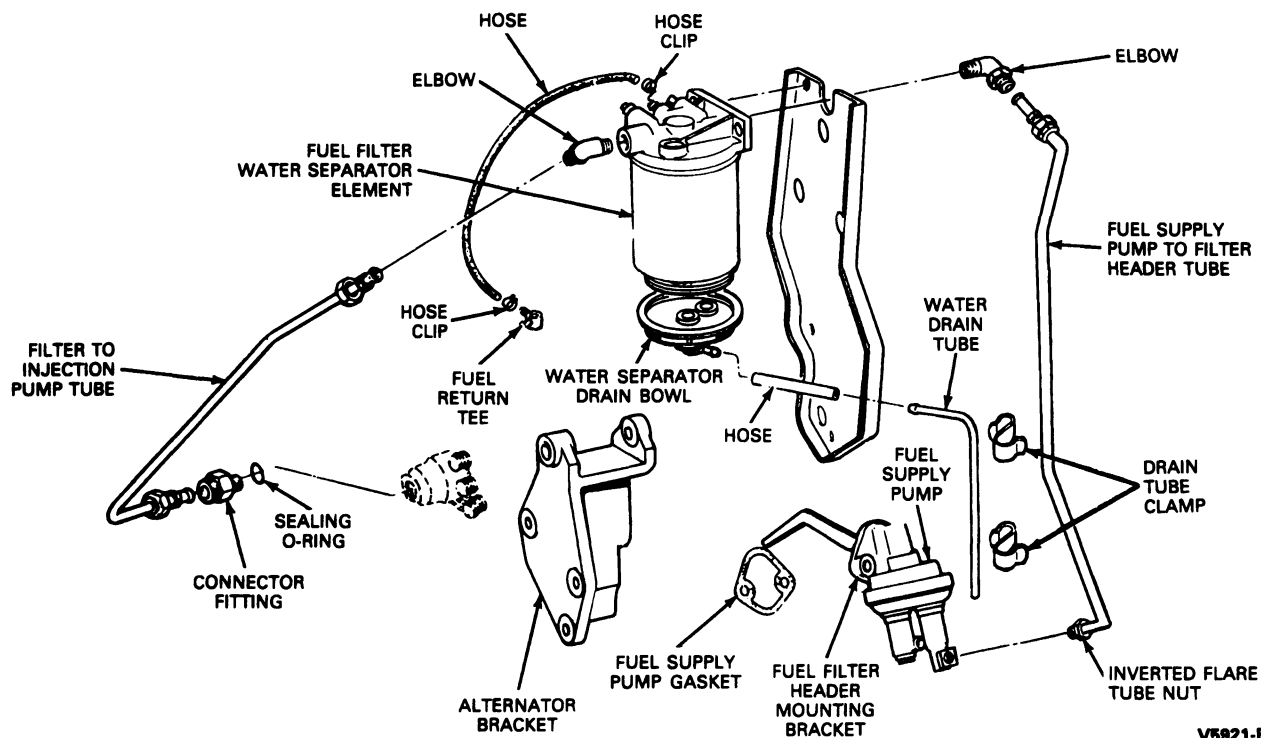
V5926-C

REMOVAL AND INSTALLATION (Continued)**Fuel Filter Removal and Installation, 7.3L Engine, E-Series**

V5925-B

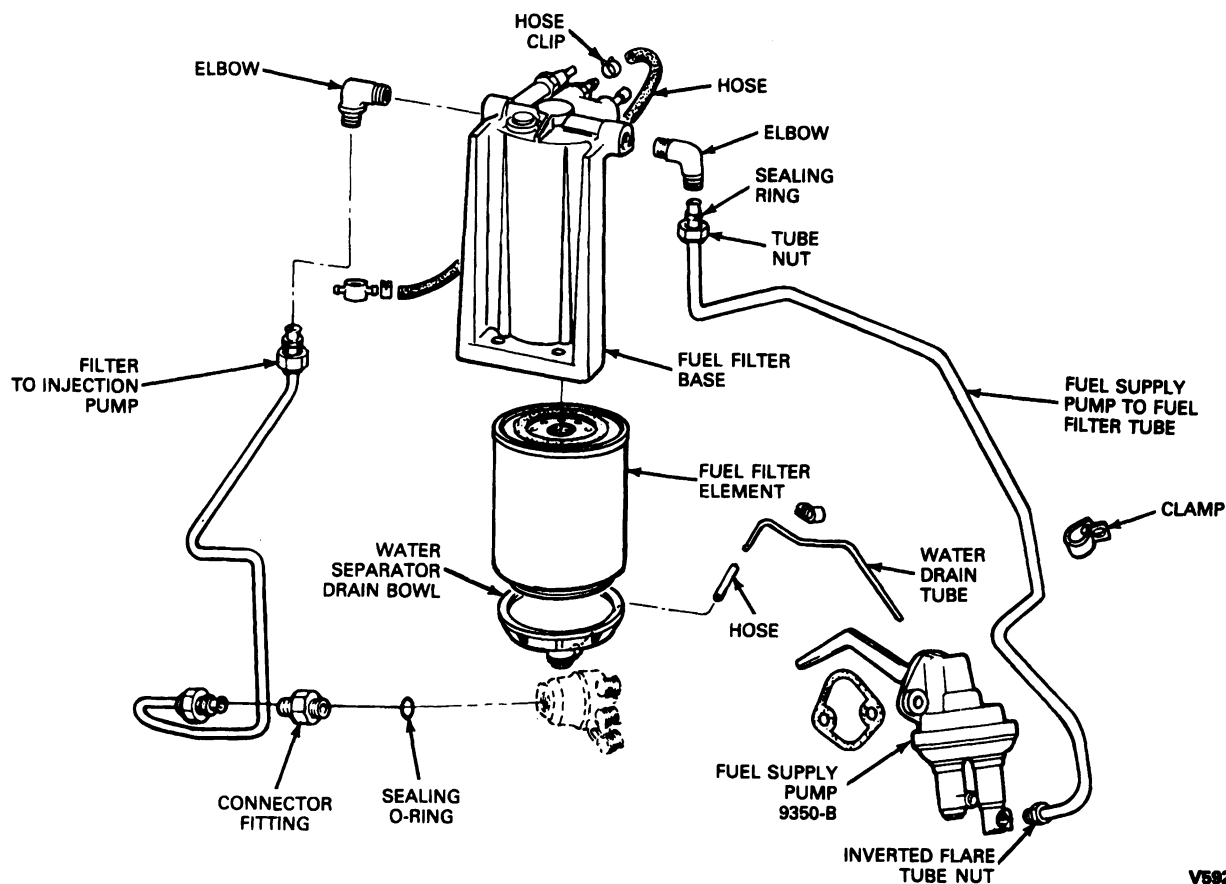
REMOVAL AND INSTALLATION (Continued)

Fuel Filter/Water Separator and Fuel Supply Pump Assembly, F-Series



REMOVAL AND INSTALLATION (Continued)

Fuel Filter/Water Separator and Fuel Supply Pump Assembly, E-Series



V5922-C

Major Service Operations

Fuel Tanks

Fuel tanks do not require special service procedures and may be steam-cleaned and / or serviced using standard procedures. After steaming, allow them to thoroughly air dry. Replace fuel tank strap bolts. Remove fuel sending unit before cleaning tank.

Fuel Tubes, Plastic

CAUTION: Ford approved nylon fuel tubing is made from material which has been tested and proven to be acceptable for use with commercially available fuels. It is also resistant to most environmental conditions. Avoid using alternate tubing materials. Use of non-approved tubing could pose a hazard in service.

CAUTION: Plastic fuel tube must not be repaired using hose and hose clamps. Push connect fittings cannot be repaired except to replace the retaining clips. Should the plastic tubes, push connect fittings or mating tube ends become damaged and leak, approved service parts must be used to service the fuel lines.

Vehicles equipped with nylon fuel tubes and push connect fittings have three types of service that can be performed on the fuel lines: replacing nylon tubing (splicing nylon to nylon), replacing push connector fittings, and replacing damaged push connect tube end.

Fuel Line Service Procedures

Fuel Lines and Hoses

CAUTION: Fuel supply lines on vehicles with fuel injected engines will remain pressurized for long periods of time after engine shutdown. The pressure must first be relieved, as outlined per the Fuel System Pressure Relief Procedure, before servicing the fuel system. Read all cautionary notes prior to relieving pressurized fuel system.

REMOVAL AND INSTALLATION (Continued)

Fuel Tubes, Plastic

CAUTION: Ford-approved nylon fuel tubing is made from material which has been tested and proven to be acceptable for use with commercially available fuels. It is also resistant to most environmental conditions. Avoid using alternate tubing materials. Use of non-approved tubing could pose a hazard in service.

CAUTION: Plastic fuel tubes must not be repaired using hose and hose clamps. Push connect fittings cannot be repaired except to replace the retaining clips. Should the plastic tubes or push connect fittings become damaged and leak, approved service parts must be used to service the fuel lines.

Fuel Lines

Vehicles equipped with nylon fuel tubes and push connect fittings have three types of service that can be performed on the fuel lines.

- Replacing nylon tubing (splicing nylon to nylon)
- Replacing push connector fittings
- Replacing damaged push connect tube ends

NOTE: Formed sections (i.e., bends) of nylon fuel lines CANNOT be repaired using straight tubing. Straight service tubing will kink if bent. Formed nylon fuel line is required to replace the damaged section.

Splicing Nylon to Nylon

1. Relieve fuel system pressure as outlined. Read cautionary note prior to relieving pressurized fuel system.
2. Cut out damaged section of tubing (straight non-formed sections only) and retain as a guide.
3. Cut a section of nylon service tubing type 11 or 12 of the same diameter and length as the damaged section of tubing.

NOTE: Type 11 or 12 nylon service tubing is available in 6.3mm (1/4-inch), 7.9mm (5/16-inch) and 9.5mm (3/8-inch) diameter sizes.

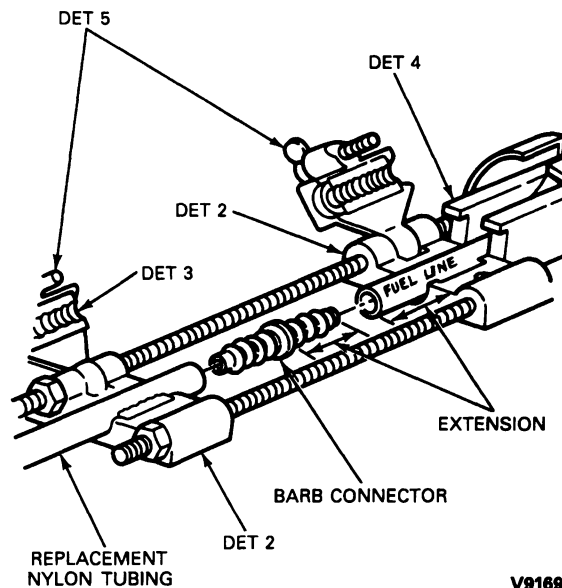
4. Select the proper plastic barbed connector(s).

- 7.9mm (5/16-inch) part #N806120 or
- 9.5mm (3/8-inch) part #N806119

for completing the splice. Two in-line connectors are required for each splice.

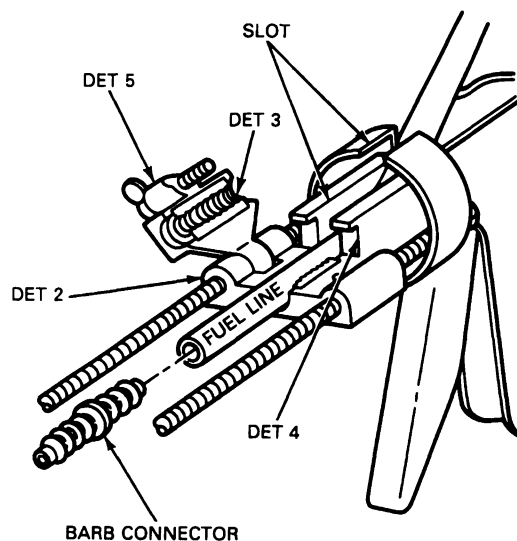
NOTE: To make insertion of the barbed connectors into the nylon line easier, the tube end may be soaked in a cup of boiling water for one minute immediately before pushing the barbed connector into the nylon. Use Rotunda Tool 134-000001 or equivalent to assist in assembly.

5. Set up Rotunda Tool 134-000001 or equivalent for in-line splice as shown in the following illustration.



V9169-A

- Select the proper inserts (DET 3) for the fuel line size and install into both sets of upper (DET 5) and lower (DET 2) block cavities.
- Connect block cavity (DET 4) to the ratcheting rod with the slot of DET 4 in line with the slot in the ratcheting tool barrel. Refer to the following illustration.

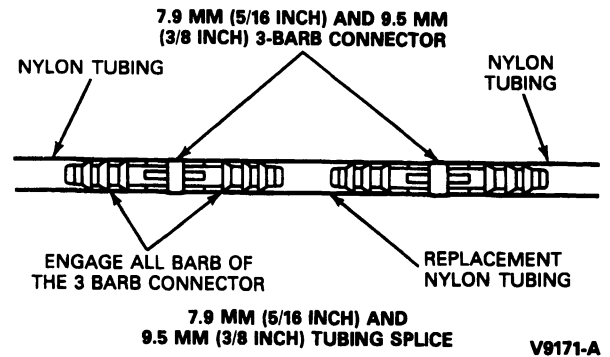


V9170-A

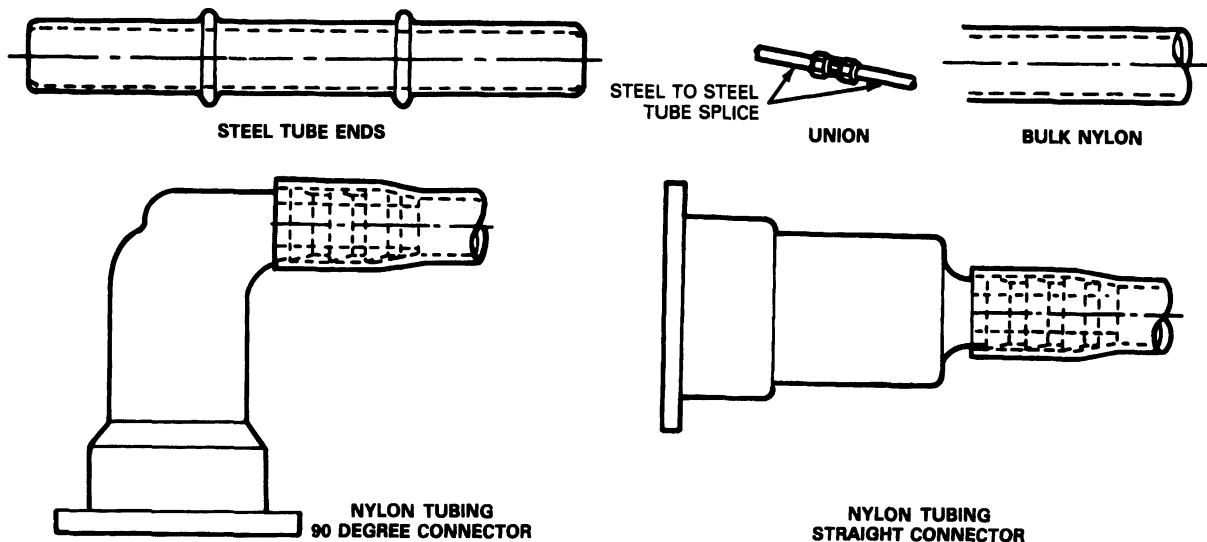
- Install both sets of upper (DET 5) and lower (DET 2) cavities to the threaded rods of the ratcheting tool. Refer to the illustration that accompanies Step 5 in this procedure.
- Install one fuel line into the lower block cavity (DET 2) closest to the ratcheting end of the tool so that the extension of the fuel line is slightly greater than the barb length of the connector.

REMOVAL AND INSTALLATION (Continued)

- Close the upper block cavity (DET 2) and tighten the thumb screw securely.
 - Route the fuel line through the slot in the tool and the slot in DET 4.
 - Place the replacement tubing in the forward lower block cavity (DET 2) and repeat the previous three steps.
 - Place the barbed connector between the ends of the lines to be spliced and ratchet the tool until the nylon line has covered all three barbs of the connector on both ends.
 - After completing the splice, unscrew the thumb screws and release the lines. Repeat the previous five steps on the opposite line end to complete the splice.
6. Completed fuel line splice is shown in the following illustration.



7. Install any remaining clips which were removed for this service and check that the fuel lines are secure in the original clips.
8. Start engine and check for leaks.

Fuel Line Service Parts

V5336-C

Replacing Damaged Steel Push Connect Tube Ends

1. Using a tube cutter, remove the damaged push connect tube end at a convenient distance from the end.
- NOTE: Allow for adequate room to tighten a union with a wrench at this location.
2. Choose a proper replacement push connect tube end.
 3. If required, form the new tube end to the same shape as the damaged tube end which was removed.

4. Select the proper size union and attach the new steel tube end to the original tube.
5. Clean off the steel tube end and replace the push connector onto the tube. (A new retainer clip is recommended.)
6. Check that the underbody clips are properly securing the fuel tubes.
7. Start engine and check for leaks.

SPECIFICATIONS

Torque Specifications

Description	N-m	Ft-Lb
Fuel Supply Pump Mounting Bolts — All	26-37	19-27
Fuel Supply Pump Outlet Connection — All	20-24	15-18
Fuel Return Line Clamp at Fuel Supply Pump — All	1.6-2.2	15-19
Organizer Clip Mounting Nuts — All	8-10	6-7
Fuel Tank Selector Valve Mounting Bolts — All	12-16	9-11
Stone Shield Mounting Nuts, Steel Aft-of-Axle Fuel Tank, F-250-350 and F-Super Duty Chassis Cab	37-50	28-36
Strap Nuts, Plastic Aft-of-Axle Fuel Tank, F-350	7-10	5-8
Skid Plate Nuts, Plastic Aft-of-Axle Fuel Tank, F-350	34-47	25-35
Shield to Frame Screw, Plastic Aft-of-Axle Fuel Tank, F-350	10-14	8-11
Fuel Tank Sender Ring, Plastic Aft-of-Axle Tank, F-350	54-75	40-55
Front Strap Nut, Plastic Midship Fuel Tank, F-Series	37-50	28-36
Rear Strap Bolt, Plastic Midship Fuel Tank, F-Series	30-41	23-30
Heat Shield to Fuel Tank Strap Nuts, Plastic Midship Fuel Tank, F-Series	16-24	12-17
Skid Plate Bolts and Nuts, Plastic Midship Fuel Tank, F-Series 4x4	16-24	12-17
Heat Shield to Frame Bolts, F-Series	11-15	9-11
Fuel Tank Sender Ring, Plastic Midship Fuel Tank, F-Series	55-68	41-50
Strap Bolts and Nuts, Steel Midship Fuel Tank, F-Series 4x2 and 4x4	30-41	23-30

(Continued)

Description	N-m	Ft-Lb
Fuel Tank Shield Bolts and Nuts, Steel Midship Fuel Tank, F-Series 4x2	16-24	12-17
Fuel Tank Strap Bracket, Steel Midship Fuel Tank, F-Series 4x4	22-28	17-20
Fuel Tank Skid Plate Bolts, Steel Midship Fuel Tank, F-Series 4x4	16-24	12-17
Strap Nuts, Aft-of-Axle Fuel Tank, F-Super Duty Commercial Stripped Chassis	60-90	44-66
Fuel Tank Sending Unit Screws, Aft-of-Axle Fuel Tank, F-Series and E-Series	9-11	7-8
Fuel Tank Shield Nuts, Aft-of-Axle Fuel Tank, E-350 Cutaway	10-14	8-10
Fuel Tank Bracket Spacer Nuts, Aft-of-Axle Fuel Tank, E-350 Cutaway	59-81	44-59
Strap to Frame Bolts, Aft-of-Axle Fuel Tank, E-350 Cutaway	87-119	65-87
Strap Nuts, Midship Fuel Tank, E-250-350	17-23	13-16
Front Shield Screw, Midship Fuel Tank, E-250-350	6-7	5-6
Rear Shield Screw, Midship Fuel Tank, E-250-350	10-14	8-10
Fuel Filler Hose Clamp	3-4	(27-35)
Filler Pipe Neck to Body Screws, F-250-350 and F-Super Duty Chassis Cab	3-4	(27-35)
Filler Pipe Neck to Support Screws, F-Super Duty Commercial and Motorhome Stripped Chassis	17-28	(15-25)
Filler Pipe Neck to Body Screws, E-250-350	1.8-2.8	(16-24)
Fuel Filler Pipe Support Bracket Clamps, E-250-350	3-4	(27-35)

TV9166A

STANDARD AND AUXILIARY DIESEL FUEL TANKS — CAPACITY IN LITERS (GALLONS)

Model		Body Style	Location	Advertised Tank Cap. Refill Liters (Gal.)
Series	Wheelbase mm (In)			
E-350 Cutaway & Stripped Chassis	3505 (138) 4013 (158) 4470 (176)	All	Aft / Axle	136 (36) 208 (55) 132 (35)
E-250-350, Super Van E-350 Super Wagon	3505 (138)	All	Midship ^a	132.7 (35)
F-250 (4x2)	3378 (133.0)	Reg. Cab	Midship Aft / Axle	72 (19) 69 (18.2)
F-250 (4x2)	3526 (138.8)	Super Cab	Midship Aft / Axle	72 (19) 69 (18.2)
F-250 (4x2)	3937 (155.0)	Super Cab	Midship Aft / Axle	72 (19) 69 (18.2)
F-250 (4x4)	3378 (133.0) w/o E4OD	Reg. Cab / Cab Chassis	Midship ^b Aft / Axle ^b	83 (22) 69 (18.2)
F-250 (4x4)	3937 (155.0)	Super Cab	Midship ^b Aft / Axle ^b	72 (19) 69 (18.2)

(Continued)

SPECIFICATIONS (Continued)

STANDARD AND AUXILIARY DIESEL FUEL TANKS — CAPACITY IN LITERS (GALLONS) (Cont'd)

Model		Body Style	Location	Advertised Tank Cap. Refill Liters (Gal.)
Series	Wheelbase mm (In)			
F-350 (4x2) and (4x4)	3378 (133.0) ^c	Reg. Cab / Cab Chassis	Midship Aft / Axle	72 (19) 69 (18.2)
F-Super Duty (4x2)	3475 (136.8)	Cab Chassis / FSD	Midship Aft / Axle ^d	72 (19) 69 (18.2)
F-Super Duty (4x2)	4084 (160.8)	Cab Chassis / FSD	Midship Aft / Axle ^d	72 (19) 69 (18.2)
F-Super Duty (4x2)	3937 (155.0)	Crew Cab	Midship Aft / Axle	72 (19) 69 (18.2)
F-250-350 (4x4) WE4OD	3378 (133.0)	Reg. Cab / Cab Chassis	Midship ^e Aft / Axle	87 (22) 69 (18.2)
F-Super Duty Commercial Stripped Chassis	4013 (158.0) 4521 (178.0)	Stripped Chassis Stripped Chassis	Aft / Axle Aft / Axle	151 (40) 151 (40)

a Steel Auxiliary Tank

b W/R.P.O. Skid Plate

c (4x4) W/O E4OD and All (4x2)

d Standard Skid Plate

e Plastic Tank

TV4267A


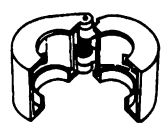
FUEL SUPPLY PUMP

Engine Ltr (CID)	Static Pressure kPa (PSI) ^①	Mounting Bolts N-m (Ft-Lb)	Fuel Lines to Pump N-m (Ft-Lb)
7.3L (445)	41-55 (6-8)	26-37 (19-27)	20-24 (15-18)

① On engine with temperatures normalized and at normal curb idle speed, transmission neutral.

CV5514-C

SPECIAL SERVICE TOOLS/EQUIPMENT

Tool Number / Description	Illustration
T74P-9275-A Fuel Tank Sender Wrench	 T74P-9275-A
T83P-19623-C Spring-Lock Coupling Tool—5/8 inch	 T83P-19623-C

Tool Number	Description
D84P-9275-A	Fuel Tank Sender Wrench
D87L-9280-A	Spring-Lock Coupling Tool—3/8 inch
D87L-9280-B	Spring-Lock Coupling Tool—1/2 inch

ROTUNDA EQUIPMENT

Tool Number	Description
059-00008	Vacuum and Pressure Tester
018-00003	Safety Can
014-00761	Vacuum / Pressure Tester
034-00002	Fuel Storage Tanker
034-00006	Suction Pump
134-00001	Plastic Fuel Line Connector Tool

SECTION 10-02 Accelerator Linkage

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION (Cont'd.)	
Kickdown Rod	10-02-16	Accelerator Control and Kickdown Cable Installation, F-250 HD, F-350, F-Super Duty with 7.5L MFI Engine	10-02-12
Throttle Valve (TV) Control Cable System, AOD Automatic Overdrive Transmission	10-02-15	Accelerator Control Cable Installation, E-150-250-350 with 5.0L MFI and 5.8L MFI Engines	10-02-9
Kickdown Rod, C6 Automatic Transmission (7.3L Diesel Only)	10-02-16	Accelerator Control Cable Installation, F-150-250-350 and Bronco with 5.0L MFI and 5.8L MFI Engines	10-02-7
Transmission Kickdown Cable, C6 Automatic Transmission (4.9L Engine)	10-02-15	Accelerator Control Cable Installation, F-Super Duty Motorhome Chassis Vehicles with 7.5L MFI Engine	10-02-15
DIAGNOSIS	10-02-1	Accelerator Control, E-250-350 7.3L Diesel Engine	10-02-11
REMOVAL AND INSTALLATION		Accelerator Control, F-250-350, F-Super Duty with 7.3L Diesel Engine	10-02-10
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Accelerator Control and Kickdown Cable Installation, F-150-250-350 and Bronco with 5.0L MFI and 5.8L MFI Engines	10-02-8		

VEHICLE APPLICATION

F-150-250-350, F-Super Duty, Bronco and E-150-250-350 Vehicles

DIAGNOSIS

The following chart will serve as an aid in diagnosing accelerator linkage problems.

ACCELERATOR PEDAL TO THROTTLE BODY

CONDITION	ACTION TO TAKE
Accelerator pedal is hard to push down or has a rough / raspy or sticky feel. NOTE: Accelerator cable should not be lubricated and it is not serviceable.	Disconnect cable end from ball stud at throttle body making sure the disconnected end of the cable or its spring does not come into contact with any of the surrounding parts. Operate the pedal by hand, observing and feeling that the full pedal range of travel is not restricted by the dash panel insulator or carpet / mat / padding. If full pedal travel to WOT is restricted, adjust insulator and / or trim items as required. Operate the pedal by foot. If cable operation is smooth, refer to the throttle body diagnosis procedures in the appropriate section in the Powertrain Control / Emissions Diagnosis Manual. If the condition reoccurs (being sure disconnected end of cable has not come into contact with anything), check the foot pedal assembly for free operation. If the pedal operation is free, replace the cable.

(Continued)

DIAGNOSIS (Continued)**ACCELERATOR PEDAL TO THROTTLE BODY (Cont'd)**

CONDITION	ACTION TO TAKE
High engine idle speed.	If the cable ball socket extends beyond the throttle lever ball stud, refer to the throttle body diagnosis procedures in the appropriate section in the Powertrain Control / Emissions Diagnosis Manual. If the socket does not extend beyond the stud, check the foot pedal assembly for free operation (free from carpet, mats, wiring, etc., contact). If the pedal operation is free, replace the cable.

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REMOVAL AND INSTALLATION**Accelerator Cable, F-150-250-350, F-Super Duty, Bronco and E-150-250-350**

Refer to the appropriate illustration when performing removal and installation procedures.

Removal and Installation

CAUTION: Be sure to install throttle return springs as shown on the illustrations.

1. Remove cable from pedal shaft.
2. Remove cable grommet from dash panel and remove cable.
NOTE: Some accelerator cables are held to the instrument panel with a screw.
3. Remove the accelerator splash shield from the accelerator cable bracket, if so equipped.
4. Remove accelerator cable from ball stud and cable mounting bracket.

For installation follow removal procedures in reverse order.

Some new accelerator cables come with a plastic core protector over the end that goes through the instrument panel. Do not remove core protector until cable has been installed in instrument panel. Refer to the appropriate illustration for accelerator cable to instrument panel holding screw tightening specifications.

NOTE: Accelerator cable grommets must be fully seated into accelerator pedal shaft assembly slotted hole and dash reinforcement hole.

WARNING: NO SURROUNDING ENGINE COMPARTMENT COMPONENTS SUCH AS WIRING OR HOSES MAY CONTACT ANY MOVING MEMBER OF THE ACCELERATOR CONTROLS. ALL VEHICLES ASSEMBLED ARE TO BE CHECKED FOR RETURN TO IDLE AS FOLLOWS: NO PERCEPTIBLE HESITATION OR PREVENTION OF RETURN TO THE IDLE POSITION MAY OCCUR DURING SLOW REMOVAL OF THE FOOT FROM THE ACCELERATOR PEDAL STARTING AT THE FULLY DEPRESSED WIDE OPEN THROTTLE (WOT) POSITION.

Accelerator Cable, F-Super Duty Commercial and Motorhome Chassis Vehicles**Removal and Installation**

1. Remove cable from pedal shaft.
2. Remove cable grommet from instrument panel and remove cable.
NOTE: Some accelerator cables are held to the instrument panel with screws.
3. Remove the accelerator splash shield from the accelerator cable bracket, if so equipped.
4. Remove accelerator cable from ball stud and cable mounting bracket.

For installation follow removal procedures in reverse order. Refer to the appropriate illustration for accelerator cable to instrument panel holding screw tightening specifications.

NOTE: Accelerator cable grommets must be fully seated into accelerator pedal shaft assembly slotted hole and dash reinforcement hole.

WARNING: NO SURROUNDING ENGINE COMPARTMENT COMPONENTS SUCH AS WIRING OR HOSES MAY CONTACT ANY MOVING MEMBER OF THE ACCELERATOR CONTROLS. ALL VEHICLES ASSEMBLED ARE TO BE CHECKED FOR RETURN TO IDLE AS FOLLOWS: NO PERCEPTIBLE HESITATION OR PREVENTION OF RETURN TO THE IDLE POSITION MAY OCCUR DURING SLOW REMOVAL OF THE FOOT FROM THE ACCELERATOR PEDAL STARTING AT THE FULLY DEPRESSED WIDE OPEN THROTTLE (WOT) POSITION.

Accelerator Pedal Shaft Assembly**Removal**

1. Remove accelerator cable from pedal shaft.
2. Remove the screws holding the pedal shaft to the instrument panel.
3. Remove the pedal shaft assembly from the instrument panel.

REMOVAL AND INSTALLATION (Continued)**Installation**

NOTE: For F-Super Duty Commercial and Motorhome Chassis vehicles, position pedal assembly to instrument panel and install holding screws.

1. For F-Series, Bronco and Econoline, position pedal assembly to instrument panel and install lower screw hand tight.
2. Install upper screw and tighten to 21-29 N·m (15-21 ft·lb).
3. Install middle screw and tighten to 21-29 N·m (15-21 ft·lb).
4. Tighten lower screw to 21-29 N·m (15-21 ft·lb).
5. Snap all accelerator cables into slotted hole in accelerator shaft assembly.

Accelerator Cable Bracket**Removal and Installation**

1. Remove the accelerator control splash shield, if equipped.
2. Remove the accelerator cable from the cable bracket.
3. Remove the transmission kickdown cable from the accelerator cable bracket, if equipped.
4. Remove the cable bracket holding screws and remove the bracket from the upper intake manifold.

For installation follow removal procedures in reverse order. Refer to the appropriate illustration for screw tightening specifications.

Throttle Valve Cable, All Models With AOD Transmission**Removal**

1. Open hood and raise vehicle just enough to gain access to transmission while still able to work on throttle body connections.
2. Install a spring on the throttle valve (TV) lever on the transmission to hold it in the full clockwise position.
3. Pry TV cable end off of TV lever.
4. Squeeze tabs on cable retainer and remove from bracket.
5. Remove throttle body splash shield if equipped. Squeeze tabs on TV cable and pull cable conduit out of bracket.
6. Snap cable off of ball on throttle body lever.

Installation

1. Insert cable into throttle accelerator cable bracket so locking tab is on top and snap cable end onto throttle body ball. **Do not** snap cable locking tab down into position.

2. Route cable to transmission and through bracket.
3. Make sure spring is in place securing TV lever in full clockwise position. Snap TV cable end onto TV lever ball and snap cable into bracket.
4. Push down locking tab at engine end of conduit fitting to lock conduit at correct length. Tab is flush with circular profile of fitting.
5. Remove spring from TV lever and install throttle body splash shield if equipped.

Kickdown Cable, Vehicles with C6 Automatic Transmission**Removal**

1. Remove throttle body splash shield if equipped.
2. Snap kickdown cable off throttle body ball. Using pliers, depress lock on kickdown cable conduit and remove it from bracket.
3. Raise vehicle enough to gain access to transmission and still be able to access throttle body area.
4. Snap kickdown cable off of transmission kickdown lever.
5. Squeeze tabs on kickdown cable conduit and remove cable from bracket and from vehicle.

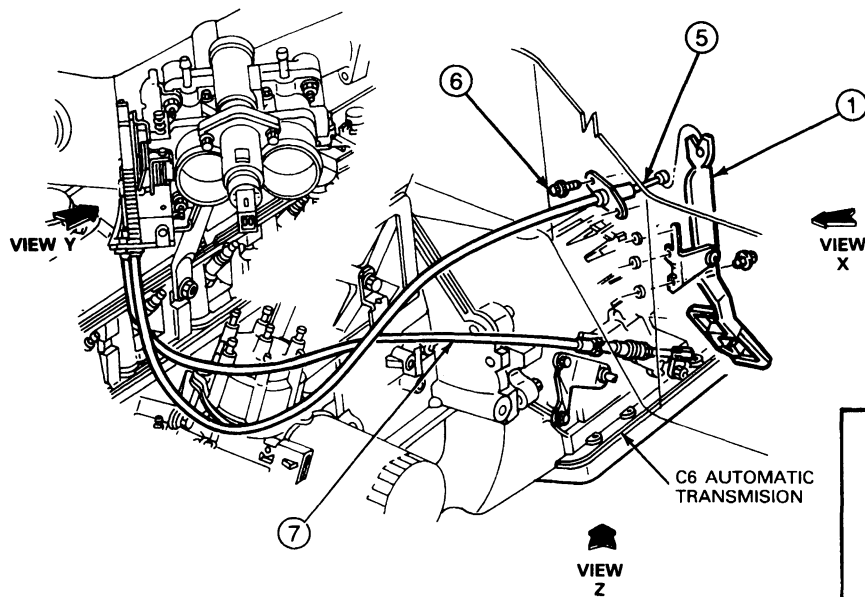
Installation

1. Make sure that throw-away red spacer is secured on cable end fitting at throttle body end. If red spacer is not present, use 5mm shim or spacer.

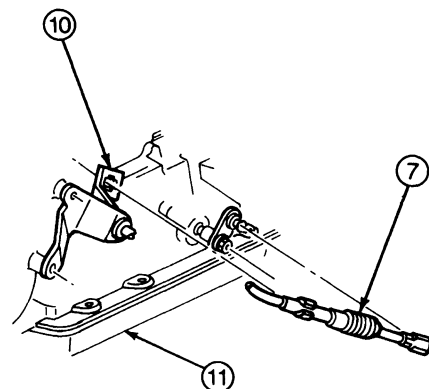
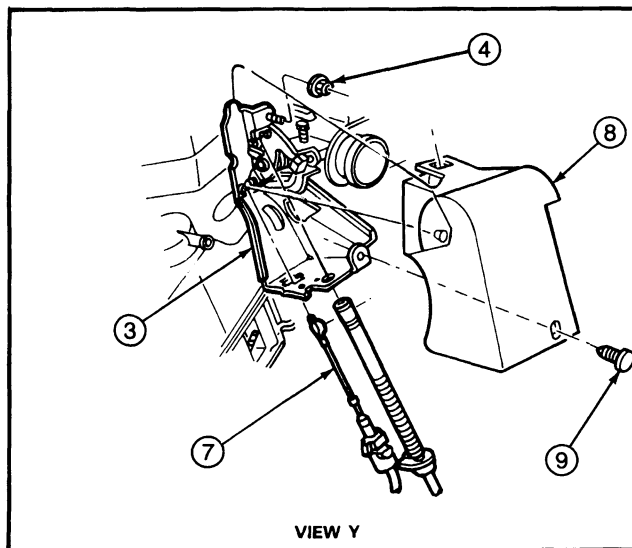
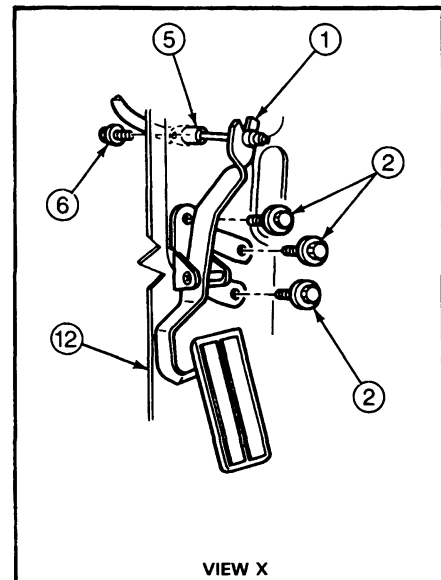
NOTE: Spacer provides 5mm (0.2-inch) gap between metal cable end stop and plastic end fitting.
2. Insert conduit fitting into engine bracket and slide cable end fitting onto ball stud on throttle lever.
3. Route cable down to transmission and insert conduit fitting into bracket and snap into place.
4. Snap cable end onto ball stud on transmission kickdown lever.
5. Ratchet cable adjusting ratcheting mechanism to correct setting by rotating to wide open throttle (W.O.T.) position by hand.
6. **REMOVE RED SPACER.**
7. Install throttle body splash shield.

REMOVAL AND INSTALLATION (Continued)

Accelerator Control and Kickdown Cable Installation, F-150-250-350 and Bronco with 4.9L MFI Engine



BRONCO F-150-250-350
WITH C6, E4OD AUTOMATIC TRANSMISSION
AND MANUAL TRANSMISSION



C6 AUTOMATIC TRANSMISSION INSTALLATION
VIEW Z

V5932-E

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9726	Accelerator Pedal Shaft Assembly
2	N801921-S2	Screw and Washer 21-29 N·m (15-21 Ft·Lb)
3	9728	Accelerator Cable Bracket
4	45357	Nut
5	9A758	Accelerator Cable Assembly
6	N610959-S2	Screw 1.7-3.4 N·m (15-30 In·Lb)

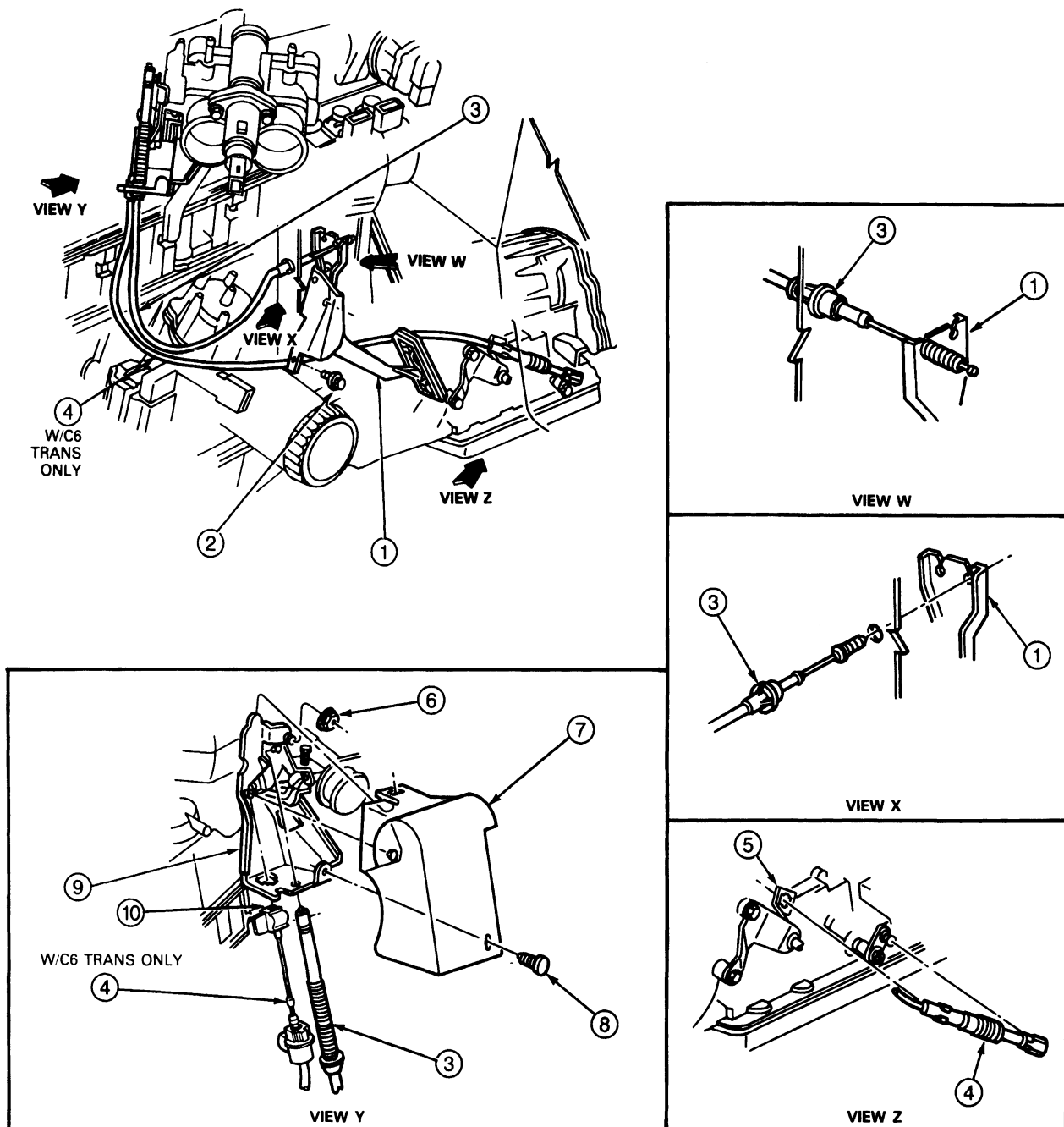
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Item	Part Number	Description
7	7A185	Transmission Kickdown Cable Assembly
8	9E766	Accelerator Control Splash Shield
9	N804527-S	Pushpin
10	7C431	Bellcrank Bracket
11	Ref.	C6 Automatic Transmission
12	Ref.	Instrument Panel

TV5932A

REMOVAL AND INSTALLATION (Continued)

Accelerator Linkage, E-150-250-350 with 4.9L MFI Engine and C6 Transmission



A16188-B

Item	Part Number	Description
1	9726	Accelerator Pedal Shaft Assembly
2	W611636-S2	Screw 21-29 N·m (15-21 Ft-Lb)

(Continued)

Item	Part Number	Description
3	9A758	Accelerator Cable Assembly
4	7A185	Transmission Accelerator Kickdown Cable (Red Spacer to be Removed after Kickdown Cable Adjustment)

(Continued)

REMOVAL AND INSTALLATION (Continued)

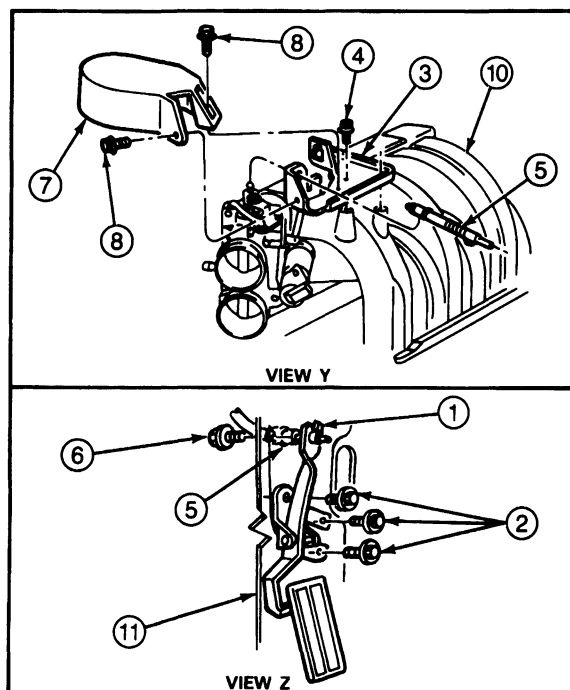
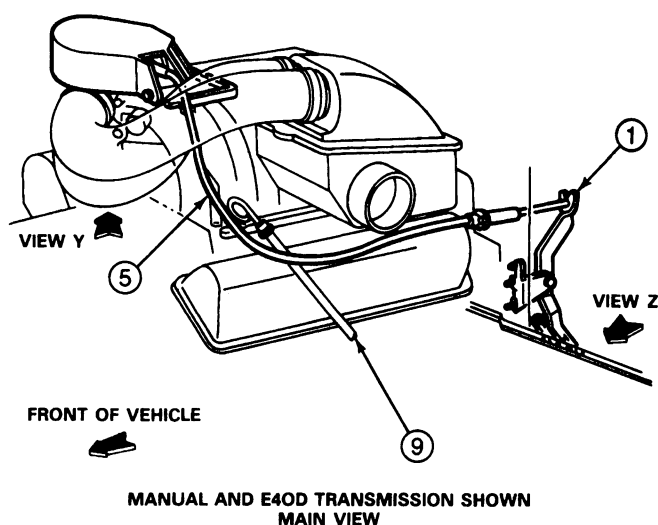
Item	Part Number	Description
5	7C431	Bellcrank Bracket
6	45357-S8	Nut
7	9E766	Accelerator Splash Shield

(Continued)

Item	Part Number	Description
8	N804527-S	Pushpin
9	9728	Accelerator Cable Bracket
10	—	5mm (0.2 inch)

TA16188A

Accelerator Control Cable Installation, F-150-250-350 and Bronco with 5.0L MFI and 5.8L MFI Engines



V4766-G

Item	Part Number	Description
1	9726	Accelerator Pedal Shaft Assembly
2	N801921-S2	Screw and Washer 21-29 N·m (15-21 Ft-Lb)
3	9728	Accelerator Cable Bracket
4	56719-S2	Bolt 21-27 N·m (16-19 Ft-Lb)
5	9A758	Accelerator Cable Assembly

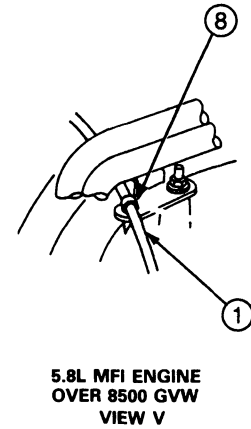
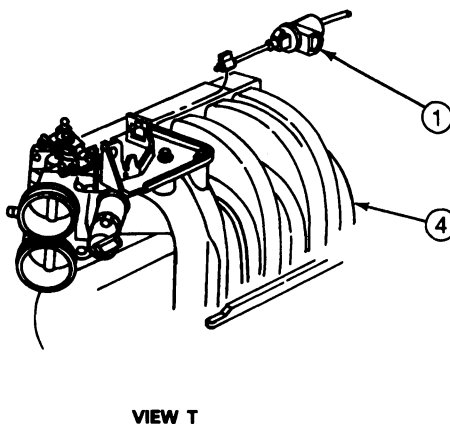
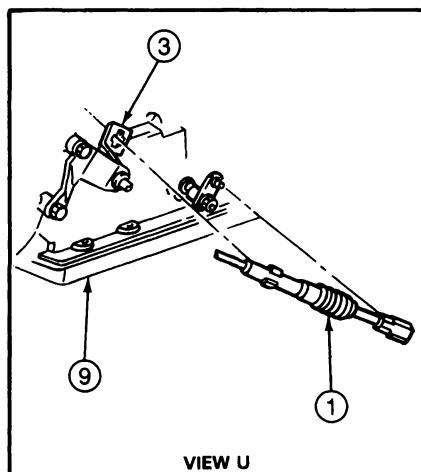
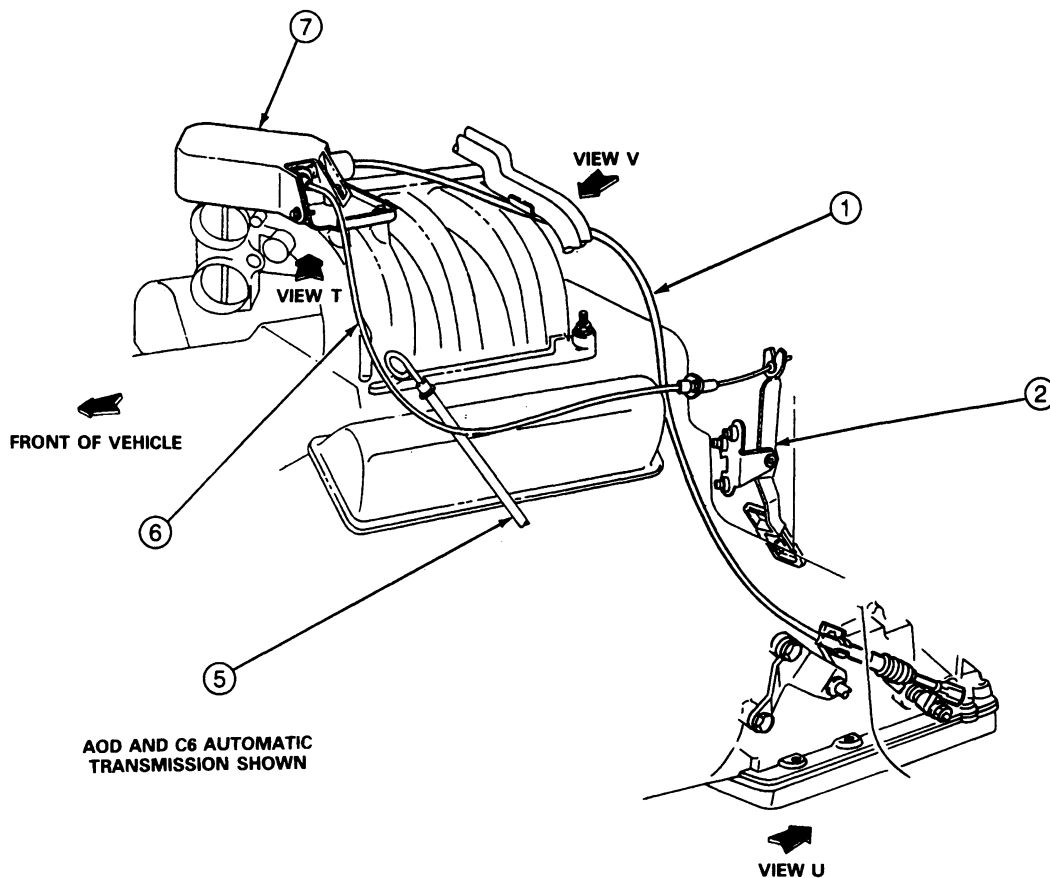
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Item	Part Number	Description
6	N610959-S2	Screw 2-3 N·m (18-26 In-Lb)
7	9E766	Splash Shield
8	N802826-S55M	Screw 5-9 N·m (45-79 In-Lb)
9	Ref.	Oil Dipstick
10	Ref.	Upper Intake Manifold
11	Ref.	Instrument Panel

TV4766A

REMOVAL AND INSTALLATION (Continued)

Accelerator Control and Kickdown Cable Installation, F-150-250-350 and Bronco with 5.0L MFI and 5.8L MFI Engines



A16196-B

Item	Part Number	Description
1	7A185	Kickdown Cable Assembly
2	9726	Accelerator Pedal Shaft Assembly

(Continued)

Item	Part Number	Description
3	7C431	Bellcrank Bracket
4	9424	Upper Intake Manifold
5	6764	Engine Oil Dipstick Tube

(Continued)

REMOVAL AND INSTALLATION (Continued)

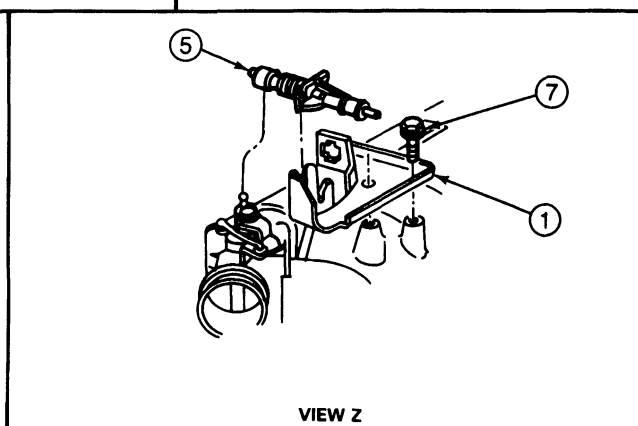
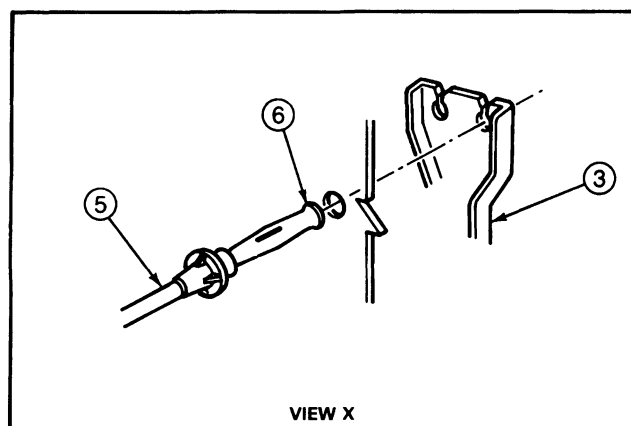
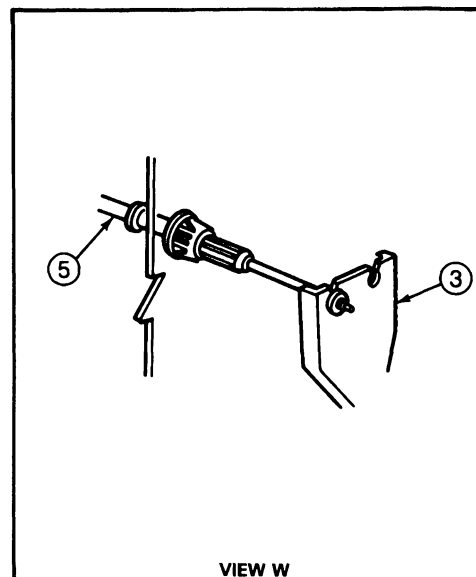
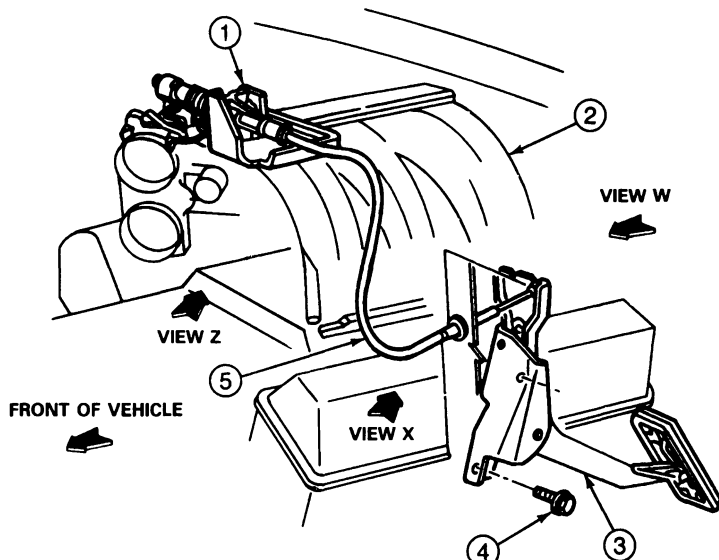
Item	Part Number	Description
6	9A758	Throttle Cable Assembly
7	9E766	Splash Shield

(Continued)

Item	Part Number	Description
8	386132-S	Clip
9	Ref.	Transmission Assembly, C6

TA16196A

Accelerator Control Cable Installation, E-150-250-350 with 5.0L MFI and 5.8L MFI Engines



A16198-B

Item	Part Number	Description
1	9728	Accelerator Cable Bracket
2	9424	Upper Intake Manifold
3	9726	Accelerator Pedal Shaft Assembly
4	W611636-S2	Screw 21-29 N-m (15-21 Ft-Lb)
5	9A758	Accelerator Cable Assembly

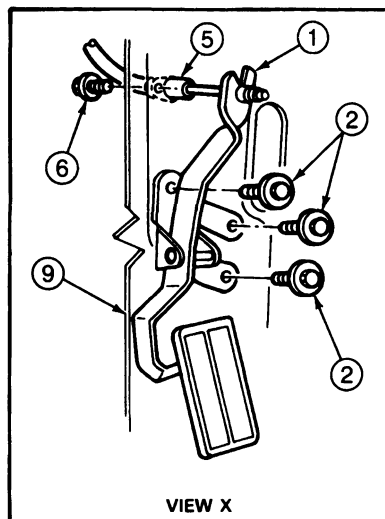
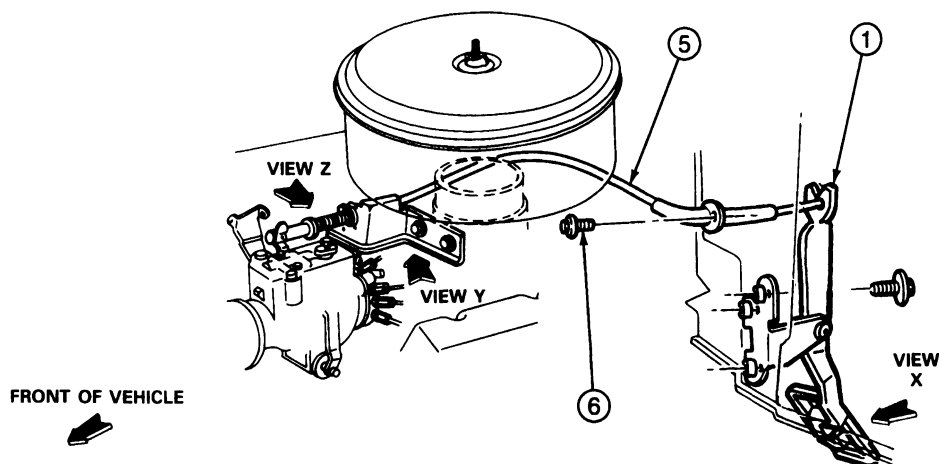
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Item	Part Number	Description
6	—	Accelerator Cable Core Protector (When Installing New Cable, Do Not Remove Until Cable is Installed in Dash)
7	56719-S2	Screw 17-23 N-m (13-16 Ft-Lb)

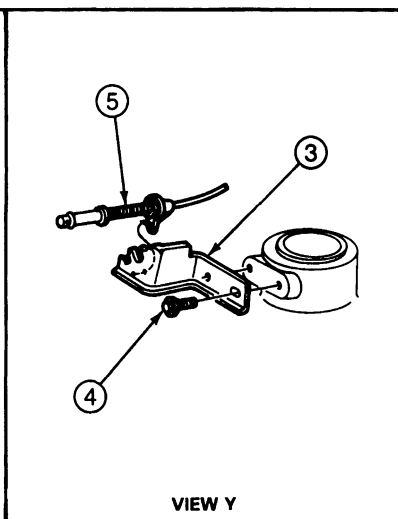
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REMOVAL AND INSTALLATION (Continued)

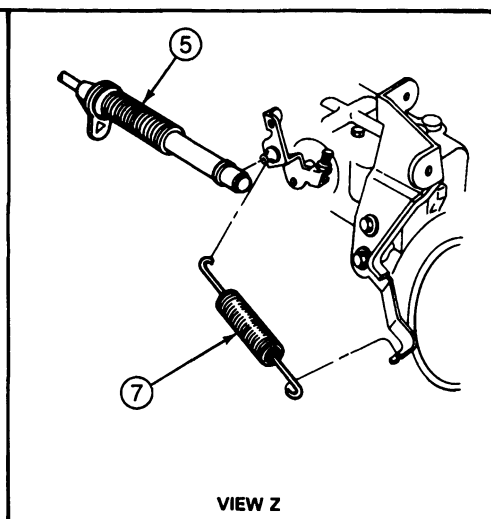
Accelerator Control, F-250-350, F-Super Duty with 7.3L Diesel Engine



VIEW X



VIEW Y



VIEW Z

V4777-F

Item	Part Number	Description
1	9726	Accelerator Pedal Shaft Assembly
2	N801921-S2	Screw and Washer 21-29 N·m (15-21 Ft-Lb)
3	9728	Accelerator Cable Bracket
4	56719-S2	Screw and Washer 17-23 N·m (13-16 Ft-Lb)

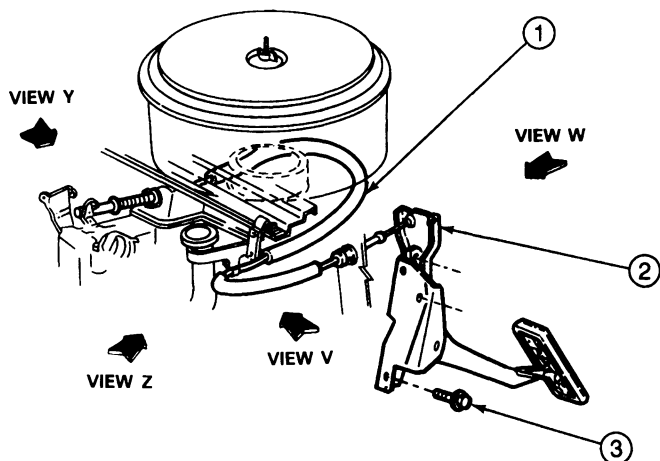
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Item	Part Number	Description
5	9A758	Accelerator Pedal Cable Assembly
6	N610959-S2	Screw 2-3 N·m (18-26 In-Lb)
7	9737	Spring
9	Ref.	Instrument Panel

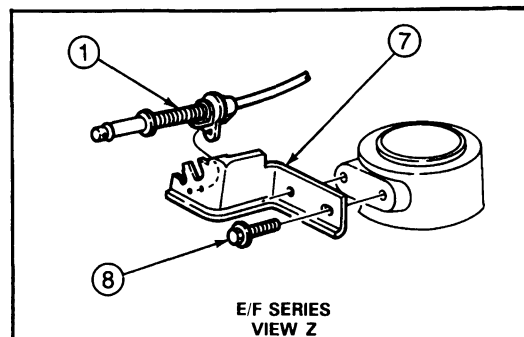
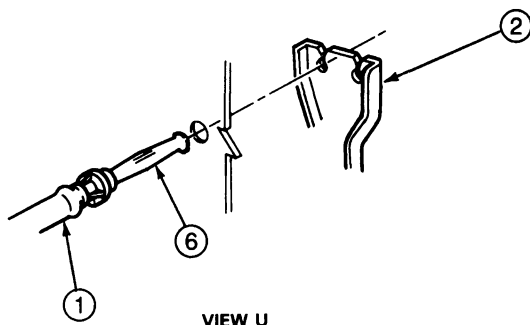
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REMOVAL AND INSTALLATION (Continued)

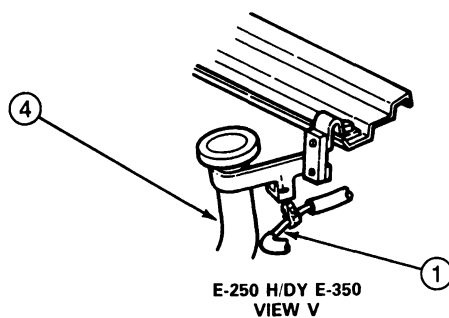
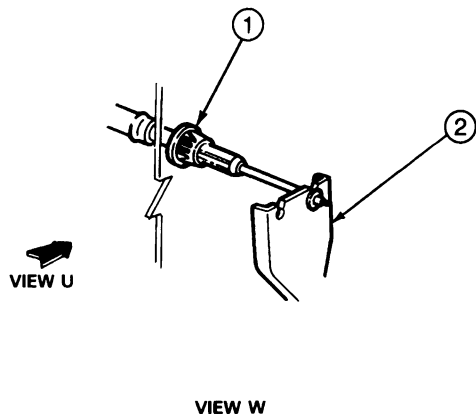
Accelerator Control, E-250-350 7.3L Diesel Engine



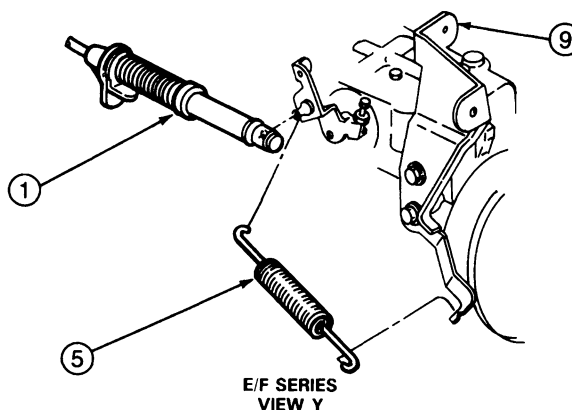
THROTTLE LINKAGE E-250-350 7.3L DIESEL ENGINE

E/F SERIES
VIEW Z

VIEW U

E-250 H/DY E-350
VIEW V

VIEW W

E/F SERIES
VIEW Y

A16200-B

Item	Part Number	Description
1	9A758	Accelerator Pedal Cable Assembly
2	9726	Accelerator Pedal Shaft Assembly

(Continued)

Item	Part Number	Description
3	W611636-S2	Screw & Washer Assembly 21-29 N·m (15-21 Ft-Lb)
4	6763	Oil Filler Tube

(Continued)

REMOVAL AND INSTALLATION (Continued)

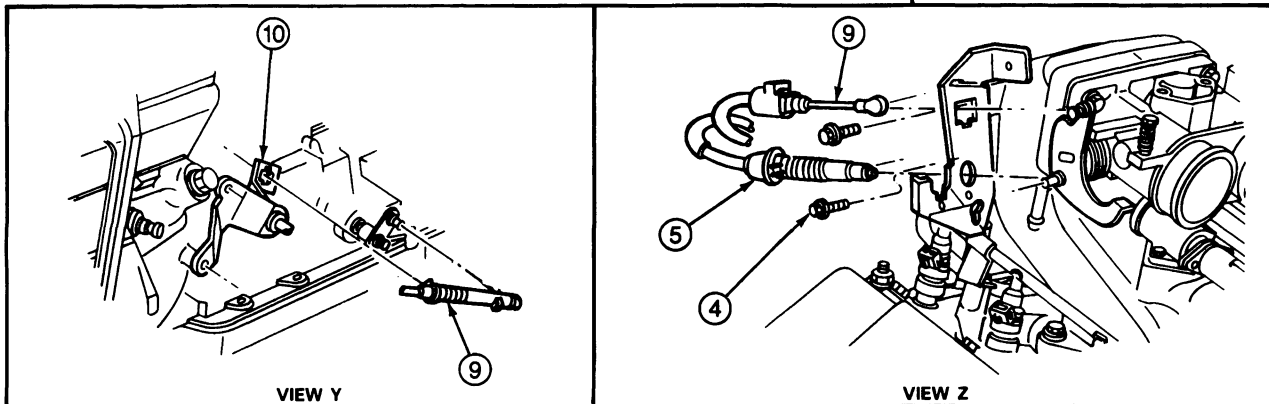
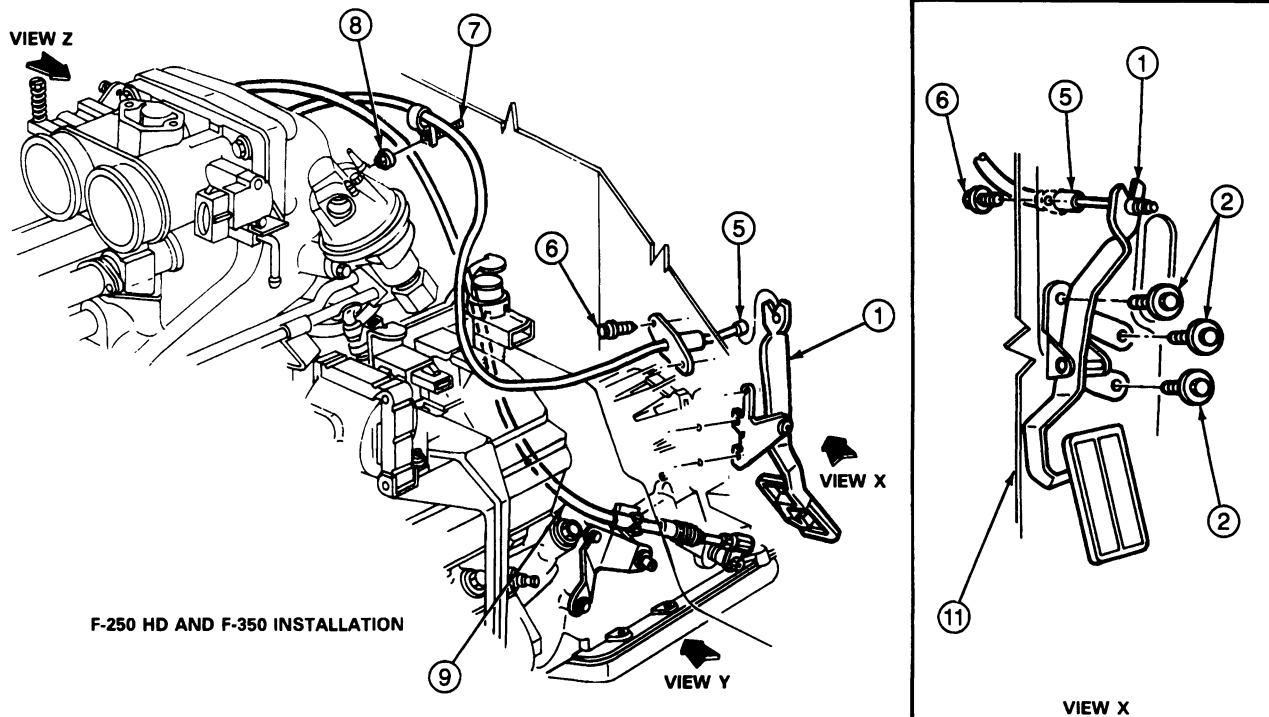
Item	Part Number	Description
5	9737	Spring
6	Ref.	Accelerator Cable Core Protector
7	9728	Accelerator Cable Bracket

(Continued)

Item	Part Number	Description
8	56719-S	Screw and Washer 17-23 N·m (13-16 Ft-Lb)
9	9741	Bracket

TA16200A

Accelerator Control and Kickdown Cable Installation, F-250 HD, F-350, F-Super Duty with 7.5L MFI Engine



Item	Part Number	Description
1	9726	Accelerator Pedal Shaft Assembly
2	N801921-S2	Screw and Washer 21-29 N·m (15-21 Ft-Lb)
3	9728	Accelerator Cable Bracket

(Continued)

Item	Part Number	Description
4	57632-S2	Screw and Washer 21-27 N·m (16-19 Ft-Lb)
5	9A758	Accelerator Pedal Cable Assembly
6	N610959-S2	Screw 2-3 N·m (18-26 In-Lb)

(Continued)

REMOVAL AND INSTALLATION (Continued)

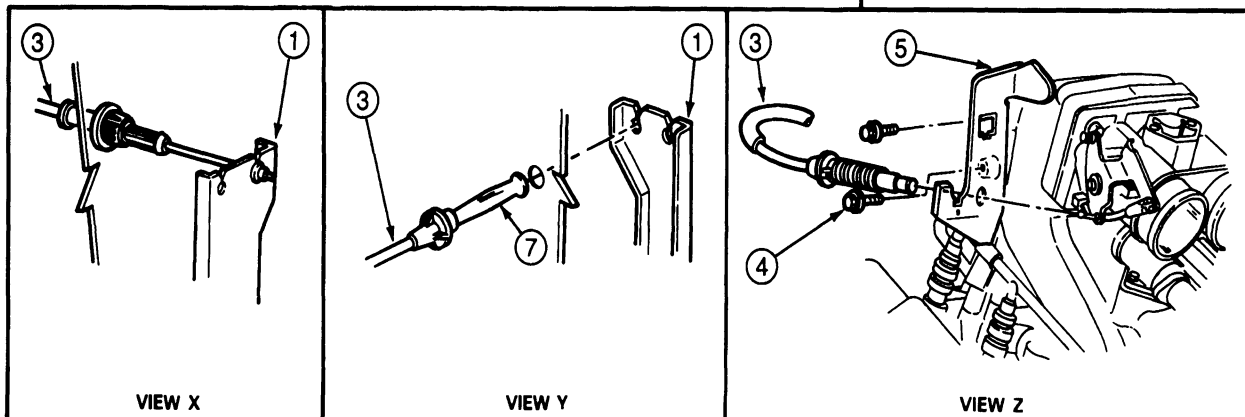
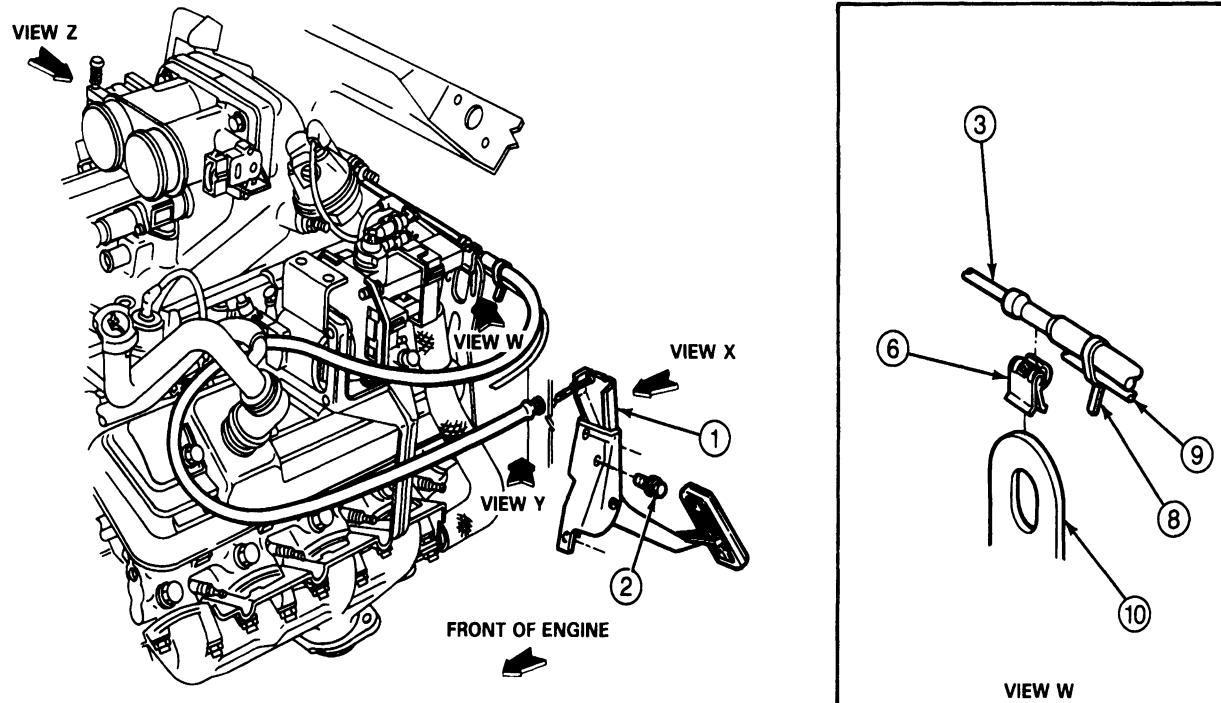
Item	Part Number	Description
7	N802989-S	Stud, Weld
8	N621906-S2	Nut and Washer 4-5 N·m (36-44 In·Lb)

(Continued)

Item	Part Number	Description
9	7A185	Transmission Kickdown Cable Assembly
10	7C431	Bellcrank Bracket
11	Ref.	Instrument Panel

TV5933A

Accelerator Cable Installation, E-250-350 with 7.5L Engine



A16190-B

Item	Part Number	Description
1	9726	Accelerator Pedal Shaft Assembly
2	W611636-S100	Screw 21-29 N·m (15-21 Ft·Lb)
3	9A758	Accelerator Cable Assembly

(Continued)

Item	Part Number	Description
4	56719-S2	Screw 21-27 N·m (16-19 Ft·Lb)
5	9728	Accelerator Cable Bracket
6	37044-S32	Clip (Accelerator Cable To Lifting Eye)

(Continued)

REMOVAL AND INSTALLATION (Continued)

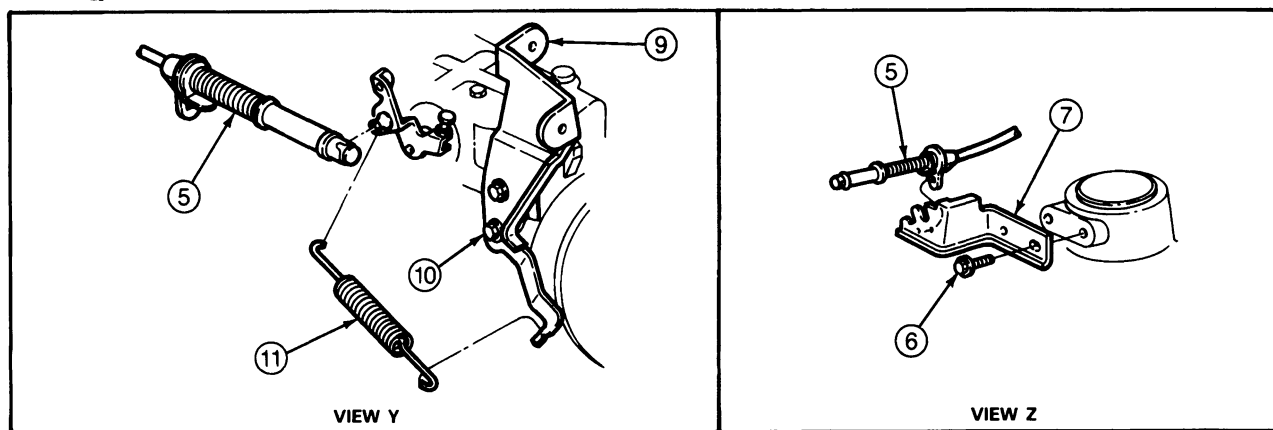
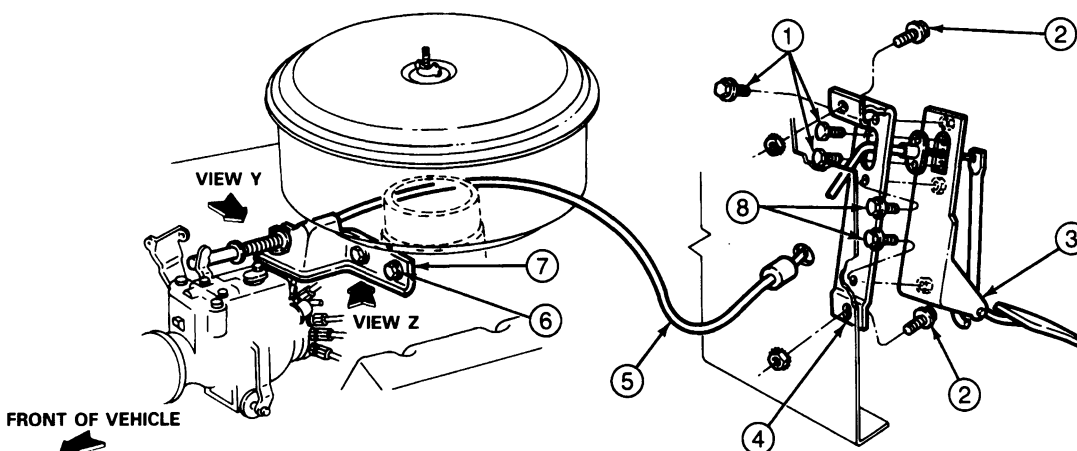
Item	Part Number	Description
7	Ref.	Accelerator Cable Core Protector
8	95874-S	Tie Strap

(Continued)

Item	Part Number	Description
9	9A825	Speed Control Actuator Assembly
10	17K056	Lifting Eye

TA16190A

Accelerator Control, F-Super Duty Commercial Chassis Vehicles, 7.3L Diesel Engine



V6283-C

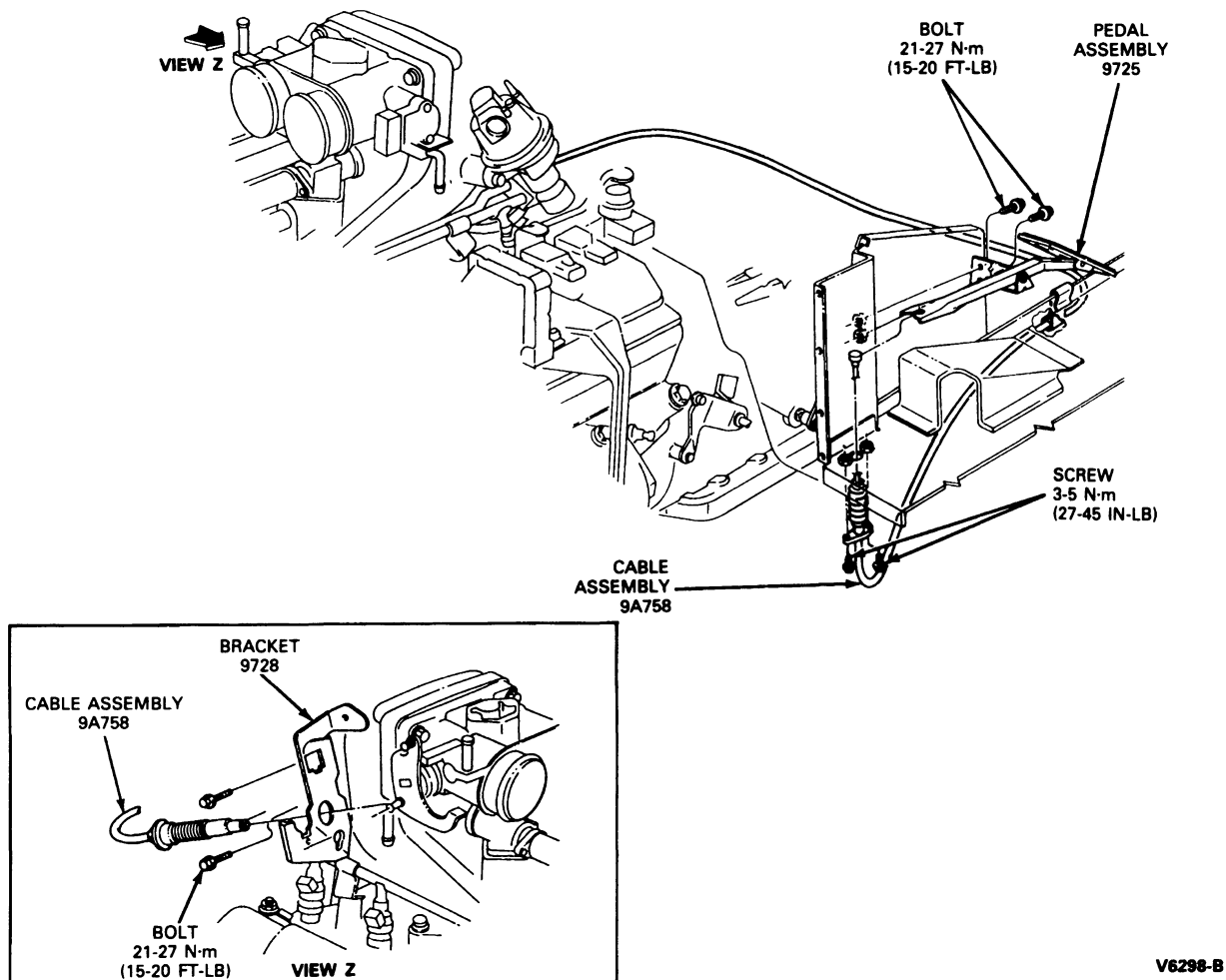
Item	Part Number	Description
1	—	Bolt 3-5 N·m (27-45 Ft-Lb)
2	N801921-S2	Screw and Washer 21-29 N·m (15-21 Ft-Lb)
3	9725	Pedal Shaft
4	9K706	Spacer

(Continued)

Item	Part Number	Description
5	9A758	Cable
6	—	Bolt 17-23 N·m (13-16 Ft-Lb)
7	9728	Bracket
8	—	Bolt 3-5 N·m (27-45 In-Lb)
9	9741	Bracket
10	57620	Bolt
11	9737	Return Spring

REMOVAL AND INSTALLATION (Continued)

Accelerator Control Cable Installation, F-Super Duty Motorhome Chassis Vehicles with 7.5L MFI Engine



ADJUSTMENTS

Transmission Kickdown Cable, C6 Automatic Transmission (4.9L Engine)

1. Install kickdown cable as outlined in the removal and installation portion of this section.
2. Ratchet cable adjusting mechanism to correct setting by rotating to wide open throttle position by hand.
3. Remove red spacer or substitute spacer.

CAUTION: Do not drive vehicle with kickdown cable disconnected. If vehicle is driven with kickdown cable disconnected, severe internal transmission damage may occur. The damage may not be immediately detectable but results in eventual transmission failure.

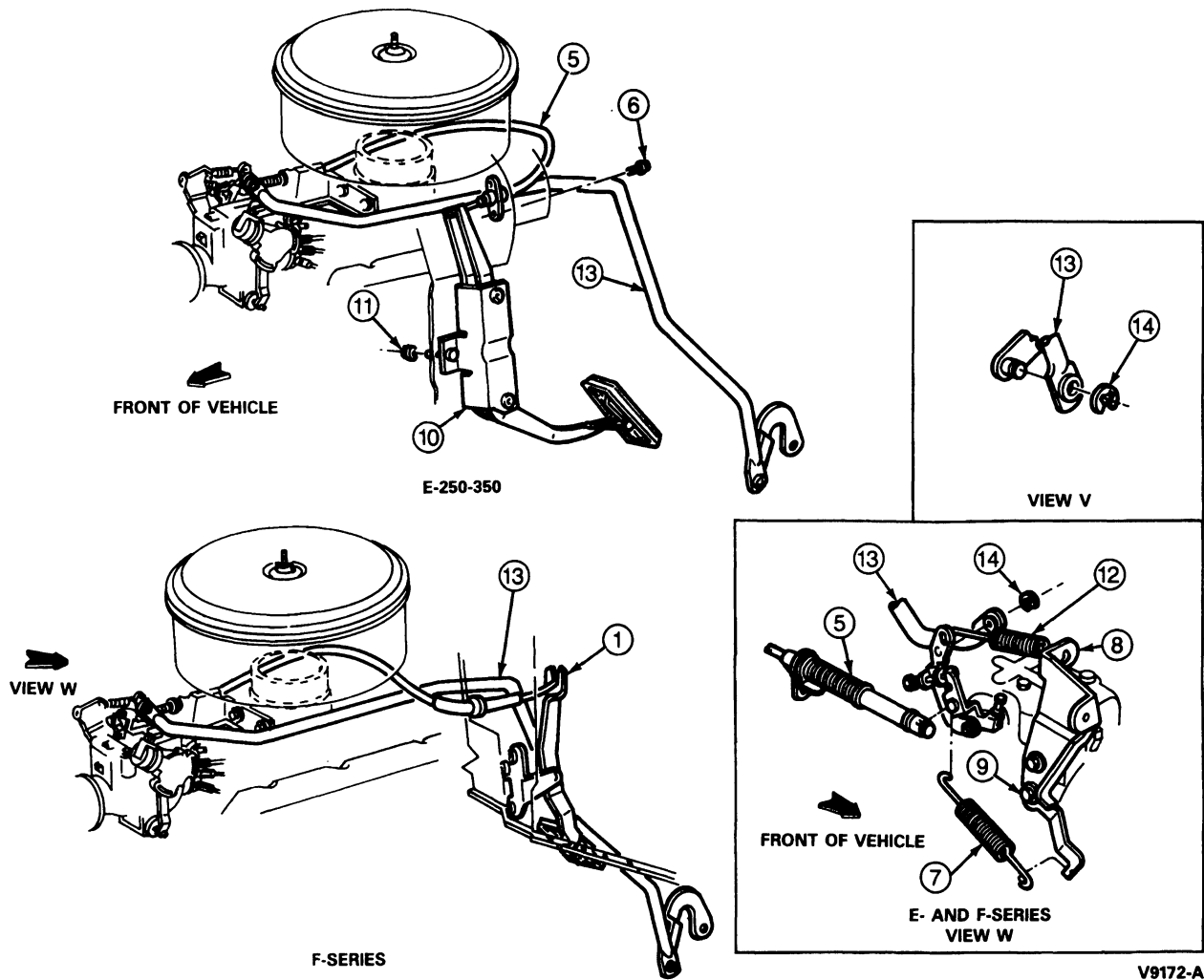
Throttle Valve (TV) Control Cable System, AOD Automatic Overdrive Transmission

Refer to Section 07-01C, for TV control cable adjustment procedure.

CAUTION: Do not drive vehicle with throttle valve control cable disconnected. If vehicle is driven with TV control cable disconnected, severe internal transmission damage may occur. The damage may not be immediately detectable but results in eventual transmission failure.

ADJUSTMENTS (Continued)

Kickdown Rod, C6 Automatic Transmission (7.3L Diesel Only)



Item	Part Number	Description
1	9726	Accelerator Pedal Shaft Assembly
5	9A758	Accelerator Pedal to Throttle Body Lever
6	N610959-S2	Screw (2) M-6 x 1.8 x 19 2-4 N-m (18-35 In-Lb)
7	9737	Spring
8	9741	Accelerator Pedal Return Spring

(Continued)

Item	Part Number	Description
9	Ref.	Bolt
10	9726	Accelerator Pedal Shaft Assembly
11	34976-S2	Nut (3) 5/16-18 20-34 N-m (15-25 Ft-Lb)
12	7C471	Spring
13	7E288	Kickdown Rod Assembly
14	—	Ext. Ring Return (2)

Kickdown Rod

1. Apply a six-pound weight to the transmission kickdown lever.
2. Rotate throttle to wide open position.
3. Insert 1.5mm (.060-inch) spacer between the throttle lever and adjusting screw.

4. Rotate adjusting screw until contact is made between screw and spacer, then tighten locknut.
5. Remove spacer.
6. With spacer removed, a gap of 1.7-2.5mm (.070-.010 inch) is acceptable.
7. Remove the six-pound weight.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N-m	Lb-Ft
Accelerator Cable to Instrument Panel Screw, F-Series and Bronco with 4.9L MFI Engine	1.7-3.4	(15-30)
Accelerator Cable to Instrument Panel Screw, F-Series with 5.0L MFI, 5.8L MFI, 7.5L MFI Engine and 7.3L Diesel Engine	2-3	(18-26)
Accelerator Cable to Instrument Panel Screw, F-Super Duty Motorhome Chassis with 7.5L Engine	3-5	(27-45)
Accelerator Cable to Instrument Panel Weld Stud, F-Series with 7.5L Engine	4-5	(36-44)

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N-m	Lb-Ft
Accelerator Cable Bracket Screw, F-Series and Bronco with 4.9L MFI, 5.0L MFI, 5.8L MFI and 7.5L MFI Engines	21-27	16-19
Accelerator Cable Bracket Screw, E-Series with 5.0L MFI and 5.8L MFI Engines and F-Series with 7.3L Diesel Engine	17-23	13-16
Accelerator Control Splash Shield, All	5-9	(45-79)
Accelerator Pedal Bracket Mounting Screw	21-29	15-21

SECTION 10-03 Speed Control

SUBJECT	PAGE	SUBJECT	PAGE
ADJUSTMENTS		REMOVAL AND INSTALLATION	
Actuator Cable	10-03-20	Actuator Cable	10-03-13
DESCRIPTION AND OPERATION		Command Switches, Air Bag Steering	
Contact Assembly (Clockspring).....	10-03-4	Wheel.....	10-03-18
Deactivator Switch	10-03-3	Control Switches, Non-Air Bag Steering	
Decreasing Set Speed	10-03-3	Wheel.....	10-03-18
Ground Brush	10-03-4	Deactivator Switch	10-03-19
Increasing Set Speed.....	10-03-3	Electronic Servo Assembly	10-03-11
Programmable Speedometer / Odometer		Speed Control Servo and Bracket	
Module (PSOM).....	10-03-3	Assembly	10-03-11
Resume	10-03-4	SPECIAL SERVICE TOOLS/EQUIPMENT	10-03-20
System Activation.....	10-03-3	SPECIFICATIONS	10-03-20
DIAGNOSIS AND TESTING		VEHICLE APPLICATION	10-03-1
Diagnosis Guides.....	10-03-7		
Visual Inspection	10-03-5		

VEHICLE APPLICATION

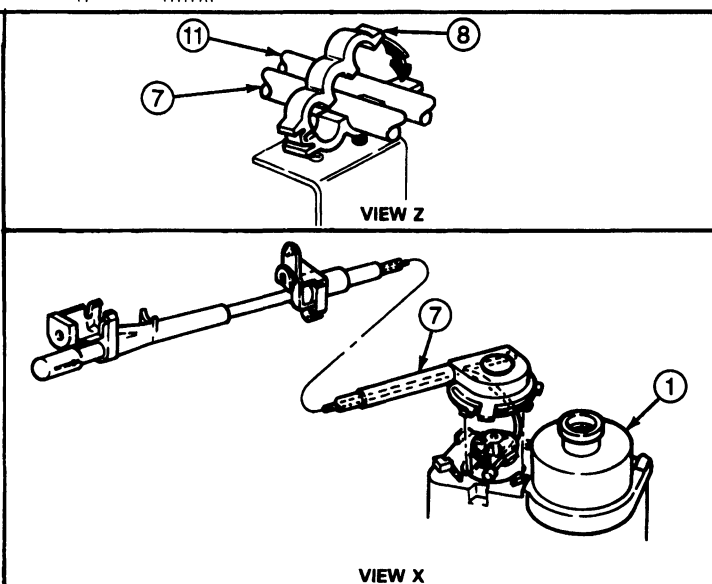
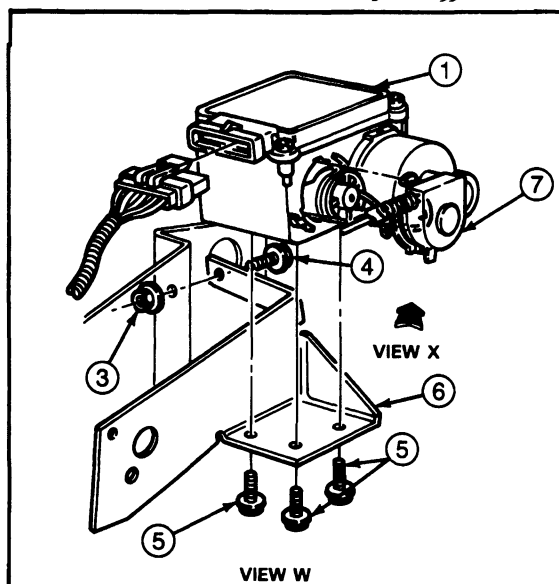
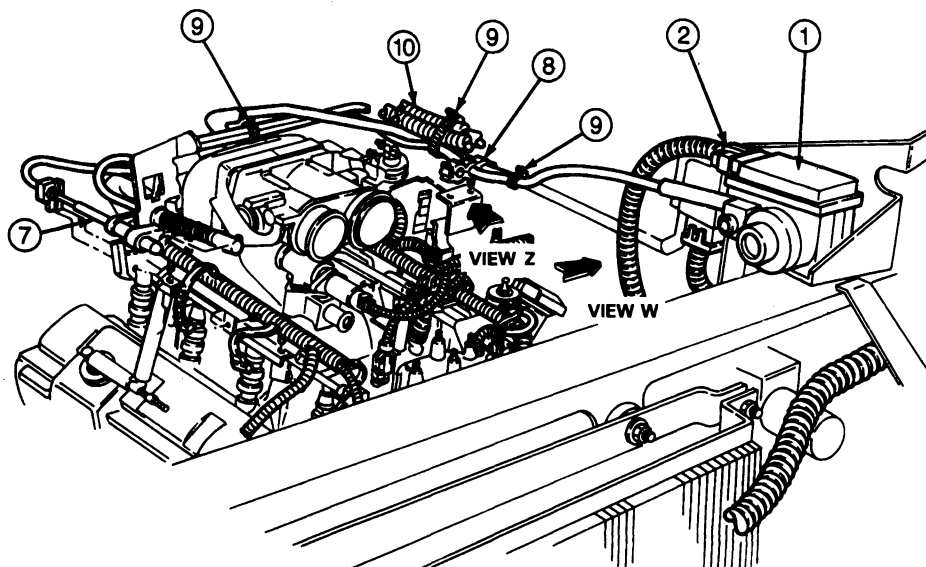
Econoline, F-Series and Bronco

DESCRIPTION AND OPERATION

The speed control system is designed to automatically maintain vehicle speed at any driver-selected speed above approximately 30 mph and below approximately 125 mph. The system is comprised of an electronic servo which consists of a throttle actuator with integrated electronics and other parts including an actuator cable, horn relay, driver control switches, a brake lamp switch and a deactivator switch. The speed signal is generated by the Programmable Speedometer / Odometer Module (PSOM). The electronic servo is mounted in the engine compartment as shown and is connected to the throttle linkage with an actuator cable.

DESCRIPTION AND OPERATION (Continued)

Speed Control System Components



V9174-A

Item	Part Number	Description
1	9C735	Servo Assembly, Speed Control
2	14401	Wiring Assembly, Speed Control
3	N620421-S2	Nut
4	N605786-S6	Bolt 15-18 N·m (12-13 Ft·Lb)
5	N806515-S2	Screw 10-13 N·m (62-88 In·Lb)

(Continued)

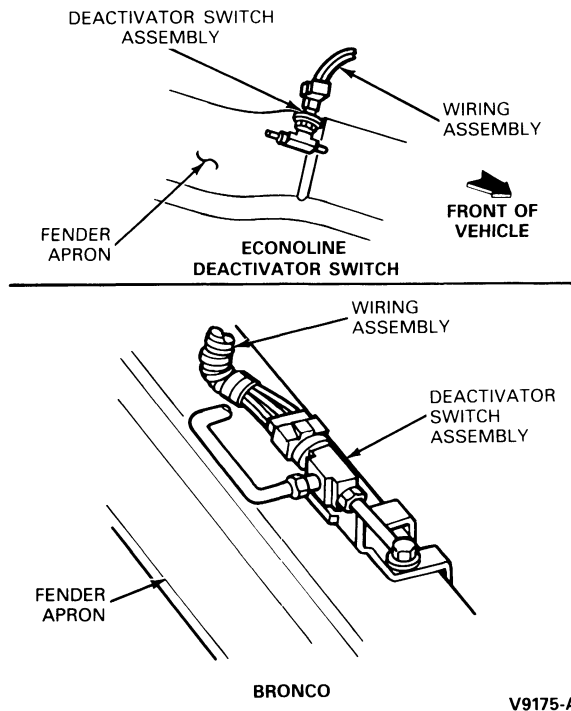
Item	Part Number	Description
6	14K730	Panel, Junction Block
7	9A825	Actuator Assembly, Speed Control
8	N804323-S	Clip
9	95875	Strap
10	9D930	Wiring Assembly, Fuel Charge
11	Ref.	Map Sensor Line

DESCRIPTION AND OPERATION (Continued)

Deactivator Switch

The deactivator switch is provided as an additional redundant safety feature in the system. Normally, when the brake pedal is depressed, an electrical signal from the brake lamp circuit to the amplifier will turn off the system. Under increased brake pedal efforts (22-45 N·m [17-33 ft-lb]), the deactivator switch mounted in the brake line will open and remove power to the speed control actuator clutch, releasing the throttle independent of the amplifier control.

Deactivator Switch



Programmable Speedometer / Odometer Module (PSOM)

All vehicles are equipped with the Programmable Speedometer / Odometer Module (PSOM) and use the speed signal generated by the PSOM as the input signal to the speed control servo.

System Activation

To operate the speed control system, the engine must be running and the vehicle speed must be greater than 48 km/h (30 mph). Under these conditions, the system is activated by pressing the ON switch in the steering wheel. Then, the operator must depress and release the SET/ACCEL switch. This will result in the current speed being maintained until a new speed is set, the brake pedal is depressed, the clutch pedal is depressed on manual transmission vehicles, or the OFF switch is depressed. Only one switch button should be depressed at a time because the speed control system will accept only one command at a time.

Increasing Set Speed

Accel

A continuous depression of the SET/ACCEL switch will cause a smooth increase in vehicle speed. Upon release of the SET/ACCEL switch the new vehicle speed will be maintained.

The vehicle speed can be manually increased at any time by depressing the accelerator until the higher speed is reached and stabilized, then depressing and releasing the SET/ACCEL switch.

Tap-Up

Current vehicle set speed may be increased 1.6 km/h (1 mph) by a momentary tap of the SET/ACCEL switch. Multiple taps of the SET/ACCEL switch will cause vehicle speed to increase in increments of 1.6 km/h (1 mph). For example, if currently set at 50 mph then five taps will increase vehicle speed and set it at 55 mph.

Decreasing Set Speed

Coast

A continuous depression of the COAST switch will cause a smooth decrease in vehicle speed. Upon release of the COAST switch the new vehicle speed will be maintained.

The vehicle speed can be manually decreased at any time by momentarily depressing the brake pedal until the lower speed is reached and stabilized, then depressing and releasing the SET/ACCEL switch.

If vehicle speed is reduced below 48 km/h (30 mph) then the driver must manually increase the speed to over 48 km/h (30 mph) and reset the system.

Tap-Down

Current vehicle set speed may be decreased 1.6 km/h (1 mph) by a momentary tap of the COAST switch. Multiple taps of the COAST switch will cause vehicle speed to decrease in increments of 1.6 km/h (1 mph). For example, if currently set at 55 mph then five taps will decrease vehicle speed and set it at 50 mph.

DESCRIPTION AND OPERATION (Continued)**Resume**

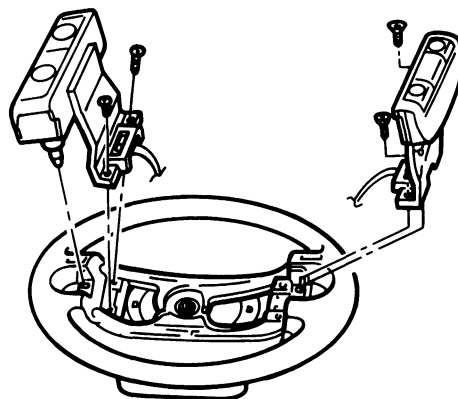
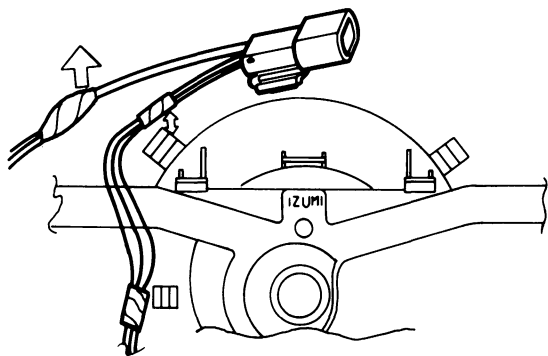
When the speed control system is disabled by pressing the brake pedal or clutch pedal if so equipped, the previous set speed may be re-established by momentarily depressing the RESUME switch. The RESUME feature will not function if the system has been turned off with the OFF switch or if the ignition switch is turned off. If the vehicle speed has dropped below 48 km/h (30 mph) then RESUME will not function until the vehicle speed becomes greater than 48 km/h (30 mph).

Contact Assembly (Clockspring)

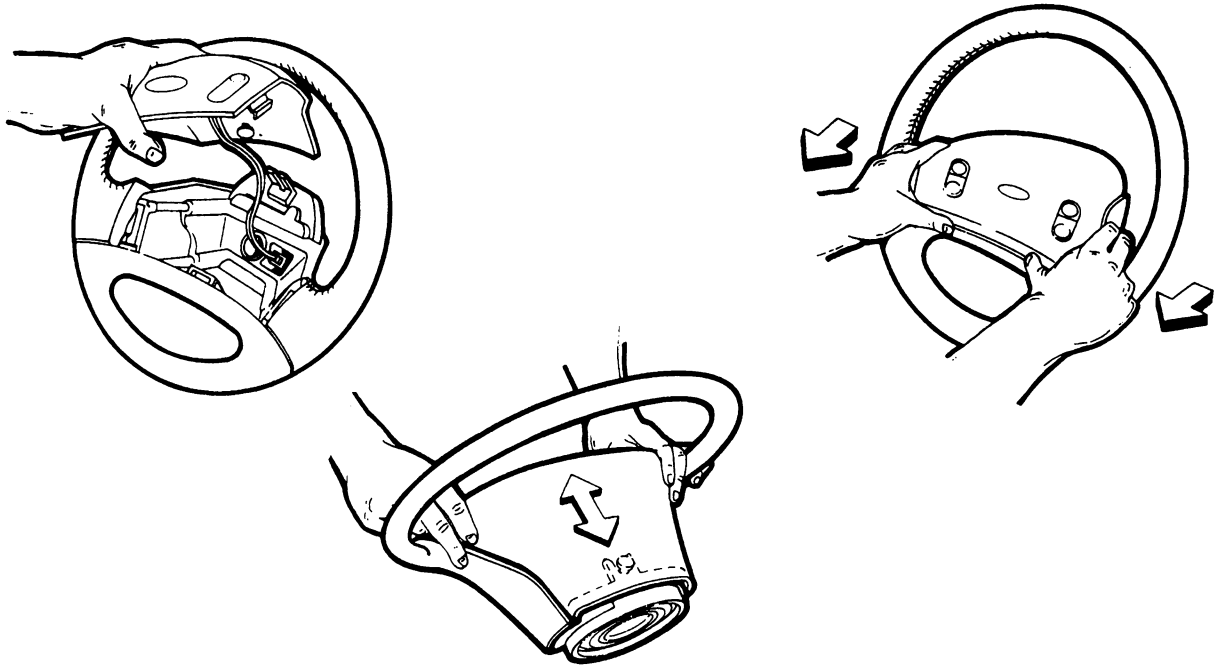
The contact assembly provides electrical interface between the steering column and the control switches in the steering wheel.

Ground Brush

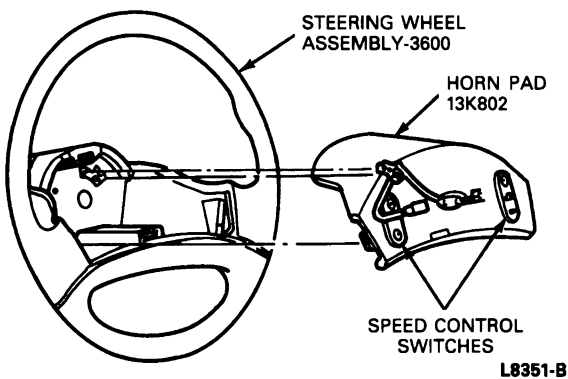
The speed control ground brush assembly provides an electrical ground path between the steering wheel and steering column.

Speed Control Switch and Wiring Installation, Econoline

V8704-B

DESCRIPTION AND OPERATION (Continued)**Horn and Speed Control Switch and Wiring Installation, Motorhome and Commercial F-Super Duty Chassis**

L8365-A

Speed Control Switch Installation, F-150-250-350, F-Super Duty Chassis Cab and Bronco

L8351-B

DIAGNOSIS AND TESTING**Visual Inspection**

Visual inspection is an important part of diagnosis. The visual inspection should be done to locate obvious reasons for customer concern.

When performing visual inspection, check all items for abnormal conditions. Look for such items as bare, broken or disconnected wires. For the speed control to function properly, the servo (throttle actuator) and throttle linkage should operate freely and smoothly.

Any concerns found by the visual inspection should be corrected before further tests of the speed control system are made. The following items should be inspected.

- If the amber RABS indicator in the instrument cluster stays lit when the ignition switch is in the RUN position, then refer to servicing the rear anti-lock brake system before continuing with the speed control diagnostics.
- Does the horn work? If not, check the horn circuit fuse, horn relay and horn circuit wiring.
- Do the stoplamps light when the brake pedal is depressed? If not, check the stoplamp circuit fuse, stoplamps, wiring and stoplamp switch.

Electronic Servo Assembly

Check for unseated connectors at the speed control servo assembly.

- Look for loose or unseated connector pins.
- Check for broken wires at the connectors.

Actuator Cable

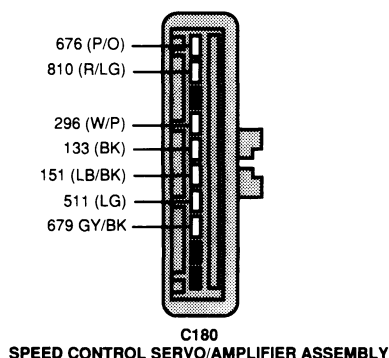
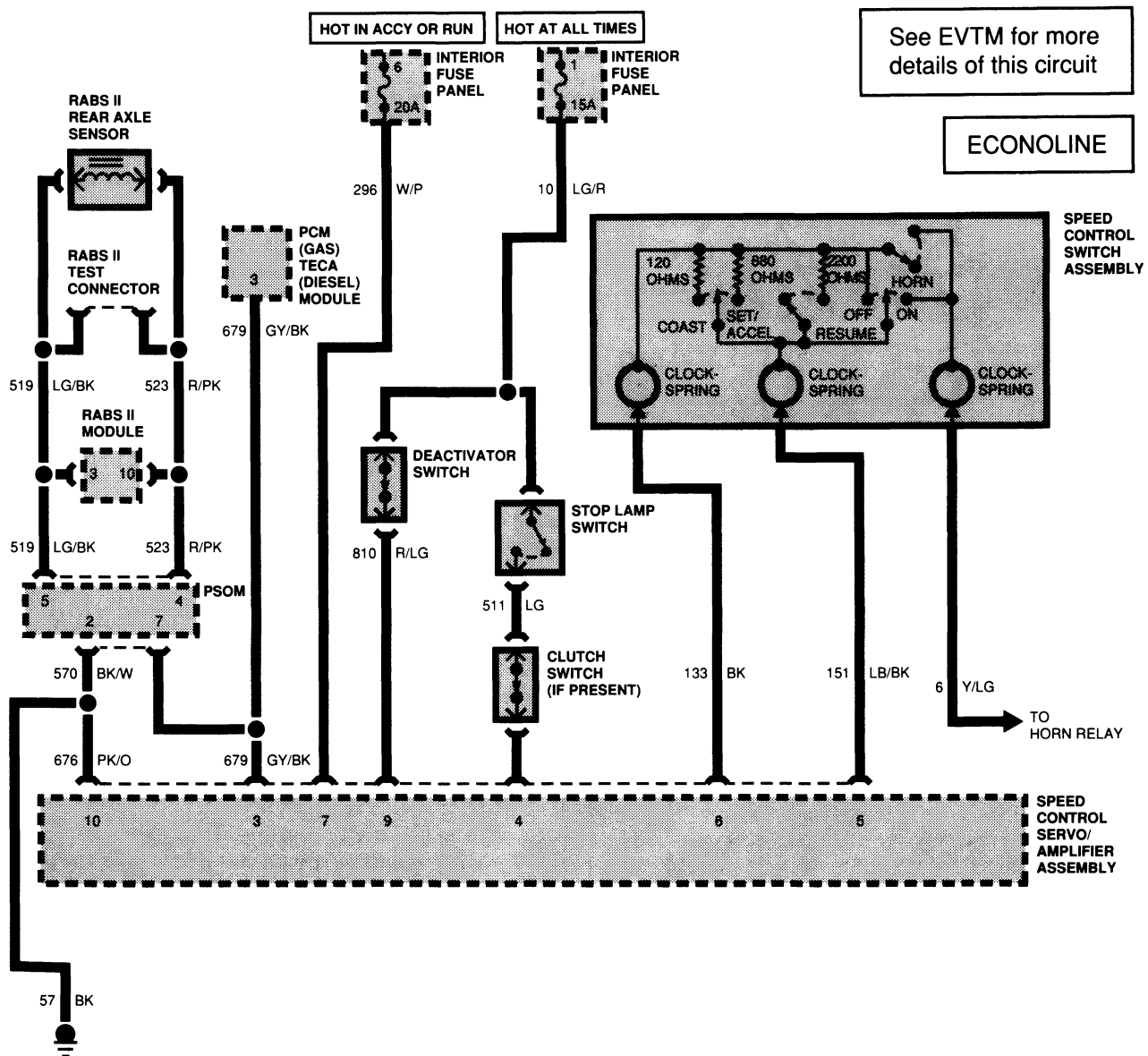
- Misadjusted cable. If misadjustment is suspected, readjust according to procedure above.
- Broken actuator cable.

Speed Control Diagnostic Sequence

NOTE: If amber RABS light remains ON, refer to Section 06-09A.

DIAGNOSIS AND TESTING (Continued)

Wiring Diagram, Speed Control System



L7315-A

DIAGNOSIS AND TESTING (Continued)

Description	Pin #	Ckt #	Wire Color
Speed Control Connector			
not used	1		
not used	2		
Speed Signal	3	679	GY/BK
Stoplamp Switch Feed	4	511	LG
Command Signal	5	151	LB/BK
Command Return to Ground	6	133	BK
Key On — +12V	7	296	W/P

(Continued)

Description	Pin #	Ckt #	Wire Color
not used	8		
Deactivator Switch	9	810	R/LG
Ground to Speed Signal	10	676	PK/O
Deactivator Switch Connector			
Battery Feed	1	10	LG/R
Servo Assembly	2	810	R/LG
Stop Lamp Switch Connector			
Battery Feed	1	10	LG/R
Servo Assembly	2	511	LG

Diagnosis Guides

Diagnostic Test	Symptom
A	Speed Control Inoperative
B	No Power To Servo
C	No Power On Deactivator Switch Input
D	Steering Wheel "ON" Switch Inoperative

(Continued)

Diagnostic Test	Symptom
E	Speed Control Surges
F	COAST/TAP-DOWN Inoperative
G	SET/ACCEL/TAP-UP Inoperative
H	RESUME Inoperative
J	No Brake Switch Shut Off
K	OFF Switch Inoperative

SPEED CONTROL INOPERATIVE — TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	VISUAL CHECK		
	<ul style="list-style-type: none"> Perform visual check. 		GO to A2 .
A2	SETUP		
	<ul style="list-style-type: none"> Disconnect harness connector from the servo assembly. Use Rotunda Digital Volt Ohmmeter 014-00407, or equivalent, to make the specified measurements at the harness connector. 		GO to A3 .
A3	VERIFY THERE IS POWER TO SERVO		
	<ul style="list-style-type: none"> With the ignition switch in RUN, measure voltage between Pin 7 (B+, Circuit 296) and Pin 10 (GND, Circuit 676). 	Battery voltage (12v nom.) Open circuit (0 volts)	Module has power, GO to A4 . No power, GO to B1 .
A4	CHECK FOR STUCK BRAKE SWITCH		
	<ul style="list-style-type: none"> With no brakes applied, measure the voltage between Pin 4 (BRK, Circuit 511) and Pin 10 (GND, Circuit 676). 	Open circuit (0 volts) Battery voltage (12v nom.)	Switch is not stuck on, GO to A5 . Switch is stuck on, REPLACE brake switch.
A5	CHECK BRAKE/CLUTCH CIRCUIT		
	<ul style="list-style-type: none"> With the ignition switch in OFF position, measure the resistance between Pin 4 (BRK, Circuit 511) and Pin 10 (GND, Circuit 676). 	Less than 20 ohms Greater than 20 ohms	Brake input Circuit OK, GO to A6 . Brake light bulbs blown or brake circuit open, SERVICE circuit including clutch switch.

DIAGNOSIS AND TESTING (Continued)

SPEED CONTROL INOPERATIVE — TEST A (Continued)

TEST STEP		RESULT	ACTION TO TAKE
A6	CHECK DEACTIVATOR CIRCUIT		
	<ul style="list-style-type: none"> With ignition switch in OFF position, and with no brakes applied, measure the voltage between Pin 9 (Deactivator, Circuit 810) and Pin 10 (GND, Circuit 676). 	Battery voltage (12v nom.) Open circuit (0 volts)	There is power, GO to A7 . No power from deactivator. GO to C1 .
A7	CHECK FOR STUCK ON SWITCH		
	<ul style="list-style-type: none"> With no steering wheel switches depressed, measure the voltage between Pin 5 (COMMAND, Circuit 151) and Pin 10 (GND, Circuit 676). 	Open circuit (0 volts) Battery voltage (12v nom.)	"ON" switch not stuck, GO to A8 . REPLACE switch.
A8	CHECK ON SWITCH OPERATION		
	<ul style="list-style-type: none"> With ignition switch in OFF position with steering wheel ON switch depressed, measure voltage between Pin 5 (COMMAND, Circuit 151) and Pin 10 (GND, Circuit 676). 	Battery voltage (12v nom.) Open circuit (0 volts)	ON switch OK, GO to A9 . "ON" switch not functioning GO to D1 .
A9	CHECK FOR STUCK COMMAND SWITCHES		
	<ul style="list-style-type: none"> With ignition switch in OFF position and with no steering wheel switches depressed, measure the resistance between Pin 5 (COMMAND, Circuit 151) and Pin 6 (COMMAND RTN, Circuit 133). 	Greater than 3k ohms Less than 3k ohms	No stuck switches, GO to A10 . One of the command switches is stuck, REPLACE switch.
A10	CHECK SET/ACCEL SWITCH OPERATION		
	<ul style="list-style-type: none"> With ignition switch in OFF position and with the SET/ACCEL switch depressed, measure the resistance between Pin 5 (COMMAND, Circuit 151) and Pin 6 (COMMAND RTN, Circuit 133). 	Approx 680 ohms Less than 640 or greater than 720 ohms	Switch is OK, GO to A11 . Switch not functioning, REPLACE switch.
A11	VERIFY SPEED SIGNAL		
	<ul style="list-style-type: none"> Operate vehicle by raising the rear wheels. Set speed at 30 MPH. Use an AC voltmeter to measure the voltage between Pin 3 (SPEED SIG, Circuit 130) and Pin 10 (GND, Circuit 131). 	4-5 volts No reading	Speed signal OK, GO to A12 . SERVICE Programmable Speedometer/Odometer, GO to Section 13-02, Speedometer/Odometer.
A12	CHECK FOR BROKEN OR BOUND ACTUATOR CABLE		
	<ul style="list-style-type: none"> Remove actuator cable from servo assembly, check for broken cable by pulling on cable and noting throttle movement. 	Cable is OK Binding or broken cable.	REPLACE servo assembly. SERVICE cable.

NO POWER TO SERVO — TEST B

TEST STEP		RESULT	ACTION TO TAKE
B1	MAKE SURE STEP A3 HAS BEEN DONE		GO to B2 .
B2	CHECK IGNITION CIRCUIT		
	<ul style="list-style-type: none"> With ignition switch in the RUN position, measure the voltage between Pin 7 (B+, Circuit 296) and ground point on the chassis. 	Battery voltage (12v nom.) Open circuit (0 volts)	Ignition circuit OK, GO to B3 . Ignition input is open circuit, REPLACE fuse or SERVICE as required.
B3	CHECK MODULE GROUND CIRCUIT		
	<ul style="list-style-type: none"> With ignition switch in "OFF" position, measure the resistance between Pin 10 (GND, Circuit 131) and ground point on the chassis. 	Open Circuit Less than 1 ohm	GND circuit open, SERVICE as required. Module power OK, repeat Test A3.

DIAGNOSIS AND TESTING (Continued)**NO POWER ON DEACTIVATOR SWITCH INPUT — TEST C**

TEST STEP		RESULT	ACTION TO TAKE
C1	MAKE SURE STEP A6 HAS BEEN DONE		GO to C2.
C2	CHECK DEACTIVATOR SWITCH		
	<ul style="list-style-type: none"> Remove body harness connector from deactivator switch. Measure the resistance between the two pins of the deactivator switch with no brakes applied. 	Less than 1 ohm Greater than 1 ohm	Deactivator switch OK, GO to C3. Deactivator switch defective, REPLACE switch.
C3	VERIFY THERE IS POWER AT DEACTIVATOR HARNESS CONNECTOR		
	<ul style="list-style-type: none"> Measure voltage between Pin 1 (Circuit 10) of the deactivator switch harness connector and chassis ground. 	Battery voltage (12v nom.) Open circuit (0 volts)	Power at connector OK, GO to C4. SERVICE for blown fuse or open in deact circuit.
C4	CHECK FOR OPEN CIRCUIT BETWEEN DEACTIVATOR SWITCH AND SERVO		
	<ul style="list-style-type: none"> Measure resistance from Pin 2 (Circuit 810) of deactivator switch and Pin 9 (DEACT) Circuit 810) of service assembly of servo assembly. 	Less than 1 ohm Open circuit (0 volts)	REPEAT Test A6. Open in wire harness. SERVICE as required.

STEERING WHEEL "ON" SWITCH INOPERATIVE — TEST D

TEST STEP		RESULT	ACTION TO TAKE
D1	MAKE SURE STEP A8 HAS BEEN DONE		GO to D2.
D2	CHECK FOR OPEN CIRCUIT IN SWITCH GROUND		
	<ul style="list-style-type: none"> With horn depressed measure voltage between Pin 6 (COMMAND RTN, Circuit 133) and chassis ground. 	Battery voltage (12v nom.) Open circuit (0 volts)	REPLACE "ON" switch. Open circuit or blown fuse in horn relay feed or open circuit in switch ground, SERVICE as required.

SPEED CONTROL SURGES — TEST E

TEST STEP		RESULT	ACTION TO TAKE
E1	CHECK FOR BINDING IN ACTUATOR CABLE / THROTTLE BODY LINKAGE		
		No binds	REPLACE servo and verify condition does not exist.
		Binds or loose bracket.	SERVICE as required.

COAST/TAP-DOWN FUNCTION INOPERATIVE — TEST F

TEST STEP		RESULT	ACTION TO TAKE
F1	SETUP		
	<ul style="list-style-type: none"> Disconnect 10 way connector from servo assembly. 		GO to F2.
F2	CHECK "COAST" SWITCH OPERATION		
	<ul style="list-style-type: none"> With ignition switch in OFF position and with "COAST" switch depressed, measure the resistance between Pin 5 (COMMAND, Circuit 151) and Pin 6 (COMMAND RTN, Circuit 133) while rotating steering wheel through full range. 	Approx 120 ohms Less than 114 or greater than 126 ohms	COAST switch OK, GO to F3. REPLACE switch.

DIAGNOSIS AND TESTING (Continued)

COAST/TAP-DOWN FUNCTION INOPERATIVE — TEST F (Continued)

TEST STEP		RESULT	ACTION TO TAKE
F3	CHECK COMMAND SWITCH RETURN CIRCUIT		
	<ul style="list-style-type: none"> Measure the resistance between Pin 6 (COMMAND RTN, Circuit 133) and Pin 10 (GND, Circuit 676). 	Open circuit	REPLACE servo assembly.
		Less than 1 ohm	Switch return is incorrectly grounded. SERVICE as required.

ACCEL/TAP UP FUNCTION INOPERATIVE — TEST G

TEST STEP		RESULT	ACTION TO TAKE
G1	SETUP		
	<ul style="list-style-type: none"> Disconnect 10 way connector from servo assembly. 		GO to G2.
G2	CHECK "ACCEL/TAP-UP" SWITCH OPERATION		
	<ul style="list-style-type: none"> With ignition switch in OFF position and with "ACCEL/TAP-UP" switch depressed, measure the resistance between Pin 5 (COMMAND, Circuit 151) and Pin 6 (COMMAND RTN, Circuit 133) while rotating steering wheel through full range. 	Approx 680 ohms	ACCEL/TAP-UP OK, GO to G3.
		Less than 646 or greater than 714 ohms	REPLACE switch.
G3	CHECK COMMAND SWITCH RETURN CIRCUIT		
	<ul style="list-style-type: none"> Measure the resistance between Pin 6 (COMMAND RTN, Circuit 133) and Pin 10 (GND, Circuit 676). 	Open circuit	REPLACE servo assembly.
		Less than 1 ohm	Switch return is incorrectly grounded. SERVICE as required.

RESUME FUNCTION INOPERATIVE — TEST H

TEST STEP		RESULT	ACTION TO TAKE
H1	SETUP		
	<ul style="list-style-type: none"> Disconnect 10 way connector from servo assembly. 		GO to H2.
H2	CHECK RESUME SWITCH OPERATION		
	<ul style="list-style-type: none"> With ignition switch in OFF position and with RESUME switch depressed, measure the resistance between Pin 5 (COMMAND, Circuit 151) and Pin 6 (COMMAND RTN, Circuit 133) while rotating steering wheel through full range. 	Approx 2200 ohms	"RESUME" OK, GO to H3.
		Less than 2090 or greater than 2310 ohms	REPLACE switch.
H3	CHECK COMMAND SWITCH RETURN CIRCUIT		
	<ul style="list-style-type: none"> Measure the resistance between Pin 6 (COMMAND RTN, Circuit 133) and Pin 10 (GND, Circuit 676). 	Open circuit	REPLACE servo assembly.
		Less than 1 ohm	Switch return is incorrectly grounded. SERVICE as required.

NO BRAKE SWITCH SHUT OFF — TEST J

TEST STEP		RESULT	ACTION TO TAKE
J1	SETUP		
	<ul style="list-style-type: none"> Disconnect 10 way connector from servo assembly. 		GO to J2.
J2	CHECK FOR BINDS IN ACTUATOR CABLE / THROTTLE BODY ATTACHMENT		
	<ul style="list-style-type: none"> Check for binding of actuator cable. 	No binds	GO to J3.
		Binds	SERVICE as required.
J3	CHECK BRAKE SWITCH OPERATION		
	<ul style="list-style-type: none"> With brakes applied, measure the voltage between Pin 4 (BRK, Circuit 511) and Pin 10 (GND, Circuit 676). 	Battery voltage (12v nom.)	REPLACE servo assembly.
		Open circuit (0 volts)	Switch not functioning, REPLACE or SERVICE.

DIAGNOSIS AND TESTING (Continued)

SPEED CONTROL WILL NOT TURN OFF WITH "OFF" SWITCH — TEST K

TEST STEP		RESULT	ACTION TO TAKE
K1	SETUP		
	<ul style="list-style-type: none"> Disconnect 10 way connector from servo assembly. 		GO to K2.
K2	CHECK OFF SWITCH OPERATION		
	<ul style="list-style-type: none"> With ignition switch in OFF position and with OFF switch depressed, measure the resistance between Pin 5 (COMMAND, Circuit 151) and Pin 6 (COMMAND RTN, Circuit 133) while rotating steering wheel through full range. 	Less than 4 ohms Greater than 4 ohms	REPLACE servo assembly. "OFF" switch not functioning, REPLACE switch.

REMOVAL AND INSTALLATION

Electronic Servo Assembly

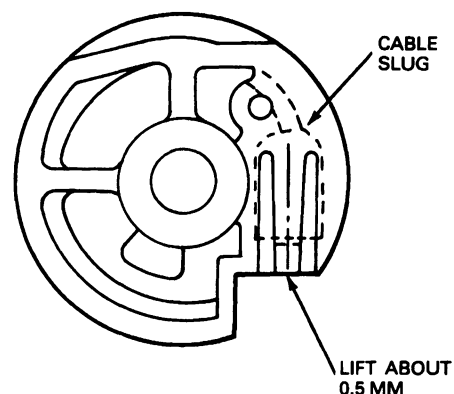
Removal

1. Remove battery from battery tray (Econoline only).
2. Remove battery tray (Econoline only).
3. Remove two screws that mount speed control bracket to vehicle.
4. Disconnect speed control 10-way connector.
5. Depress accelerator, then push locking arm on actuator assembly cap and rotate cap counterclockwise.
6. Remove cable ball slug from servo rotor.
7. Gently pry up the arm **slightly** with a small screwdriver, and at the same time push the ball slug out of the servo rotor slot. **Excessive bending of the arm will cause it to break. DO NOT USE servos with damaged or missing locking arms.**
8. Remove bracket from the servo assembly; keep bracket and three screws for reuse.

Installation

1. Remove cable from nesting slot located in cap and make sure seal is present and pressed into position.
2. Lock cable ball in slot located in servo rotor.
3. Pull cable taut at end opposite servo assembly.
4. Insert cap locking tabs into servo slots as shown in this section.
5. Rotate cap clockwise until locking arm engages locking tab on servo assembly. **DO NOT USE servos with damaged or missing locking arms.**

Speed Control Servo Rotor



V9138-A

Speed Control Servo and Bracket Assembly

Installation

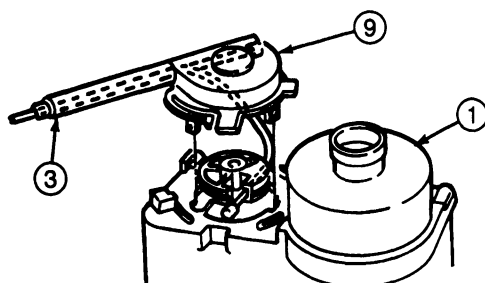
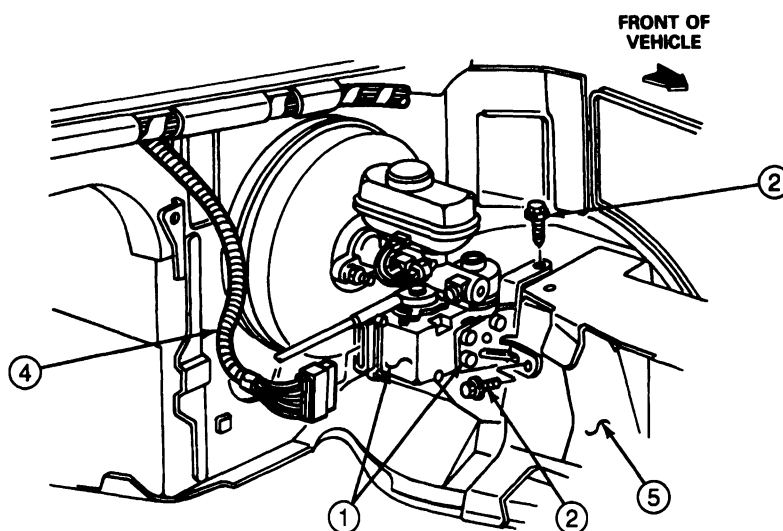
1. Attach bracket to servo with three screws. Tighten to 10-13 N·m (7-10 ft-lb).
2. Attach speed control 10-way connector to speed control actuator.
3. Make sure the rubber seal is fully seated on actuator cable cap.
4. Depress accelerator pedal if cable is attached to throttle and lock cable ball in slot located in servo pulley.
5. Release accelerator cable or pull cable at throttle end.
6. Insert cap locking tabs into servo slots as shown.
7. Rotate cap clockwise until locking arm engages locking tab on servo.

REMOVAL AND INSTALLATION (Continued)

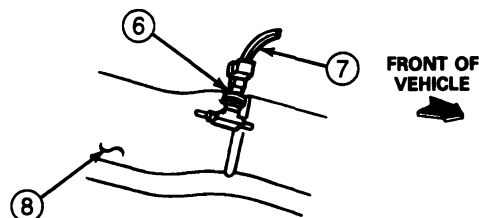
8. Position actuator and bracket assembly and mount with two screws.
9. Adjust actuator cable as described.
10. Install battery tray (Econoline only).

11. Install battery (Econoline only).

NOTE: On vehicles equipped with EEC, when the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

Speed Control System Components

**CABLE INSTALLATION
TO SERVO AND BRACKET ASSEMBLY**



DEACTIVATOR SWITCH

V8461-B

Item	Part Number	Description
1	9C734	Servo and Bracket Assembly
2	N610958-S36	Screw
3	9A825	Actuator Assembly
4	12A581	Wiring Assembly

(Continued)

Item	Part Number	Description
5	Ref.	LH Side of Fender Apron
6	9F924	Switch Assembly — Speed Control
7	14406	Wiring Assembly
8	—	Frame Rail
9	—	Actuator Cable Cap

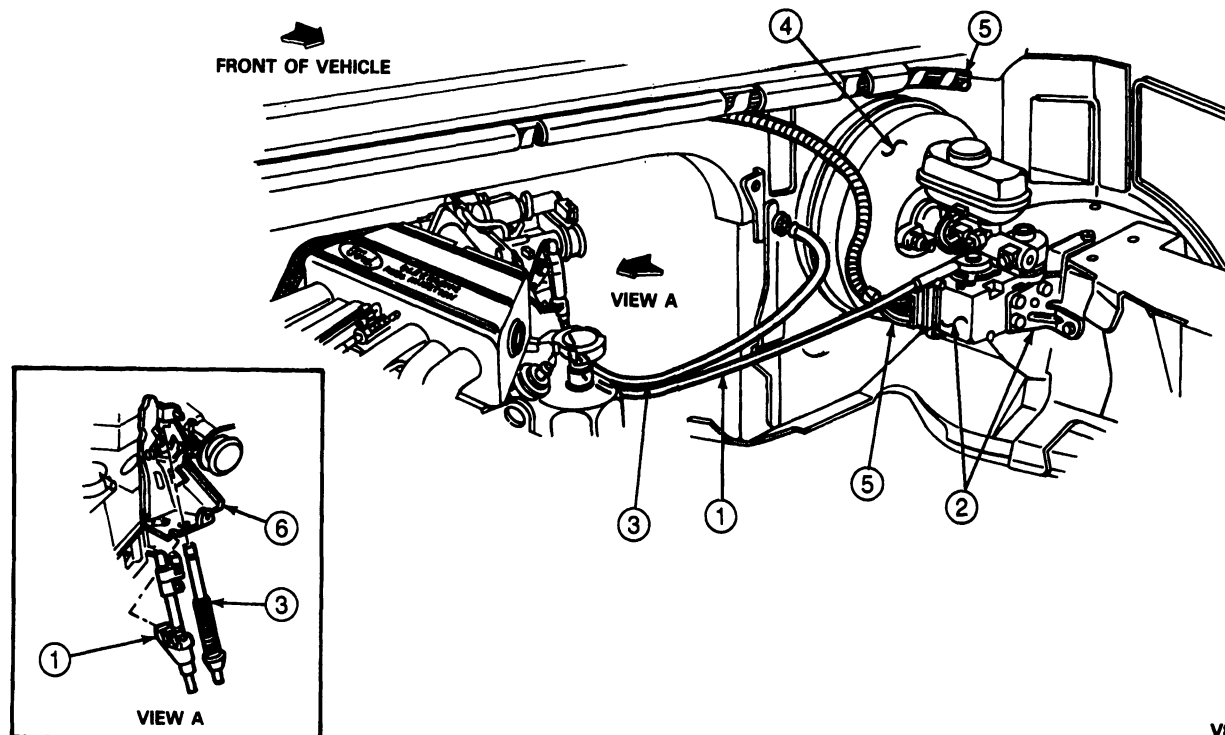
REMOVAL AND INSTALLATION (Continued)**Actuator Cable****Removal**

1. Remove actuator cable from servo assembly as described in this section.
2. Remove engine cover from inside of vehicle, if necessary, to reach throttle bracket (Econoline only).
3. Remove actuator cable from throttle bracket.

4. Remove actuator cable from accelerator cable.

Installation

1. Snap actuator cable onto accelerator cable.
2. Snap actuator cable to throttle cable bracket.
3. Attach actuator cable to servo assembly as described in servo assembly installation.
4. Adjust actuator cable as described in this section.

Speed Control Servo and Cable Installation, 4.9L MFI Engine

V8465-A

Item	Part Number	Description
1	9A825	Actuator Assembly
2	9C734	Servo and Bracket Assembly
3	—	Accelerator Cable Assembly

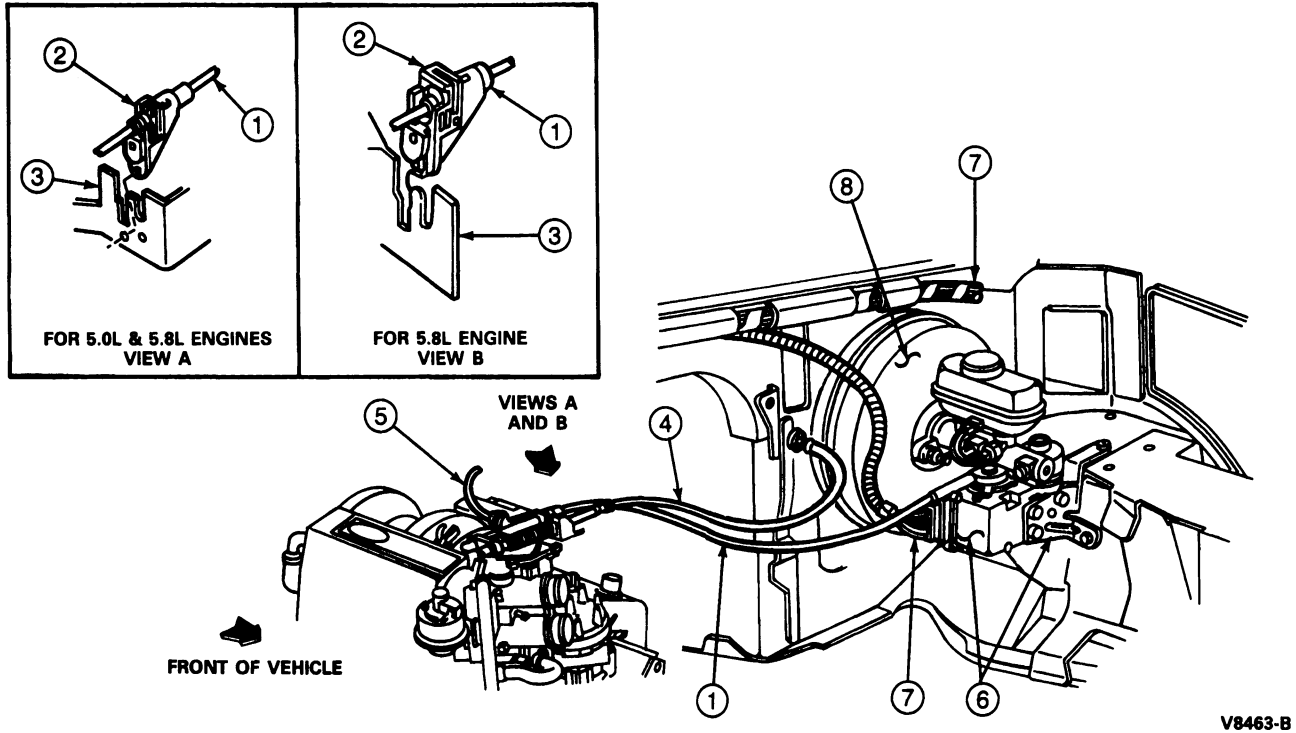
(Continued)

Item	Part Number	Description
4	—	Brake Cylinder Assembly
5	12A581	Wiring and Connector
6	—	Throttle Bracket Assembly

TV8465A

REMOVAL AND INSTALLATION (Continued)

Speed Control and Cable, Installation, 5.0L and 5.8L MFI Engines



Item	Part Number	Description
1	9A825	Actuator Assembly
2	9D726	Clip
3	—	Throttle Bracket Assembly
4	—	Accelerator Cable Assembly

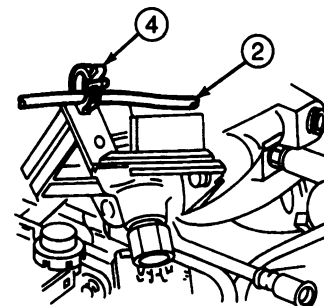
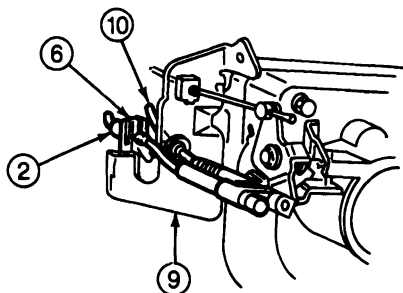
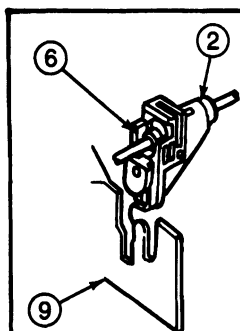
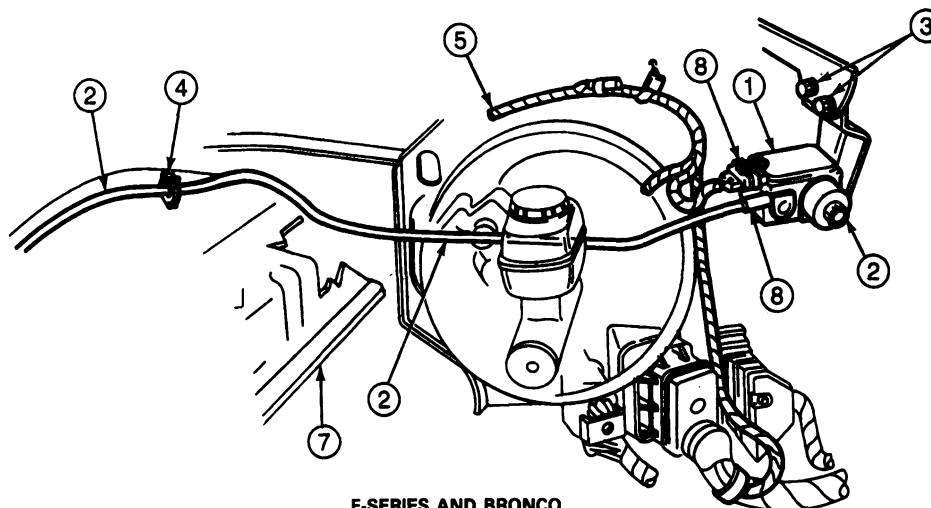
(Continued)

Item	Part Number	Description
5	—	Transmission Kick-Down Cable
6	9C734	Servo and Bracket Assembly
7	12A581	Wiring Assembly
8	—	Brake Cylinder

TV8463A

REMOVAL AND INSTALLATION (Continued)

Speed Control and Cable Assembly, Installation, 7.5L MFI Engine

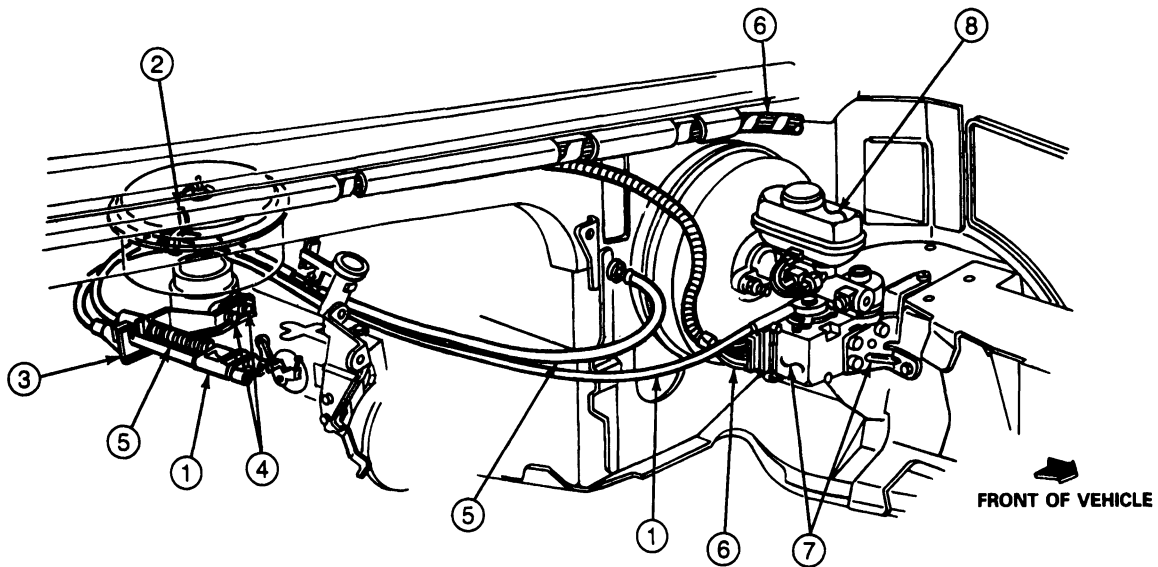


V9176-A

Item	Part Number	Description
1	9C735	Servo and Bracket Assembly
2	9A825	Actuator Assembly
3	N605786-S6	Bolt 15-18 N·m (12-13 Ft-Lb)
4	—	Clamp

(Continued)

Item	Part Number	Description
5	14401	Wiring Assembly
6	N804323-S	Clip
7	Ref.	Engine Assembly
8	Ref.	Connector, Wiring
9	Ref.	Cable, Actuator
10	Ref.	Cable, Throttle

REMOVAL AND INSTALLATION (Continued)**Speed Control Servo and Cable, Installation, 7.3L Diesel Engine**

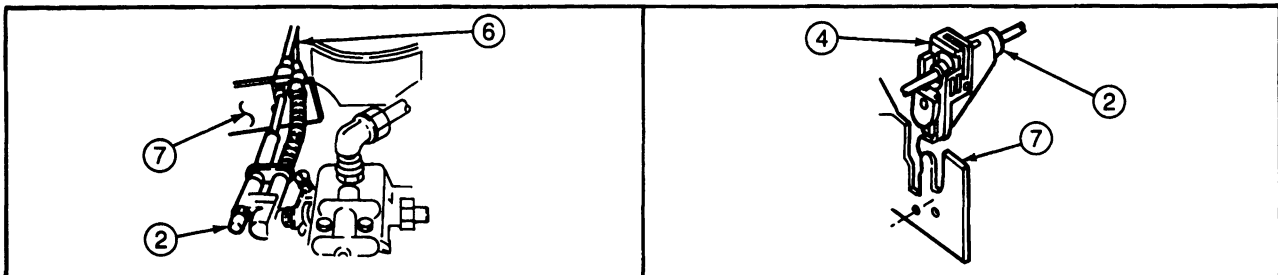
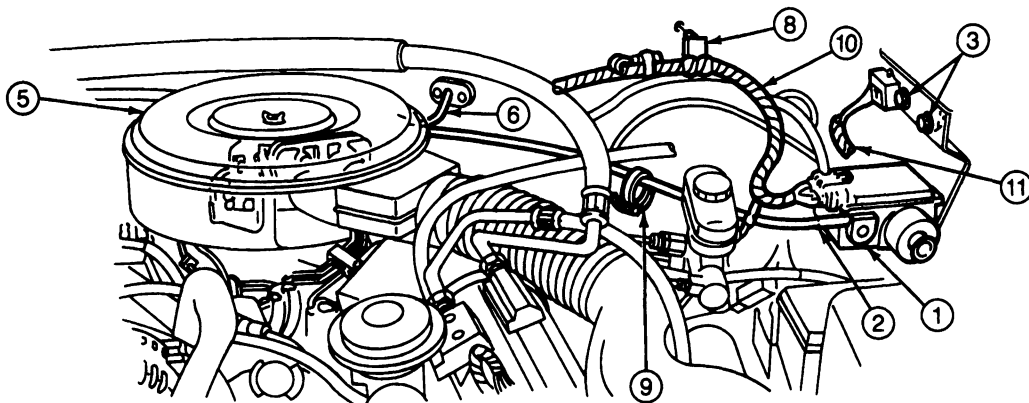
V8469-A

Item	Part Number	Description
1	9A825	Actuator Assembly
2	95874-S	Strap
3	—	Existing Bracket
4	—	Existing Screws

(Continued)

Item	Part Number	Description
5	—	Accelerator Cable Assembly
6	12A581	Wiring Assembly
7	9C734	Servo and Bracket Assembly
8	—	Brake Cylinder Assembly

TV8469A

Speed Control Servo and Cable Installation, 7.3L Diesel Engine, F-Series and Bronco

V9177-A

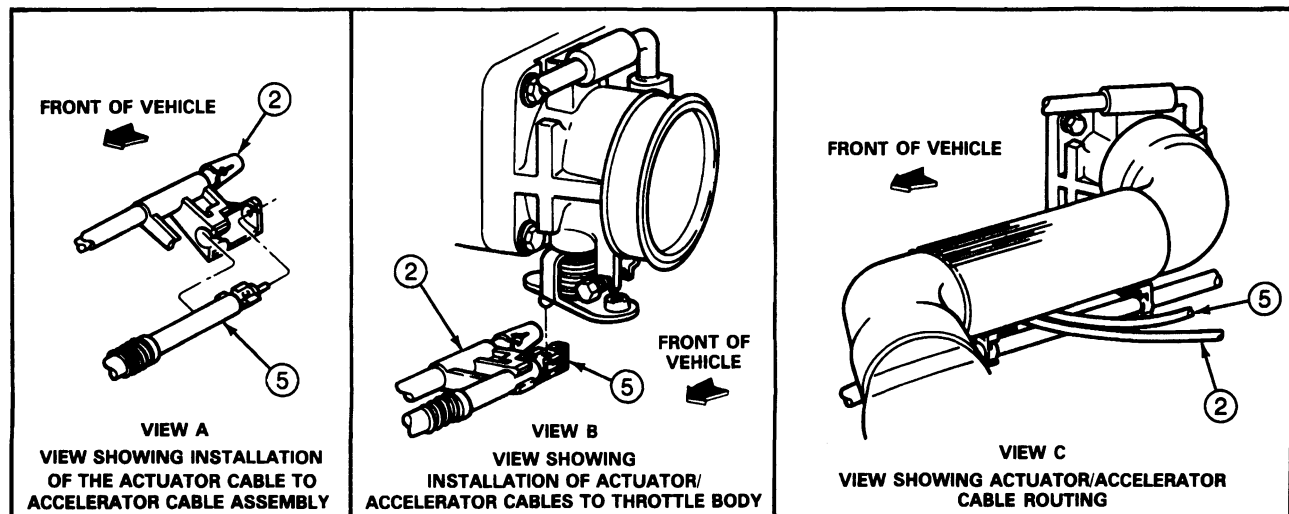
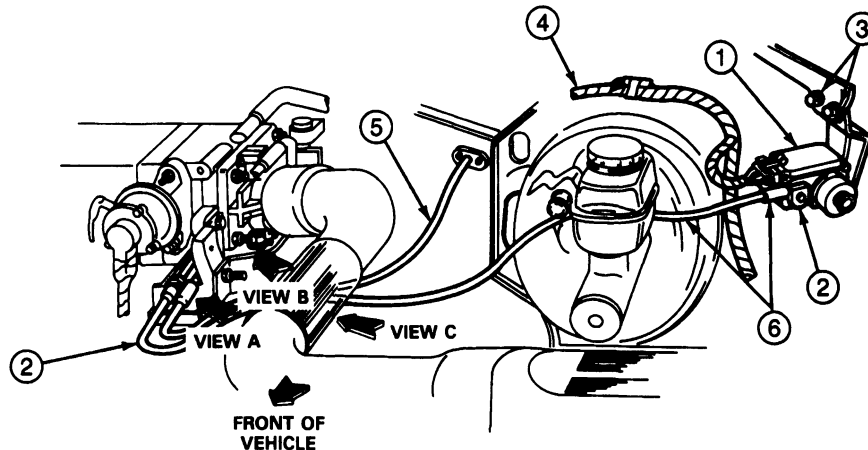
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9C734	Servo Assembly
2	9A825	Actuator Assembly
3	N608902-S2	Bolt 15-18 N·m (12-13 Ft-Lb)
4	9A825	Clip
5	Ref.	Air Cleaner Assembly

(Continued)

Item	Part Number	Description
6	9A758	Cable, Accelerator
7	9728	Bracket, Throttle
8	N804323-S	Clip
9	95B74	Strap
10	12A581	Wiring Assembly
11	12A	Wiring Assembly

Speed Control Servo and Cable, Lightning Truck



V9178-A

Item	Part Number	Description
1	9C734	Servo and Bracket Assembly
2	9A825	Actuator Assembly

(Continued)

Item	Part Number	Description
3	N608902-S2	Bolt 15-18 N·m (12-13 Ft-Lb)
4	Ref.	Wiring Assembly
5	Ref.	Cable, Throttle
6	Ref.	Cable, Actuator

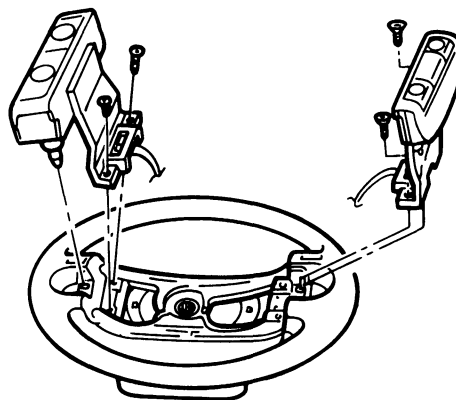
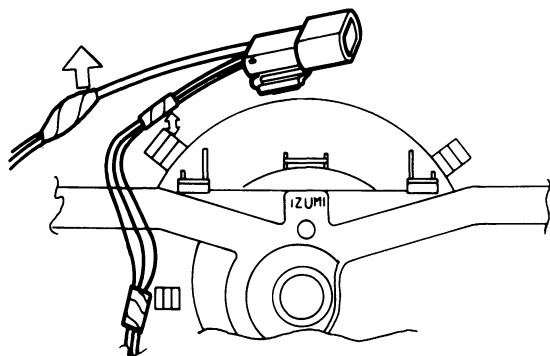
REMOVAL AND INSTALLATION (Continued)**Command Switches, Air Bag Steering Wheel****Removal**

1. Disconnect battery ground cable and air bag backup power supply. Refer to Section 11-04C.
WARNING: THE BACKUP POWER SUPPLY MUST BE DISCONNECTED BEFORE ANY AIR BAG COMPONENT IS SERVICED.
2. Remove four nut and washer assemblies retaining air bag module to steering wheel and lift module away from steering wheel.
3. Disconnect air bag electrical connector from clockspring contact connector.

4. Remove air bag module from steering wheel.

WARNING: PLACE AIR BAG MODULE ON BENCH WITH TRIM COVER FACING UP.

5. Disconnect horn / speed control blackwire harness connector at clockspring contact connector located in upper center of steering wheel.
6. Remove two retaining screws from base of each speed control switch.
7. Remove electrical tape from wire connectors located at each upper clip in steering wheel.
8. Disconnect speed control switch wires from untaped wire connectors and remove switches.

Command Switches Air Bag Steering Wheel, Removal

V8704-B

Installation

1. Position speed control switches onto steering wheel and install retaining screws.
2. Connect wiring harness to horn button wires at each upper connector and wrap each upper connector with electrical tape. Reinstall all horn / speed control wires in steering wheel clips.
3. Connect speed control / horn black wire harness connector to clockspring contact connector. Make sure wires are positioned so that no interference is encountered when installing air bag module.
4. Position air bag module on steering wheel so that clockspring contact connector can be connected to the air bag module.
5. Install air bag module on steering wheel and install four nut and washer assemblies. Tighten to 4-5.6 N·m (35-50 in-lb).

6. Connect air bag backup power supply and battery ground cable.

NOTE: On vehicles equipped with EEC, when the battery is disconnected and reconnected, some abnormal drive symptoms may occur while the Powertrain Control Module (PCM) relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

**Control Switches, Non-Air Bag Steering Wheel
Removal and Installation**

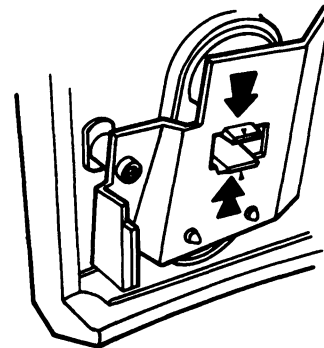
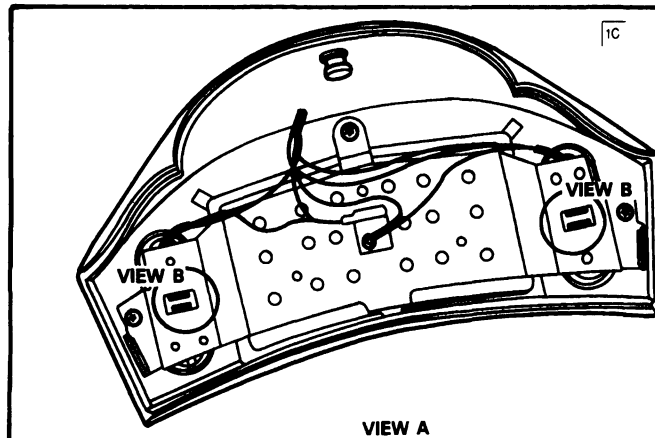
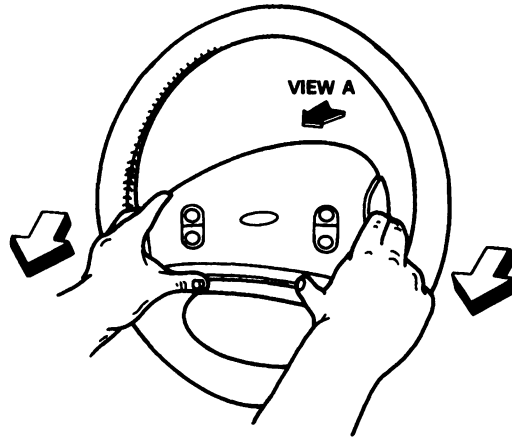
1. Unsnap the horn cover from the steering wheel by grasping the sides of the horn cover and pulling toward yourself.
2. Disconnect the horn / speed control wire harness and remove the horn cover from the steering wheel.

REMOVAL AND INSTALLATION (Continued)

3. Remove the three screws attaching the horn lower contact plate to the back side of the horn cover.

4. Remove the speed control switches from the lower contact plate by squeezing the switch retaining tabs.

For installation, follow removal procedures in reverse order. Tighten the two lower contact plate attaching screws to 2.0-2.3 N·m (18-20 in-lb).

Control Switches, Non-Air Bag Steering Wheel

VIEW IN CIRCLE B

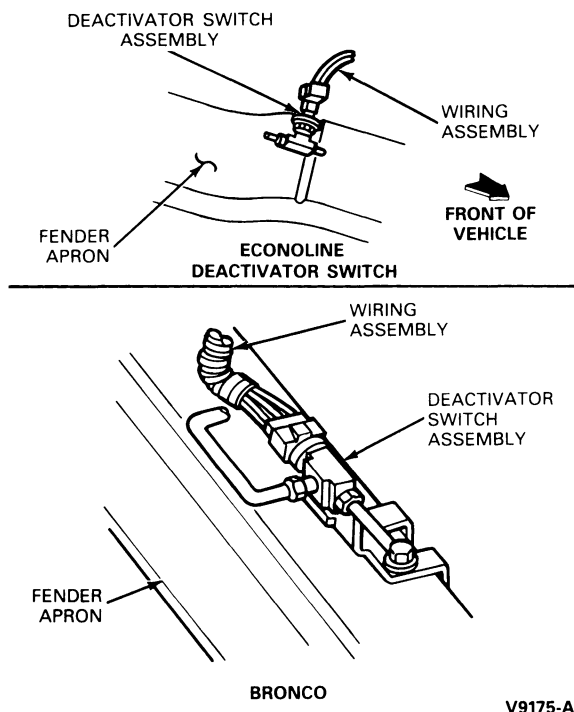
V8705-A

Deactivator Switch**Removal and Installation**

1. Disconnect deactivator switch connector. Deactivator switch is located inside front frame rail by left front door, Econoline, and top of frame rail under brake master cylinder, F-Series and Bronco.

2. Unscrew switch and remove.

For installation, follow removal procedures in reverse order. Tighten switch to 15-20 N·m (12-14 ft-lb) and bleed brake lines as described in Section 06-09.

REMOVAL AND INSTALLATION (Continued)**Deactivator Switch**

2. Set throttle plate to closed position.
3. Pull on the actuator cable to take up any slack. Back off at least one notch so that there is 1mm (.040 inch) of slack in the cable. The cable must not be pulled tight for proper operation.
4. While holding the cable, insert the retaining clip and snap securely.

SPECIFICATIONS**TORQUE SPECIFICATIONS**

Description	N·m	Lb·Ft
Servo Bracket Screws	10-13	62-88 (In·Lb)
Servo Bracket Bolt	15-18	12-13
Deactivator Switch	15-20	12-14
Air Bag Module Nuts	4.0-5.6	36-49 (In·Lb)

SPECIAL SERVICE TOOLS/EQUIPMENT**ROTUNDA EQUIPMENT**

Tool Number	Description
014-00407	Digital Volt Ohmmeter

ADJUSTMENTS**Actuator Cable**

1. Remove cable retaining clip from actuator cable at throttle bracket.

Index/ Important Information

METRICS

**J1930 TERMINOLOGY
LIST**

GLOSSARY

ALPHABETICAL INDEX

**WE WANT TO HEAR
FROM YOU**

INTRODUCTION

Most threaded fasteners are covered by specifications that define required mechanical properties, such as tensile strength, yield strength, proof load and hardness. These specifications are carefully considered in initial selection of fasteners for a given application. To assure continued satisfactory vehicle performance, replacement fasteners used should be of the correct strength, as well as the correct nominal diameter, thread pitch, length, and finish.

Most original equipment fasteners (English system or Metric) are identified with markings or numbers indicating the strength of the fastener. These markings are described in the pages that follow. Attention to these markings is important in assuring that the proper replacement fasteners are used.

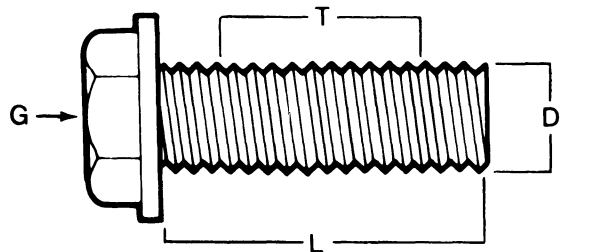
Further, some metric fasteners, especially nuts, are colored blue. This metric blue identification is in most cases a temporary aid for production start-up, and color will generally revert to normal black or bright after start-up.

English system and metric system fasteners are available through your Ford Parts and Service operation.

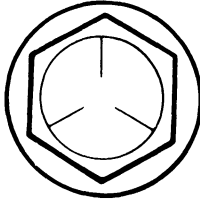
NOMENCLATURE FOR BOLTS

(ENGLISH) INCH SYSTEM

Bolt, 1/2-13x1

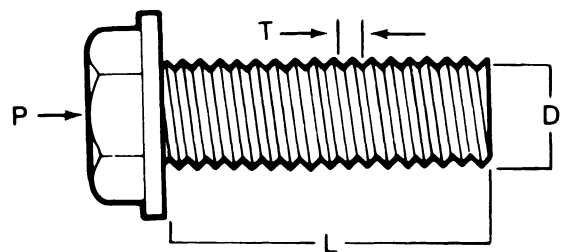


G—Grade Marking
(bolt strength)
L— Length, (inches)**
T— Thread Pitch
(thread/inch)
D—Nominal Diameter
(inches)

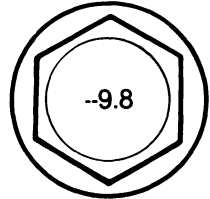


METRIC SYSTEM

Bolt M12-1.75x25



P— Property Class*
(bolt strength)
L— Length (millimeters)**
T— Thread Pitch (thread width
crest to crest mm)
D—Nominal Diameter
(millimeters)



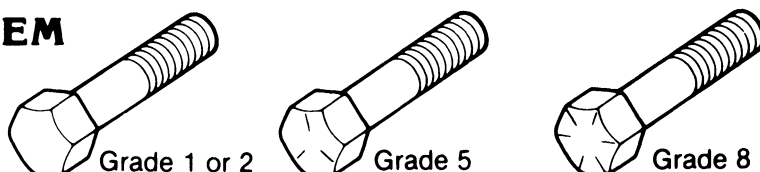
*The property class is an Arabic numeral distinguishable from the slash SAE English grade system.

**The length of all bolts is measured from the underside of the head to the end.

Metrics

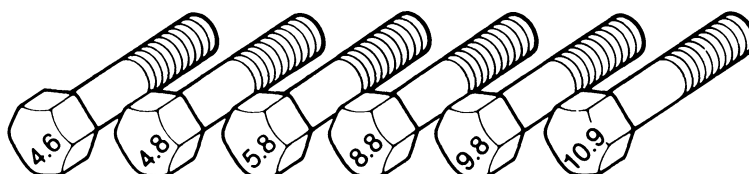
BOLT STRENGTH IDENTIFICATION

(ENGLISH) INCH SYSTEM



English (Inch) bolts—Identification marks correspond to bolt strength—increasing number of slashes represent increasing strength.

METRIC SYSTEM



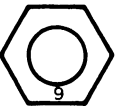
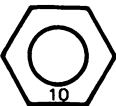


Metric bolts—Identification class numbers correspond to bolt strength—increasing numbers represent increasing strength. Common metric fastener bolt strength property are 9.8 and 10.9 with the class identification embossed on the bolt head.

HEX NUT STRENGTH IDENTIFICATION

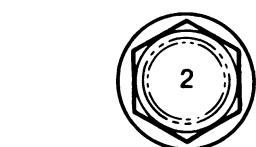
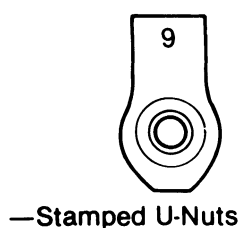
(ENGLISH) INCH SYSTEM

METRIC SYSTEM

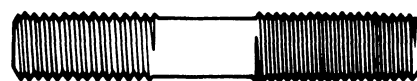
Grade	Hex Nut Grade 5	Hex Nut Grade 8	Class	Hex Nut Property Class 9	Hex Nut Property Class 10
Identification			Identification		
	3 Dots	6 Dots		Arabic 9	Arabic 10
Increasing dots represent increasing strength.			May also have blue finish or paint daub on hex flat. Increasing numbers represent increasing strength.		

OTHER TYPES OF PARTS

Metric identification schemes vary by type of part, most often a variation of that used of bolts and nuts. Note that many types of English and metric fasteners carry no special identification if they are otherwise unique.



—Tapping, thread forming and certain other case hardened screws



CLASS
10.9



CLASS
9.8



CLASS
8.8

—Studs, Large studs may carry the property class number. Smaller studs use a geometric code on the end.

Metrics

ENGLISH METRIC CONVERSION

Description	Multiply	By	For Metric Equivalent
ACCELERATION	Foot/sec ²	0.3048	metre/sec ² (m/s ²)
	Inch/sec ²	0.0254	metre/sec ²
TORQUE	Pound-inch	0.11298	newton-metres (N·m)
	Pound-foot	1.3558	newton-metres
POWER	horsepower	0.746	kilowatts (kw)
PRESSURE or STRESS	inches of water	0.2491	kilopascals (kPa)
	pounds/sq. in.	6.895	kilopascals (kPa)
	pounds/sq. in.	0.069	bar
ENERGY or WORK	BTU	1055.	joules (J)
	foot-pound	1.3558	joules (J)
	kilowatt-hour	3,600,000. or 3.6 x 10 ⁶	joules (J = one W's)
LIGHT	foot candle	10.764	lumens/metre ² (lm/m ²)
FUEL PERFORMANCE	miles/gal	0.4251	kilometres/litre (km/l)
	gal/mile	2.3527	litres/kilometre (l/km)
VELOCITY	miles/hour	1.6093	kilometres/hr. (km/h)
LENGTH	inch	25.4	millimetres (mm)
	foot	0.3048	metres (m)
	yard	0.9144	metres (m)
	mile	1.609	kilometres (km)
AREA	inch ²	645.2	millimetres ² (mm ²)
		6.45	centimetres ² (cm ²)
	foot ²	0.0929	metres ² (m ²)
VOLUME	yard ²	0.8361	metres ²
	inch ³	16,387.	mm ³
		16.387	cm ³
		0.0164	litres(1)
	quart	0.9464	litres
	gallon	3.7854	litres
	yard ³	0.7646	metres ³ (m ³)
MASS	pound	0.4536	kilograms (kg)
	ton	907.18	kilogram (kg)
	ton	0.90718	tonne (t)
FORCE	kilogram	9.807	newtons (N)
	ounce	0.278	newtons
	pound	4.448	newtons
TEMPERATURE	degree fahrenheit	(°F – 32) 0.556	degree Celsius (°C)

Metrics

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal Inch	Metric mm
1/64	.015625	.397
1/32	.03125	.794
3/64	.046875	1.191
1/16	.0625	1.588
5/64	.078125	1.984
3/32	.09375	2.381
7/64	.109375	2.778
1/8	.125	3.175
9/64	.140625	3.572
5/32	.15625	3.969
11/64	.171875	4.366
3/16	.1875	4.763
13/64	.203125	5.159
7/32	.21875	5.556
15/64	.234375	5.953
1/4	.250	6.35
17/64	.265625	6.747
9/32	.28125	7.144
19/64	.296875	7.54
5/16	.3125	7.938
21/64	.328125	8.334
11/32	.34375	8.731
23/64	.359375	9.128
3/8	.375	9.525
25/64	.390625	9.922
13/32	.40625	10.319
27/64	.421875	10.716
7/16	.4375	11.113
29/64	.453125	11.509
15/32	.46875	11.906
31/64	.484375	12.303
1/2	.500	12.7

Fractions	Decimal Inch	Metric mm
33/64	.515625	13.097
17/32	.53125	13.494
35/64	.546875	13.891
9/16	.5625	14.288
37/64	.578125	14.684
19/32	.59375	15.081
39/64	.609375	15.478
5/8	.625	15.875
41/64	.640625	16.272
21/32	.65625	16.669
43/64	.671875	17.066
11/16	.6875	17.463
45/64	.703125	17.859
23/32	.71875	18.256
47/64	.734375	18.653
3/4	.750	19.05
49/64	.765625	19.447
25/32	.78125	19.844
51/64	.796875	20.241
13/16	.8125	20.638
53/64	.828125	21.034
27/32	.84375	21.431
55/64	.859375	21.828
7/8	.875	22.225
57/64	.890625	22.622
29/32	.90625	23.019
59/64	.921875	23.416
15/16	.9375	23.813
61/64	.953125	24.209
31/32	.96875	24.606
63/64	.984375	25.003
1	1.00	25.4

Metrics

TORQUE CONVERSION

NEWTON METRES (N·m)	POUND-FEET (LB·FT)
1	0.7376
2	1.5
3	2.2
4	3.0
5	3.7
6	4.4
7	5.2
8	5.9
9	6.6
10	7.4
15	11.1
20	14.8
25	18.4
30	22.1
35	25.8
40	29.5
50	36.9
60	44.3
70	51.6
80	59.0
90	66.4
100	73.8
110	81.1
120	88.5
130	95.9
140	103.3
150	110.6
160	118.0
170	125.4
180	132.8
190	140.1
200	147.5
225	166.0
250	184.4

POUND-FEET (LB·FT)	NEWTON METRES (N·m)
1	1.356
2	2.7
3	4.0
4	5.4
5	6.8
6	8.1
7	9.5
8	10.8
9	12.2
10	13.6
15	20.3
20	27.1
25	33.9
30	40.7
35	47.5
40	54.2
45	61.0
50	67.8
55	74.6
60	81.4
65	88.1
70	94.9
75	101.7
80	108.5
90	122.0
100	135.6
110	149.1
120	162.7
130	176.3
140	189.8
150	203.4
160	216.9
170	230.5
180	244.0

J1930 Terminology List

NOTE: Certain Ford component names have been changed in this Service Manual to conform to Society of Automotive Engineers (SAE) directive J1930.

SAE J1930 standardizes automotive component names for all vehicle manufacturers.

This chart lists new 1993 SAE J1930 component names and the obsolete 1992 component names.

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
4X4 Low	4X4L	– 4X4L – 4X4 Low
Air Conditioning	A/C	– A/C – Air Conditioning
Air Conditioning Clutch	ACC	– ACC – Air Conditioning Clutch
Air Conditioning Cyclic Switch	ACCS	– ACCS – Air Conditioning Cyclic Switch
Air Conditioning Demand	ACD	– ACD – Air Conditioning Demand
Air Conditioning On	ACON	– ACON – Air Conditioning On
Automatic Ride Control	ARC	– ACL – Acceleration Signal
Barometric Pressure	BARO	– BP – Barometric Pressure
Battery Positive Voltage	B+	– BATT+ – Battery Positive
Blower	BLR	– BLR – Blower
Brake On/Off	BOO	– BOO – Brake On/Off
Bypass Air	BPA	– BPA – Bypass Air
Canister Purge	CANP	– CANP – Canister Purge
Charge Air Cooler	CAC	– Intercooler
Clutch Pedal Position switch	CPP switch	– CES – CIS – Clutch Engage Switch – Clutch Interlock Switch
Coast Clutch Solenoid	CCS	– CCS – Coast Clutch Solenoid
Computer Control Dwell	CCD	– CCD – Computer Control Dwell
Constant Control Relay Module	CCRM	– IRCM – Integrated Relay Control Module
Crankshaft Position sensor	CKP sensor	– CPS – VRS – Variable Reluctance Sensor

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Cylinder Identification	CID	– CID – Cylinder Identification
Data Link Connector	DLC	– Self-Test connector
Data Negative	DATA-	– DATA- – Data Negative
Data Output Line	DOL	– DOL – Data Output Line
Data Positive	DATA+	– DATA+ – Data Positive
Daytime Running Lamps	DRL	– DRL – Daytime Running Lamps
Defroster	DEF	– DEF – Defroster
Diagnostic Test Mode	DTM	– Self-Test mode
Diagnostic Trouble Code	DTC	– Self-Test code
Differential Pressure Feedback EGR	DPFE	– DPFE – Differential Pressure Feedback EGR
Distributor Ignition	DI	– CBD – DS – TFI – Closed Bowl Distributor – Duraspark Ignition – Thick Film Ignition
Dual Overhead Cam	DOHC	– DOHC – Dual Overhead Cam
Dual Plug Inhibit	DPI	– DPI – Dual Plug Inhibit
EGR Pressure Transducer	EPT	– EPT – EGR Pressure Transducer
EGR Temperature	EGRT	– EGRT – EGR Temperature
EGR Vacuum Regulator	EVR	– EVR – EGR Vacuum Regulator
EGR Valve Position	EVP	– EVP – EGR Valve Position
Electronic Air Pump	EAP	– EAP – Electronic Air Pump
Electronic Engine Control	EEC	– EEC – Electronic Engine Control
Electronic Ignition	EI	– DIS – EDIS – Distributorless Ignition System – Electronic Distributorless Ignition System
Electronic Pressure Control	EPC	– EPC – Electronic Pressure Control
Electronic Secondary Air Injection	EAIR	– EAM – Electronic Air Management

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Engine Coolant Temperature	ECT	– ECT – Engine Coolant Temperature
Engine RPM sensor	RPM sensor	– RPMS – Engine RPM sensor
Exhaust Gas Recirculation	EGR	– EGR – Exhaust Gas Recirculation
Fan Control	FC	– EDF – Electro-Drive Fan
Flexible Fuel sensor	FF sensor	– FCS – FFS – FFV – Fuel Compensation Sensor – Flex Fuel Sensor
Flexible Fuel vehicle	FF vehicle	– FFV – Flexible Fuel Vehicle
Fuel Pressure Regulator Control	FPRC	– FPRC – Fuel Pressure Regulator Control
Fuel Pump	FP	– FP – Fuel Pump
Fuel Pump Monitor	FPM	– FPM – Fuel Pump Monitor
Governor Control Module	GCM	– GEM – Governor Electronic Module
Ground	GND	– GND – Ground
Headlamp	HDL	– HDL – Headlamp
Heated Oxygen Sensor	HO2S	– HEGO – Heated Exhaust Gas Oxygen Sensor
High Fan Control	HFC	– HEDF – High Speed Electro-Drive Fan
High Fuel Pump	HFP	– HFP – High Fuel Pump
High Output	HO	– HO – High Output
High Swirl Combustion	HSC	– HSC – High Swirl Combustion
Idle Air Control	IAC	– ISC – Idle Speed Control
Idle Air Control Bypass Air	IAC BPA	– ISC-BPA – Idle Speed Control — Bypass Air
Ignition Control Module	ICM	– DIS module – EDIS module – TFI module
Ignition Diagnostic Monitor	IDM	– IDM – Ignition Diagnostic Monitor
Inertia Fuel Shutoff switch	IFS switch	– Inertia Switch

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Intake Air Temperature	IAT	– ACT – Air Charge Temperature
Intake Manifold Runner Control	IMRC	– IAC – Inlet Air Control
Keep Alive Memory	KAM	– KAM – Keep Alive Memory
Keep Alive Power	KAPWR	– KAPWR – Keep Alive Power
Knock Sensor	KS	– KS – Knock Sensor
Low Fan Control	LFC	– EDF – Electro-Drive Fan
Low Fuel Pump	LFP	– LFP – Low Fuel Pump
Malfunction Indicator Lamp	MIL	– CEL – “CHECK ENGINE” Light – “SERVICE ENGINE SOON” Light
Manifold Absolute Pressure	MAP	– MAP – Manifold Absolute Pressure
Manifold Absolute Pressure Per Altitude	MAPPA	– GMAPPA – Governor Manifold Absolute Pressure Per Altitude
Manual Lever Position	MLP	– MLP – Manual Lever Position
Mass Air Flow	MAF	– MAF – Mass Air Flow
Mass Air Flow Return	MAF RTN	– MAF RTN – Mass Air Flow Return
Multiport Fuel Injection	MFI	– EFI – Electronic Fuel Injection
Octane Adjust	OCT ADJ	– OCT ADJ – Octane Adjust
Overhead Cam	OHC	– OHC – Overhead Cam
Oxidation Catalytic Converter	OC	– COC – Conventional Oxidation Catalyst
Park/Neutral Position switch	PNP switch	– NDS – NGS – TSN – Neutral Drive Switch – Neutral Gear Switch – Transmission Select Switch Neutral
Positive Crankcase Ventilation	PCV	– PCV – Positive Crankcase Ventilation
Power Ground	PWR GND	– PWR GND – Power Ground

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Power Steering Pressure switch	PSP switch	<ul style="list-style-type: none"> – PSPS – Power Steering Pressure Switch
Powertrain Control Module	PCM	<ul style="list-style-type: none"> – ECA – ECM – ECU – EEC processor – Engine Control Assembly – Engine Control Module – Engine Control Unit
Pressure Feedback EGR	PFE	<ul style="list-style-type: none"> – EPT – Exhaust Pressure Transducer
Profile Ignition Pickup	PIP	<ul style="list-style-type: none"> – PIP – Profile Ignition Pickup
Programmable Speedometer/Odometer Module	PSOM	<ul style="list-style-type: none"> – PSOM – Programmable Speedometer/Odometer Module
Pulsed Secondary Air Injection	PAIR	<ul style="list-style-type: none"> – MPA – PA – Thermactor II – Managed Pulse Air – Pulse Air
Reduction Oxidation Catalytic Converter	REDOX	<ul style="list-style-type: none"> – REDOX – Reduction Oxidation Catalytic Converter
Scan Tool	ST	<ul style="list-style-type: none"> – GST – NGS – Generic Scan Tool – New Generation STAR Tester
Secondary Air Injection	AIR	<ul style="list-style-type: none"> – AM – CT – MTA – Air Management – Conventional Thermactor – Managed Thermactor Air – Thermactor
Secondary Air Injection Bypass	AIRB	<ul style="list-style-type: none"> – AM1 – TAB – Air Management 1 – Thermactor Air Bypass
Secondary Air Injection Diverter	AIRD	<ul style="list-style-type: none"> – AM2 – TAD – Air Management 2 – Thermactor Air Diverter
Self-Test Input	STI	<ul style="list-style-type: none"> – STI – Self-Test Input
Self-Test Output	STO	<ul style="list-style-type: none"> – STO – Self-Test Output
Sequential Multiport Fuel Injection	SFI	<ul style="list-style-type: none"> – SEFI – Sequential Electronic Fuel Injection

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Shift Indicator Lamp	SIL	– SIL – Shift Indicator Lamp
Shift Solenoid	SS	– SS – Shift Solenoid
Signal Return	SIG RTN	– SIG RTN – Signal Return
Solid State Relay	SSR	– SSR – Solid State Relay
Spark Output	SPOUT	– SAW – Spark Angle Word
Speed Density	SD	– SD – Speed Density
Super High Output	SHO	– SHO – Super High Output
Supercharger/Supercharged	SC	– SC – Supercharger/Supercharged
Tachometer	TACH	– TACH – Tachometer
Three Way Catalytic Converter	TWC	– TWC – Three Way Catalytic Converter
Three Way + Oxidation Catalytic Converter	TWC+OC	– TWC & COC – Three Way Catalyst and Conventional Oxidation Catalyst
Throttle Body	TB	– TB – Throttle Body
Throttle Body Injection	TBI	– CFI – Central Fuel Injection
Throttle Position	TP	– TP – Throttle Position
Throttle Position Output	TPOUT	– TPOUT – Throttle Position Output
Torque Converter Clutch	TCC	– CCC – CCO – MCCC – Converter Clutch Control – Converter Clutch Override – Modulated Converter Clutch Control
Torque Converter Clutch solenoid	TCC solenoid	– LUS – MLUS – Lock Up Solenoid – Modulated Lock Up Solenoid
Transmission Control Module	TCM	– 4EAT Module
Transmission Control Switch	TCS	– TCS – Transmission Control Switch

J1930 Terminology List

New Term	New Acronyms/ Abbreviations	Old Acronyms/ Term
Transmission Control Indicator Lamp	TCIL	– TCIL – Transmission Control Indicator Lamp
Transmission Oil Temperature	TOT	– TOT – Transmission Oil Temperature
Transmission Range Reverse	TRR	– TSR – Transmission Select Switch Reverse
Transmission Range Overdrive	TROD	– TSOD – Transmission Select Switch Overdrive
Transmission Range Drive	TRD	– TSD – Transmission Select Switch Drive
Transmission Range Low	TRL	– TSL – Transmission Select Switch Low
Transmission Speed Sensor	TSS	– TSS – Transmission Speed Sensor
Turbocharger/Turbocharged	TC	– TC – Turbocharger/Turbocharged
Variable Control Relay Module	VCRM	– VRCM – Variable Relay Control Module
Vehicle Power	VPWR	– VPWR – Vehicle Power
Vehicle Speed Sensor	VSS	– VSS – Vehicle Speed Sensor
Wide Open Throttle	WOT	– WOT – Wide Open Throttle

Glossary

The glossary is a list of technical terms or acronyms and their definitions. It is not intended to be a dictionary of components and their functions. If you desire a detailed description of a specific component, refer to the related Service Manual Group.

4EAT: 4-Speed Electronic Automatic Transaxle.

4X4L: 4X4 Low input switch.

A4LD: Automatic 4-Speed Lock-up – converter Drive.

ACC: A/C Clutch Compressor signal input to the EEC-IV processor relating status of the A/C clutch.

ACCS: A/C Cycling Switch.

ACD: Air Conditioner Demand switch.

ACL: Automatic Adjustable Shock Controller.

A/C: Air Conditioning.

A/C DV: Air Cleaner Duct and Valve motor.

A/CL BIMET: Air Cleaner Bimetal sensor.

A/C P: A/C Pressure Cut-out switch.

ACV: (Thermactor) Air Control Valve.

AHFSS: Air Conditioning/Heater Function Select Switch input to the EEC-IV processor relating status of the A/C heater function select switch.

AIR (THERMACTOR): Secondary Air Injector. A system for injection of air into the exhaust system to aid in the control of hydrocarbon and carbon monoxides in the exhaust.

AIRB (AM1): Secondary Air Injector Bypass.

AIRB/AIRD (TAB/TAD): Secondary Air Injection Bypass/Diverter.

AIR BPV: (Thermactor) Air Bypass Valve.

AIRD (AM2): Secondary Air Injector Diverter.

AMBIENT TEMPERATURE: Temperature of air surrounding an object e.g., temperature where vehicle is being worked on.

ANTI-BFV: Anti-Backfire Valve.

AOD: Automatic Overdrive.

A/T: Automatic Transaxle.

ATDC: After Top Dead Center.

AVOM: Analog Volt-Ohm Meter.

AXOD: Automatic Transaxle Overdrive.

AXOD-E: Automatic Transaxle Overdrive, Electronically Controlled.

B+ (BATT+): Battery Positive Voltage.

BARO (BP): Barometric Pressure Sensor.

BASE IDLE: Idle RPM determined by throttle lever hardset on throttle body while Idle Speed Control is fully retracted and disconnected.

BATT: Battery.

BATT (-): Battery negative post or its circuit.

BOB: (Breakout Box) An EEC-IV test device which connects in series with the processor and the EEC-IV harness and permits measurements of processor inputs and outputs.

BOO: Brake On-Off input to the EEC-IV processor indicating a braking drive mode.

BPA: By-Pass Air Solenoid. Used to control idle speed on EFI and SEFI vehicles.

BREAKOUT BOX: A service tool that “tees” in-between the EEC-IV processor and the 60-pin harness connector. The breakout box contains 60 test pins that can be probed for EEC-IV testing.

BTDC: Before Top Dead Center.

BV: Bowl Vent (Carburetor Fuel Bowl).

BVT: Back Pressure Variable Transducer.

CANP: Canister Purge solenoid or its control circuit.

CARB (FBC): Carburetor.

Glossary

CATALYST: A muffler-like device in the exhaust system containing a monolithic substrate (a ceramic honeycomb structure) that is coated with catalytic metals such as platinum or palladium. When hot exhaust gases come in contact with these metals a chemical reaction takes place to consume unburned hydrocarbon, carbon monoxide and nitrous oxides.

CCD: Computer Controlled Dwell.

CCRM (IRCM): Constant Control Relay Module.

CFAN: Condenser Fan Relay.

CCS: Coast Clutch Solenoid or its control circuit.

CFI: Central Fuel Injection. A computer controlled fuel metering system which sprays atomized fuel into a throttle body mounted atop the intake manifold.

“CHECK ENGINE” OR “SERVICE ENGINE SOON” LAMP: A dash panel lamp used either to aid in the identification and diagnosis of EEC system problems or to indicate that maintenance is required on non-EEC equipped vehicles.

CID: Cylinder Identification sensor or its signal circuit.

CKP (VR or VRS): Crankshaft Position Sensor. A non-contact CKP transducer that converts mechanical motion into electrical control signals.

CKP (PIP): Crankshaft Position.

CLC: Converter Lock-up Clutch.

CLUTCH: Clutch engagement switch or its control circuit.

COMPUTED TIMING: The total spark advance in degrees before top dead center. Calculated by the EEC-IV processor based on input from a number of sensors.

CONTINUOUS SELF-TEST: A continuous test of the EEC-IV system conducted whenever the vehicle is in operation.

CPP (CES): Clutch Pedal Position.

CSE GND: Case Ground (EEC-IV processor case).

CURB IDLE: Computer controlled idle rpm.

CWM: Cold Weather Modulator.

DCL: Data Communications Link.

DFI (FI): Direct Fuel Injection.

DFS: Decel Fuel Shut-off.

DI (CBD): Distributor Ignition.

DI (EDIS): Distributor Ignition.

DI (TFI): Distributor Ignition.

DLC: Data Link Connector.

DOL: Data Output Link. Fuel calculation data from the EEC-IV processor to the electronic tripminder.

DPDIS: Dual Plug Distributorless Ignition System.

DPH: Dual Plug Head.

DPI: Dual Plug Inhibit.

DSS: Down Shift Solenoid.

DV: Delay Valve.

DVOM: Digital Volt-Ohm Multimeter that displays voltage or resistance measurements in digital form on a Liquid Crystal Display (LCD).

DV TW: Delay Valve Two-Way.

EATC: Electronic Automatic Temperature Control.

E4OD: Electronic 4-Speed Overdrive transmission.

ECA: Electronic Control Assembly.

ECT: Engine Coolant Temperature sensor or its signal circuit.

ECTF: Cooling Fan Engine Coolant Temperature sensor.

EEC: Electronic Engine Control. A computer controlled system of engine control.

EEGR: Electronic EGR Valve (Sonic).

EGR: Exhaust Gas Recirculation system designed to allow the flow of inert exhaust gases into the combustion chamber to cool the combustion and thus reduce nitrous oxides in the exhaust.

Glossary

EGRC: EGR Control vacuum solenoid valve or its control circuit.

EGR S/O: EGR Shut-Off.

EGRT: EGR Temperature sensor.

EGRV: EGR Vent vacuum solenoid valve or its control circuit.

EHC: Exhaust Heat Control vacuum solenoid valve or its control circuit.

EI (DIS): Electronic Ignition.

ENGINE RUNNING SELF-TEST: A test of the EEC-IV system conducted with the engine running and the vehicle at rest.

EPC: Electronic Pressure Control (used in E4OD transmissions).

ER: Engine Running Self-Test (same as KOER).

ERS: Engine RPM Sensor or its signal circuit.

EVP: EGR Valve Position sensor or its signal circuit.

EVR: EGR Vacuum Regulator solenoid or its control circuit.

FC (EDF): Fan Control.

FCS: Fuel Control Solenoid or its control circuit.

FF (FCS): Flexible Fuel.

FIPL: Fuel Injection Pump Lever sensor or its signal circuit.

FLC: Fluid Lock-Up Converter.

FMEM: Failure Mode Effects Management. This alternative strategy protects vehicle function from adverse effects of an EEC component failure.

FP: Fuel Pump relay or its control circuit.

FPM: Fuel Pump Monitor. A circuit in the EEC system used to monitor the electric fuel pump operation on some EEC-IV equipped vehicles.

FTO: Filtered Tach Output. An output from the DIS TFI-IV module which provides a filtered ignition signal to the processor in order to control dwell.

FUEL RICH/LEAN: A qualitative evaluation of air/fuel ratio based on an A/F value known as stoichiometry or 14.7. In the EEC-IV system rich/lean is determined by a voltage signal from the EGO sensor. An excess of oxygen (lean) is an EGO voltage of less than 0.4 volts, a rich condition is indicated by an EGO voltage of greater than 0.6 volts.

FWD: Front Wheel Drive.

GND or GRND: A common ground circuit for all vehicle power.

GOOSE: A brief opening and closing of the throttle.

HALL EFFECT: A process where current is passed through a small slice of semi-conductor material at the same time as a magnetic field to produce a small voltage in the semi-conductor.

HBV: Heater Blower Voltage input to the EEC-IV processor reflecting heater blower voltage demand.

HFC (HEDF): Fan Control.

HIC: Hot Idle Compensator.

HLOS: Hardware Limited Operation Strategy. Certain types of computer malfunctions will place the EEC-IV processor into HLOS mode. Output commands are replaced with fixed values.

HO: High Output.

HO2S (HEGO): Heated Oxygen Sensor.

HSC: High Swirl Combustion.

IAS: Inlet Air Solenoid valve or its control circuit.

IAT (ACT): Intake Air Temperature.

IAT (VAT): Intake Air Temperature.

IBP: Integral Back Pressure.

IDLE LIMITER: A device to control minimum and maximum idle fuel richness. The idle limiter is intended to prevent unauthorized persons from making overly rich idle adjustments.

Glossary

IDM: Ignition Diagnostics Monitor. A continuous monitor of the ignition input to the EEC-IV processor used to detect intermittent ignition faults.

IGN: Ignition circuit or system.

INJ: Injector (Fuel).

INJ GND: Injector Ground (Fuel).

ISC: Idle Speed Control. Currently there are two types of computer controlled idle speed controls: DC motor ISC and air bypass ISC.

ITR: In-Tank Reservoir.

ITS: Idle Tracking Switch. Used on CFI vehicles to inform EEC if the throttle is in contact with the DC motor.

KAM: Keep Alive Memory. A series of vehicle battery powered memory locations in the microprocessor which allows the microprocessor to store input failures identified during normal operation for use in later diagnostic routines and adapts some calibration parameters to compensate for changes in the vehicle system.

KAPWR: Keep Alive Power.

KEY ON ENGINE RUNNING SELF-TEST: A test of the EEC-IV system conducted with power applied and the engine at idle.

KOEO: Key On Engine Off Self-Test.

KOER: Key On Engine Running Self-Test (same as Engine Running (ER) Self-Test).

KS: Knock Sensor or its signal circuit.

L: Liters.

MA or MAF: Mass Air Flow sensor or its signal circuit.

MAP: Manifold Absolute Pressure sensor or its signal circuit.

MC (FBC): Mixture Control.

MC-VAF: Measuring Core Volume Air Flow Meter.

MECS: Mazda Equipped Control System.

MFI (EFI): Multiport Fuel Injection. A computer controlled fuel system that distributes atomized fuel through an injector located in each intake port of the engine. The fuel injectors are fired using bank-to-bank circuitry.

MIL: Malfunction Indicator Lamp. An electric circuit between the EEC-IV processor and the "CHECK ENGINE" or "SERVICE ENGINE SOON" lamp on the dash panel of EEC-equipped vehicles.

MLP: Manual Lever Position switch or its signal circuit.

MONITOR BOX: An optional EEC-IV test device which connects in series with the EEC-IV processor and its harness, and permits measurements in various units of processor inputs and outputs.

M/T: Manual Transaxle.

O2S (EGO): Oxygen Sensor.

OASIS: On-line Automobile Service Information System.

OBD (SELF-TEST): On-Board Diagnostic.

OCC: Output Circuit Check.

OC (COC): Oxidation Catalytic Converter.

OCIL: Overdrive Cancel Indicator Lamp.

OCS: Overdrive Cancel Switch.

OCT ADJ: Octane Adjust device which modifies spark advance.

OHC: Overhead Cam.

OPEN CIRCUIT: A circuit which does not provide a complete path for the flow of current.

OSC: Output State Check.

OVERLAY CARD: A plastic card used with the Monitor box to identify EEC-IV signals for each engine. The card also programs the monitor for auto mode measurements.

PAIR (THERMACTOR II): Pulsed Secondary Air Injection. See Pulse Air System.

Glossary

PCM (MCU): Powertrain Control Module.

PCV: Positive Crankcase Ventilation. A system which controls the flow of crankcase vapors into the engine intake manifold where they are burned in combustion rather than being discharged into the atmosphere.

PFE: Pressure Feedback EGR sensor or its signal circuit.

PNP (NDS): Park/Neutral Position Switch.

PNP (NGS): Neutral Gear Switch or its signal circuit.

PNP (NPS): Park/Neutral Position Switch.

PROCESSOR: EEC-IV Electronic Control Assembly.

PSG: Pulse Signal Generator.

PSP (PSPS): Power Steering Pressure switch.

PULSE AIR SYSTEM: Part of the emission control system that utilizes a reed-type check valve which allows air to be drawn into the exhaust system as a result of exhaust pulses.

PVS: Ported Vacuum Switch.

PWR GND: Power Ground.

QUICK TEST: A functional diagnostic test of the EEC system consisting of vehicle preparation and hookup. Key On Engine Off, Engine Running and Continuous Self-Tests.

RECORDER: An optional EEC-IV test device which works jointly with the Monitor box. It allows up to 8 EEC-IV signals to be electronically recorded over a 50 second period.

RELAY: A switching device operated by a low current circuit which controls the opening and closing of another circuit of higher current capacity.

RELIEF VALVE: Pressure limiting valve located in the exhaust chamber of the thermactor air pump. It functions to relieve part of the exhaust airflow if the pressure exceeds a calibrated value.

RWD: Rear Wheel Drive.

SC: Super Charged.

SCB (SBS): Supercharger Bypass.

SDV: Spark Delay Valve.

SFI (SEFI): Sequential Multiport Fuel Injection. A computer controlled fuel system that distributes atomized fuel through an injector located in each intake port of the engine. Each injector is fired separately and has individual circuits.

SHO: Super High Output.

SHORT CIRCUIT: An undesirable connection between a circuit and any other point.

SIG RTN: Signal Return circuit for all sensor signals except HEGO.

SIL: Shift Indicator Light. A system that provides a visual indication to the driver of a vehicle when to shift to the next higher gear to obtain optimum fuel economy.

SOLENOID: A wire coil with a moveable core that changes position by means of electro-magnetism when current flows through the coil.

SPOUT: Spark Output Signal from the EEC-IV processor.

SPOUT (SAW): Spark Output.

SS1: Shift Solenoid 1 or its control circuit.

SS2: Shift Solenoid 2 or its control circuit.

SS 3/4-4/3: Shift Solenoid 3/4-4/3. Output from the EEC-IV processor to the transmission that selects 3rd and 4th gears.

STAR: Self-Test Automatic Readout. A testing device in which the EEC and MCU systems output service codes in a digital format.

STI: Self-Test Input circuit in the EEC and MCU systems used to initiate Self-Test.

STO: Self-Test Output circuit in the EEC and MCU systems that transmits diagnostic trouble codes (pulses) to either a VOM or STAR tester.

TBI (EFI): Electronic Fuel Injection. A computer controlled system that distributes atomized fuel through an injector located in each intake port of the engine. The fuel injectors are fired using bank-to-bank circuitry.

Glossary

TCC (CCC): Torque Converter Clutch.

TCC (CCO): Torque Converter Clutch.

TCC (LUS): Torque Converter Clutch.

TCM: Transaxle Control Module.

TCP: Temperature Compensated (Acceleration) Pump.

TGS: Top Gear Switch. A lock out mechanism that prevents the SIL from lighting when the vehicle is in top gear.

THS: Transmission Hydraulic Switch. An input to the processor that indicates the occurrence of a shift between specific gears.

THS 3/2: Transmission Hydraulic Switch 3rd/2nd gear.

THS 4/3: Transmission Hydraulic Switch 4th/3rd gear.

TIMING: Relationship between spark plug firing and piston position usually expressed in crankshaft degrees before (BTDC) or after (ATDC) top dead center of the compression stroke.

TIV: Thermactor Idle Vacuum valve.

TK: Throttle Kicker vacuum solenoid valve or its control circuit.

TOT: Transmission Oil Temperature sensor or its signal circuit.

TP: Throttle Position sensor or its signal circuit.

TSP: Throttle Solenoid Positioner.

TTS: Transmission Temperature Switch.

TVV: Thermal Vent Valve.

TVV (TVS): Thermal Vacuum Valve.

TWC: Three Way Catalyst.

VAF: Vane Air Flow sensor or its signal circuit.

VBAT: Vehicle Battery voltage.

VCK-V: Vacuum Check Valve.

VCV: Vacuum Control Valve.

VDV: Vacuum Delay Valve.

VM: Vane Meter.

VOM: Volt-Ohm Meter used to measure voltage and resistance. Readings are indicated by sweep hand on a printed scale rather than a digital display.

VOTM: Vacuum Operated Throttle Modulator.

VPWR: Vehicle Power supply voltage regulated to 10-14 volts.

VR/S: Vacuum Regulator/Solenoid.

VRDV: Vacuum Retard Delay Valve.

VREF: Reference voltage supplied by the EEC-IV processor to some sensors and regulated to 4-6 volts.

VRESER: Vacuum Reservoir.

VREST: Vacuum Restrictor.

VRIS: Variable Resonance Induction System.

VRV: Vacuum Regulator Valve.

VSC: Vehicle Speed Control sensor or its signal circuit.

VSS: Vehicle Speed Sensor or its signal circuit.

VVA: Venturi Vacuum Amplifier.

VVC: Variable Voltage Choke relay or its control circuit.

VVV: Vacuum Vent Valve.

WAC: Wide-open throttle A/C Cutoff.

WOT: Wide-Open Throttle.

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